



IN FACULTY OF ENGINEERING

Proceedings of 19th FEA Research Symposium iGent Tower, February 19, 2019

#FEARS2019

Contents

Main Sponsors	4
Sponsors	7
Preface	8
Organizing Committee	9
Posters	10
How will AI shape our future	158

Main Sponsors

MAIN SPONSORS









DOCTORAL SCHOOLS

GHENT UNIVERSITY

IN FACULTY OF ENGINEERING

Sponsors

SPONSORS





Preface

Foreword by the Editor

The 19th Faculty of Engineering and Architecture Research Symposium (FEARS) took place in the iGent Tower at Tech Lane Science Park Ghent on the 19th of February 2019. Over the years FEARS has been a staple event in the faculty where researchers present their work yet broader their horizon as well with panels, keynotes and workshops.

More than 70 posters were presented at the event by researchers of the faculty. Junior PhD researchers got their feet wet by presenting their first research result in a poster or pitch or Senior PhD researchers summarized their years of labor in the same manner. The posters accompanied by their abstracts are found in this booklet, sorted by the last name of the first author. Two poster awards were granted. The first winner was chosen by a jury of 7 professors of our faculty and given to Arne De Keyser (poster 16). A second one was chosen by EOS magazine, the largest popular-scientific magazine of the BeNeLux, and given to Jana Becelaere (poster 5).

Some researchers took on the challenge to briefly present their work in a two-round pitch contest. First, 13 of them presented their work in a mere 3 minutes. The audience selected the best 5 pitch presentations for the final. Here, the remaining 5 presented for 10 minutes and finally a jury consisting of industry partners chose Thibaut Vanzwijnsvoorde as the best presenter.

Besides presenting their research, researchers were made more aware of their role in and impact on society with a panel and keynote on this subject. The panel moderated by Dr. Hetty Helsmoortel, was held on the topic of *The impact of our research on society*, together with 5 panel members Prof. An Verberckmoes, Dr. Wim Audenaert, Prof. Jeroen De Wulf, Johan Bil and Esther De Smet. The audience was inspired by Hetty and the panel members to be the architect of their future by letting their research matter. Marc Lambotte, CEO of Agoria, gave his views on the sense and nonsense research during his keynote. We learned that the only real commodity Belgium has is our brains.

The FEARS event would have not been a success without the researchers, as these form the base of the event. I am grateful to the industry partners who sponsored the event, as without a budget, no event can be organized. And finally I want to thank the whole organizing committee, consisting of mainly PhD students, for their individual efforts in making the 19th edition of FEARS a resounding success. I hope to see all of you back at FEARS 2020.

Kevin Dekemele, Editor Book of Abstract Head of Organizing Committee

Organizing Committee

Alexandra Bouriakova, Materials, Textiles & Chemical Engineering • Andries Daem, Electrical Energy, Metals, Mechanical Constructions & Systems • prof. Patrick De Baets, Dean of the Faculty of Engineering and Architecture • Laurence De Meyst, Structural Engineering • Kevin Dekemele, Electrical Energy, Metals, Mechanical Constructions & Systems • Brigitte Devocht, PR commision • Jasper Juchem, Electrical Energy, Metals, Mechanical Constructions & Systems • Jeroen Lauwaert, Materials, Textiles & Chemical Engineering • Maëli Lissens, Materials, Textiles & Chemical Engineering • Gieljan Vantyghem, Structural engineering • Beau Van Vaerenbergh, Materials, Textiles & Chemical Engineering •

Posters

1. Vitor Adriano, Stijn Hertelé & Wim De Waele

Effects of Weld Flaws on the Outcome of Fracture Toughness Tests

Vitor.SoaresRabeloAdriano@ugent.be

Weld flaws are undesirable, however, due to the welding process characteristic, are unavoidable. These flaws create local stress concentration that may affect in a harmful way the structural integrity of welded structures. Moreover, experimental tests used to determine weld fracture toughness can be influenced by the presence of internal flaws. Among these tests, the Single Edge Notch Tension (SENT) test configuration has been applied broadly for thin-walled structures, such as pipelines, pressure vessels, and offshore construction. The reason for that is because the SENT specimen has a geometry constraint similar to the one found in these thin-walled structures. This enables to directly use their result for structural integrity assessment. Despite the influence of internal flaws in the outcome of laboratory tests, current SENT standards do not address this problem. This research intends to fill the gap regarding this matter by means of an extensive numerical and experimental investigation. In this sense, SENT specimens containing volumetric porosities were produced and Computed Tomography (CT) scans were performed to characterize the porosities. In addition, a Finite Element (FE) model was created and an extensive parametric study will be carried on

SOETE LABORATORY - EEMMECS (EA08)

Vitor Adriano Supervisors: Prof. Stijn Hertelé, Prof. Wim De Waele

EFFECTS OF WELD FLAWS ON THE OUTCOME OF FRACTURE TOUGHNESS TESTS

Weld flaws

The construction of heavily loaded metal structures often involves welding. Unavoidable weld imperfections create local stress concentrations that may affect the structural integrity.



To perform high-level structural integrity assessments in welded structures, parameters related to the material resistance to fracture need to be known a priori.

For thin walled structures (e.g. pipelines, pressure vessels and offshore constructions) Single Edge Notch Tension (SENT) has been used as a fracture mechanics test configuration. The specimen has a stress state similar to the one found in these structures, which enables to obtain more realistic fracture toughness values than other test configurations.



Volumetric flaws can influence the outcome of laboratory fracture tests performed in SENT specimens. Furthermore, techniques to measure crack growth during the test, such as Unloading Compliance (UC) and Direct Current Potential Drop (DCPD) might have their accuracy affected.

Finite element model

A parametric mechanical-electrical finite element model has been developed in the software Abaqus[®] using an object oriented Python script. Computed Tomography (CT) scans of welded SENT specimens were performed by the UGent Centre for X-ray Tomography (UGCT) and the results are translated into the FE model. Some outputs from the model are Direct Current Potential Drop (DCPD) across the flaw block and crack driving force parameters like Crack Mouth Opening Displacement (CMOD).



Experimental tests

In order to validate the numerical model and to evaluate/compare the accuracy of some experimental methodologies used to measure crack size, a set of SENT tests on porous welds (previously CT scanned) will be carried out. A double clip gauge set up will be used to measure crack opening and a Digital Image Correlation technique will be applied to capture the displacement field from the side of the specimen. In addition, the crack growth will be measured using DCPD, UC and crack silicone replicas.



Research impact

There is a lack of guidance on current SENT test standards regarding their validity for specimens containing internal volumetric flaws. This research intends to update/improve SENT test methodologies.

Contact: Vitor.SoaresRabeloAdriano@UGent.be@ugent.be www.soetelaboratory.ugent.be 👎 Universiteit Gent 💆 @ugent 👘 Ghent University



The authors wish to acknowledge the financial support of UGent (Basic Research Fund - BOF, grant O1NO4217) and EPRG (project EPRG201/2018). UGCT is acknowledged for performing the X-ray CT scans used in this project. For this project, porous welds were designed and produced by the Belgian Welding Institute (BIL). 2. Sepideh Akrami, Vera van Beek, Esther Rosenbrand, Adam Bezuijen, Ulrich Förster & André Koelewijn

Backward Erosion Piping Mechanism and Course Sand Barrier as a Prevention Measure

Sepideh.Akrami@ugent.be

Backward erosion piping is an internal erosion mechanism that can affect the safety of waterretaining structures. A phenomenon that can occur underneath levees when a local disruption on the downstream side of water-retaining structure causes concentration of seepage flow at that location and transport of sand particles which forms a shallow pipe in the upstream direction below the cohesive layer. This pipe may grow progressively upstream towards the river and finally leads to embankment collapse. To make an existing structure more resistant against backward erosion piping, the coarse sand barrier (CSB) is considered as a promising measure in Deltares, in the Netherlands. In this method, a layer of coarse-grained sand is placed in the path of the pipe to prevent further erosion of the sand. Thus, a pipe can progress backward towards upstream until encounters the CSB, which prevents further progression of the pipe unless a significantly higher head drop compared to the case without CSB is applied. Therefore, a three-phase experimental programme consisting of small-, medium- and large-scale experiments is performed to investigate the feasibility of this method. This poster presents conceptual aspects of this research and results confirming that the CSB is highly effective piping inhibiting measure.

GEOTECHNICAL ENGINEERING

Sepideh Akrami, Vera van Beek, Esther Rosenbrand, Adam Bezuijen, Ulrich Förster, André Koelewijn

BACKWARD EROSION PIPING MECHANISM AND COURSE SAND BARRIER AS A PREVENTION MEASURE

1. Introduction

1.1 Backward erosion piping mechanism

Backward erosion piping is an internal erosion mechanism that can affect the safety of water-retaining structures. A phenomenon that can occur underneath levees when a local disruption of water structure caused an opening in the cohesive cover laver (this can be a ditch or a shrinkage crack). With sufficient hydraulic gradient over the dike, this may cause concentration of seepage flow at that location and transport of sand particles by seepage water towards the surface and forms a shallow pipe in the upstream direction below the cohesive layer. This pipe grows progressively towards the river and when it reaches the river, the flux through the pipe increases dramatically, which can lead to embankment collapse (e.g. Sellmeijer, 1988; Van Beek et al., 2011, 2015). Several dike failures have been assigned to backward erosion piping The failures near Zalk, Nieuwkuijk and Tholen in the Netherlands (Vrijling et al., 2010), one of the failures in the levee system of New Orleans as a result of Katrina (Vrijling et al., 2010), and several cases in China on the Yangtze and Nenjiang rivers as a result of the 1998 flood (Yao et al., 2009) are examples of dike failures due to backward erosion piping



1.2 Principle of the coarse sand barrier

There are several methods to increase the factor of safety against backward erosion piping. However, these traditional mesures like berns are not economically efficient in terms of land use, and vertical mesures such as cut-off walls are also costly because of the long stretches that have to be reinforced. Therefore, an alternative costefficient technique is required. This may be the coarse sand barrier which is now being developed at research institute Deltares in the Netherlands with the aim of investigating the potential of application of this method for the pilot location in Gameren, the Netherlands.



progress backwards towards upstream until encounters the CSB, which prevents further progression of the pipe unless a significantly higher head drop compared to the case without a CSB is applied, which consequently results in a much higher safety level for the levee.

2. Feasibility study

The feasibility of the CSB is being investigated in a three-stage experimental project at Deltares. This project has been carried out to investigate the feasibility, to determine the strength of the barrier, and observe scale effects of this measure, since scaling effects are associated with piping (Bezujien and Steedman 2010). Therefore, a research program consisting of a series of small-, medium- and largescale experiments has been carried out.



seepage length of 0.35 m and barrier thickness of 0.05 m



Fig. 4. Medium-scale laboratory experiment (seepage length of 1.4 m and barrier thickness of 0.3 m)



Fig. 5. Large-scale tests on a test embankment in the Delta Flume (seepage length of 15 m and barrier thickness of 0.3 m)

3. Test procedure

During the experiments, water enters the set-up and a constant head drop between the inlet and outlet of the set-up is applied for S minutes or longer. In case of sand transport, the head is kept constant until the transport stops, and after which the head is increased again. Flow rate is measured for each head increment and also head measurements are recorded for each step, using stand pipes in the small-scale experiments and using pore pressure transducers in the medium- and large-scale experiments.

4. Results

In the experiments, upon creation of a head difference in the sand sample, the flow is concentrated towards the exit hole, resulting in sand erosion that can be noticed in the cylinder on the top of the set-up. Increasing the head further leads to progression of the pipe, which grows from the opening in the acrylate plate to the barrier. When the pipe reaches the barrier, the flow towards the pipe is insufficient to cause pipe formation in the barrier. Therefore, the combination of high flow rates and lower erosion resistance in the background sand next to the pipe result in pipe formation perpendicular to the flow direction, along the entire with of the barrier, which formed a T-share pipe as sketched and shown here and also described by Negrinelii et al. (2016) and Bezuijen et al. (2018) in small-scale experiments with a CSB. The transverse development of the pipe causes the flow to be redistributed, reducing the load on the barrier.



Fig. 6. Schematic presentation (Bezuijen et al., 2018) and picture of the T-shape pipe

5. Conclusion

The CSB is considered a highly effective piping inhibiting measure. The stability against backward erosion piping for the sand tested in these experiments, in presence of CSL increased significantly depending on the configuration. The CSB have a relatively high resistance against primary erosion due to its high hydraulic conductivity relative to the hydraulic conductivity of the fine background sand. Thus, with a higher hydraulic conductivity contrast, a larger portion of the total head drop will be dissipated over the fine sand upstream of the barrier, resulting in relatively low local gradients in the barrier which consequently lead to a much higher safety level for the levees.

6. Acknowledgements

The Dutch Water Authority of Rivierenland and the National Flood Protection Programme HWBP Riviewaterstaat are asymptotediated for their financial sunnert

7. References

 Brougen, A., Sheedman, R.S. 2005. Scaling of hydraxile processor. Physical Probebing in Genetochnics: Proceedings, 7th 107962 2000, [Eds. Springtum, L., Stane, I.S. Senser, L.). (2014). Explore 16 microsci dong taxolos.
 Brouding, A., Shandhen, Y., Din Her, Y., Machanele, C.2001. Explorements for a caratro sand harmer as a messare against bachward emotion spring. Physical Intel 2014; J. U. Broth, Y., Machanele, C.2001. Explorements for a caratro sand harmer as a messare against bachward emotion spring. Physical Intel 2014; Dir. Rev. For Appl. Acad. Scaling, C.2002. 2029 [Eds. Hollmann, A., Divol, S., Goolery, R., Statistens, S. & Berghall, J. 1987; O.Q. Statistic Scansor Manu-Harman.

nchul (1 1957-1942 Taylor & Francis Group, London. Heyrnind, G., Van Beek, VM, Earit, R. 295, Experimental and rumerical investigation of backward ensise piping in heterogeneous sands. *Scient Decomm Proceedings*, 2007;12(5): Earits, 1), Mithéleusa, E. & Monan, S.J. 477-482. Taylor & Francis Group, London.

Selbreijer, J.B. 1988. On the executavism of piping andre impervisor shockness, Pub Ditexis, bett University of Technology, Deth.
 Verging, K., Kok, W., Cala, E.G.F., Spein, W.G., van der Merz, H.T., van den Bez, P. & Schwecknedisk, T. (2002). Poping realized of rekension of piperson and the executive of a Relationation of Relationation. Bell Relationation of Relationation of Relationation of Relationation of Relationation. Bell Relationships of Relationships of Relationships of Relationships. Bell Relationships of Relationships of Relationships of Relationships of Relationships of Relationships of Relationships. Bell Relationships of R

Echnicatesport Ubeclit, Universite in a state of the second sta

Via Beek, VIX. 2015. Biochevend Flowins Paping Antibative And Poppression PHD Basis, Detit University of Technology, Detit. - Yao, Q., Ku, J. San, D. J. & Daal J. (2009) Data collection of dilte breach cases of Dina, Sino-Dath cooperation project report. Beijing, China:



in Ghent University



3. Jens Baetens, Greet Van Eetvelde & Lieven Vandevelde

Optimal Operation of Fans in a Cooling System, Considering Varying Electricity Prices

j.Baetens@ugent.be

An evaporative induced draft cooling system is one of the most wide spread utility systems in the industry. Pumps circulate water through heat exchangers, situated in the processes. The heated water is sprayed in a cooling tower, where fans induce an airflow. The airflow supports the evaporation of the water, resulting in a temperature drop. In recent years, electricity prices have become more volatile. One of the main reasons is the integration of fluctuating renewable energy sources in the electricity grid in combination with rigid electricity demand. The price reflects the balance on the grid and markets: it rises when a production-consumption mismatch occurs. Machines which can adapt their consumption profile – like the fans in a cooling tower - can therefore profit from these fluctuations. It can be a win-win situation: economically interesting for the consumer, i.e. the cooling system operator, technically interesting for the grid operator (by the implicit balancing of the electricity grid).

ELECTRICAL ENERGY LABORATORY (EELAB)

Jens Baetens, Greet Van Eetvelde and Lieven Vandevelde

OPTIMAL OPERATION OF FANS IN A COOLING SYSTEM, CONSIDERING VARYING ELECTRICITY PRICES.

Cooling system as a thermal battery

Evaporative cooling: efficient and widespread An evaporative induced draft cooling system is one of the most wide spread willity systems in the industry Pumps (P) circulate water through heat exchangers (HEX), situated in the processes. The heated water is sprayed in a cooling tower, where fans (F) induce an airflow. The airflow supports the evaporation of the water, resulting in a temperature drop.

Large volumes in industrial setting

Water basins with volumes of 100s to 1000s m³, cooling towers with 1 to 10s of tans and multi MW process heat dissipation: industrially sized systems come in may different sizes. What they all have in common is the consumption of electricity for the system to operate, more specifically for the fans and pumps. Installed power can range from 10s of kW to multiple MWs.

The combination of the large thermal time constant of the system with the much faster fan response possibility creates potential for economic optimisations.



Volatile electricity prices: high potential!

In recent years, electricity prices have become more volatile. One of the main reasons is the integration of fluctuating renewable energy sources in the electricity grid in combination with rigid electricity demand. The price reflects the balance on the grid and markets: it rises when a production-consumption mismatch occurs. Machines which can adopt their consumption profile – like the fans in a cooling tower – can therefore profit from these fluctuations. It can be a wim-win situation: economically interesting for the consumer, i.e. the cooling system operator, technically interesting for the grid operator (by the implicit balancing of the electricity grid).







Precooling Precooling Ref 0 min 10 min 10

Precooling:

increasing switch off period duration

Precooling is the lowering of the temperature of the water, before a period of temperature increase. This can be done by increasing and decreasing the fan power. This concept – which is a form of load shifting – can be used to elongate the duration of a switch off period.

Simulation to check flexibility options

By modelling the cooling tower system, simulations can be run to check the possibilities of rans switching on and off. If can be checked if the maximum temperature would be exceeded, if precooling is possible, what the maximum duration of a switch off period can be etc. Also the economic part are taken into account: what are the gains in changing the cooling system's operation?





Contact jBastens@ugent.be www.ugent.bs(kol/eemmecs/en/research/eelab/electricalenergy-laboratory f UniversiteitGent @ @ugent in Ghent University



4. Saeedeh Bakhtiari, Wim De Waele & Stijn Hertelé

Accelerated Ultra High Cycle Fatigue Testing

Saeedeh.Bakhtiari@ugent.be

Accelerated ultra high cycle fatigue testing Ultra high cycle fatigue (UHCF) testing using conventional methods is time consuming. So, acceleration methods are required to have a time efficient test. In UHCF the crack initiation mechanism is different than the High Cycle Fatigue (HCF). It initiates at the sub-surface, while it happens on the surface in HCF. Moreover, there is not enough information regarding the failure in UHCF. As a result, fatigue tests are required to study the material behavior in UHCF. The purpose of the current project is applying accelerated methods in material characterization, and fatigue testing at component, and sub-assembly level. To accelerate the fatigue test in component level, stepwise fatigue testing method is used which uses the component temperature rise during the fatigue test to predict the fatigue limit. In subassembly level, a few methods such as increasing the test frequency, or load are chosen which will be applied to convert the long time testing to a time-efficient fatigue test.

IN FACULTY OF ENGINEERING

SOETE LABORATORY - EEMMECS (EA08)

Saeedeh Bakhtiari Supervisors: Professor Wim De Waele – Professor Stijn Hertelé

ACCELERATED ULTRA HIGH CYCLE FATIGUE TESTING



Abstract

- Ultra high cycle fatigue (UHCF) testing using conventional methods is time consuming.
- · Acceleration methods are required to have a time efficient test.
- Accelerated methods are applied in material characterization and fatigue testing at component and subassembly level.









The authors acknowledge the financial support of Vlaio and CNHi under the O&O project "WeReClean".



5. Jana Becelaere, Chris Vervaet, Richard Hoogenboom & Karen de Clerck

Therapeutic nanofibers? Innovative oral drug delivery for improved bioavailability

Jana.Becelaere@ugent.be

Over 2/3rd of all newly developed drugs are rendered useless because they don't dissolve in our stomach! Their high crystallinity prevents any active ingredients from entering our system. For this reason, these poorly water-soluble drugs have become a hot research topic. However, since current techniques prove to be insufficient, we develop a new oral formulation technique based on solvent electrospinning to give these drugs their full healing potential. The high potential of solvent electrospinning poorly water-soluble drugs with a polymeric matrix is clearly shown in this research. With a considerable increase in drug release and the confirmation of a monophasic, amorphous material a time-stable oral formulation technique is presented.

Therapeutic nanofibers? Innovative oral drug delivery for improved bioavailability

Jana Becelaereª, Chris Vervaet^b, Richard Hoogenboom^c, Karen de Clerck^a

^a Centre for Textile Science and Engineering (CTSE), Department of Materials, Textiles and Chemical Engineering, Faculty of Engineering and Architecture, Ghent University

^b Laboratory of Pharmaceutical Technology, Department of Pharmaceutics, Faculty of Pharmaceutical Sciences, Ghent University ^c Supramolecular Chemistry Group, Department of Organic and Macromolecular Chemistry, Faculty of Sciences, Ghent University

Jana.Becelaere@UGent.be

Medicine

Poorly water-soluble drugs have become a hot topic. Due to their high crystallinity, oral dosage forms of these drugs are rendered essentially useless as the body is unable to acquire the drug.

However, as over two-thirds of all newly developed drugs can be classified as poorly water-soluble, a solution is needed. Current techniques prove to be insufficient, thus **solvent electrospinning** is being put forward!



Thermal analysis

sufficiently

MDSC study shows a monophasic

amorphous material. Together with a T.

than

room

hiaher

FEA RESEARCH SYMPOSIUM

2019

Solvent electrospinning

A fast and cost-efficient technique. Through the solvent electrospin process the drug is obtained in its **amorphous** form, thereby **increasing its solubility**.



Combining the considerable increase in drug release with a homogeneous and time stable material, the high potential of solvent electrospinning poorly water-soluble drugs with a polymeric matrix is proven!

ENGINEERING – MATCH

FACULTY OF ENGINEERING

AND ARCHITECTURE

GHENT

UNIVERSITY

.011

DEPARTMENT OF MATERIALS, TEXTILES AND CHEMICAL

CENTRE FOR TEXTILE SCIENCE AND ENGINEERING - CTSE

fwo

6. Hadhemi Bechaouech, Mohamed N. Ibrahim & Alex Van Den Bossche

Performance Comparison Between 12/8 and 12/16 combinations of switched reluctance machine

Hadhemi.Bechaouech@ugent.be

In the recent days, Switched Reluctance Machines (SRMs) occupy a great interest in several industrial applications thanks to their several advantages such as simple and robust construction, low cost, high reliability, and easy cooling. However, SRMs have also drawbacks such as some challenges in their control, high acoustic noise, high levels of torque ripple and vibrations. Compared to the conventional switched reluctance machines with higher stator pole number than the rotor, in this paper a new family of SRMs with higher number of rotor poles than stator is introduced. The 12/16 SRM has been designed and simulated by means of Finite element method (FEM). In addition, the performance of 12/8 and 12/16 SRMs has been compared.

DEPARTMENT OF ELECTRICAL ENERGY, METALS, MECHANICAL CONSTRUCTIONS AND SYSTEMS EELAB GROUP Hadhemi Bechaouech, Mohamed N. Ibrahim, Alex Van Den Bosshe

PERFORMANCE COMPARISON BETWEEN 12/8 AND 12/16 COMBINATIONS OF SWITCHED RELUCTANCE MACHINE

Abstract

In the recent days, Switched Reluctance Machines (SRMs) occupy a great interest in several industrial applications thanks to their several advantages such as simple and robust construction, tow cost, high reliability, and easy cooling. However, SRMs have also drawbacks such as some challenges in their control, high acoustic noise, high levels of torque ripple and vibrations. Compared to the conventional switched reluctance machines with higher stator pole number than the rotor, in this paper a new family of SRMs with higher number of rotor poles than stator is introduced. The 12/16 SRM has been designed and simulated by means of Finite element method (FEM). In addition, the performance of 12/8 and 12/6 SHs has been compared.

Introduction

The switched reluctance motor (SRM) is an electric motor in which torque is produced by the tendency of its moveable part to move to a position where the inductance of the excited winding is maximized.





s a doubly-salient, singly- excited The r



The use of the two-dimensional FEM in the modeling of electrical machines is generally easier and faster than three-dimensional, because of the symmetry exists in the electric machines, the results od 2D and 3D have a great similarity-the calculation of inductance, flux, and other static parameters with FEM must implement the geometry of the machine.





From solving the non-linear Poisson's equation in 2D dimensions case. Magnetic distribution will be acquired the value of magnetic vector potential *A* which allows identifying the magnetic

The flux linkage for one phase in SRM

 $\phi = \frac{l}{d} \int \rightarrow dv$

The magnetic co-energy as a function of flux linkage is

Wem $=\int_0^l \varphi(heta,i)\,\partial i| heta=const$ The static torque can be calculated as follov

 $T(\theta, i) = \frac{\partial W' em}{\partial \theta} | i = const$





Fig 3. Flux linkage curves of the studied SRM by FEMM.

Figure 2 shows the magnetic flux density for the two extreme positions of the studied SRM, In the figure 3 we note that the area enclosed between curves for aligned position and unaligned position is smaller for the 12/16 SRM than that of the 12/8 one.

> Torque



Fig 4. Torque curves of SRM 12/8 (left) and SRM 12/16 (right)

As shown in figure 4 the 12/16 SRM produced higher torque in comparison to the 12/8 SRM at all current values. So this is lead as to conclude that the choice of number of poles of stator, Ns, and rotor, Nr, is important since they have significant implications on the torque.

Conclusion

- Pole number of rotor and stator play an important role in improving the efficiency of SRM motor
- Changing the configuration of motor efficiency is change
- Hence, care should be taken in choosing the best structure for poles which yields maximum efficiency

< Hadhemi Bechaouec < PhD Student >

C DEPARTMENT OF ELECTRICAL ENERGY, METALS, MECHANICAL CONSTRUCTIONS AND SYSTEMS EELAB> e-mail Hadhemi.Bechaouech@ugent.be



7. Brecht Berteloor, Jeroen Beeckman, Kristiaan Neyts, Gert Stuyven & Koenraad Vermeirsch

Digital Patterned Photoalignment of Liquid Crystals

brecht.berteloot@ugent.be

Photoalignment is a way to define the orientation of the director of liquid crystal with the aid of polarized light. The liquid crystal will align according to the rotation of the linear polarization that was incident on the photosensitive alignment layer. In this poster, a technique is shown which allows for easily customizable alignment patterns. The setup uses a spatial light modulator which can induce phase delays that are controllable for each individual pixel. With the aid of two quarter-wave plates, the linear polarization from the laser source can be rotated by any desired amount per pixel. The alignment pattern is thus easily defined only by displaying this pattern on the spatial light modulator which simply acts as a second monitor. Specific patterns allow for the fabrication of flat optics based on the geometric phase principle. This geometric phase difference that is crated by a change in rotation of the liquid crystal. The specific phase difference is equal to twice the rotation angle of the director of the liquid crystal.

LIQUID CRYSTALS AND PHOTONICS GROUP

Brecht Berteloot, Jeroen Beeckman, Kristiaan Neyts, Gert Stuyven, Koenraad Vermeirsch

DIGITAL PATTERNED PHOTOALIGNMENT OF LIQUID CRYSTALS

Photoalignment

GHENT UNIVERSITY

- Defining the orientation of liquid crystals through linearly polarized light exposed on a photosensitive layer
- The liquid crystal aligns according to the rotation of the linear polarization •



8. Atiyyah Binti Haji Musa, Benny Malengier, Jerry Ochola & Lieva Van Langenhove

Comfort of Textiles: A study of fabric handle measurements

atiyyah.bintihajimusa@ugent.be

A study on measurement of textile comfort is presented, involving three main types of measurements in which comfort is assessed, i.e., objective measurement, subjective assessment and modelling. In objective measurements, an instrument known as Fabric Touch Tester (FTT) was employed. It measures 13 fabric parameters within its four modules i.e., bending, compression, thermal and surface, and predicts comfort properties i.e., smoothness, softness and warmth, total hand and touch. For subjective assessment, a panel of 30 trained humans was established and an improved questionnaires-rating method was developed and implemented with the blindfolded panels. Subsequently, a model describing the textile-skin relationship is constructed using the Finite Element Modelling (FEM) software Abaqus@. This model can be used to investigate how the properties found to have most impact on the comfort perception influence the human fingertip. Through this study, we can conclude that FTT is a device which is able to distinguish between samples with small differences in treatment, fiber content, production settings and most suitable for clothing fabrics. It was found however that customized models are required for some technical fabrics as the generic FTT predicted comfort results can then deviate from the panel judgement.

Comfort of Textiles

A study of fabric handle measurements

A. Binti Haji Musa^{*1,2}, B. Malengier¹, J. Ochola³ and L. Van Langenhove¹

¹Ghent University, Department of Materials, Textiles and Chemical Engineering, Technologiepark 907, 9052 Zwijnaarde, Belgium ²Universiti Teknologi MARA Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia ³Moi University, Department of Manufacturing, Industrial & Textile Engineering, Eldoret, 30100, Kenya

Introduction

- Comfort is a feel of being stress-free that is always a goal for humans. Being in a state of comfort relates to satisfaction which leads to quality of life.
- Fabric comfort is a globally discussed issue as humans are dealing with fabrics every single day. Since everyone
 perceives comfort differently, the result is subjective and different for each individual. Hence, many attempts have been
 made in order to communicate about this subject objectively so that everyone would understand the same common
 language of fabric comfort.
- In this work, we focus on the methods to quantify fabric handle by using;
 - · Fabric Touch Tester (FTT),
 - · Human panels, and also
 - · Finite Element Modelling (FEM) of textile-skin.
- Various types of fabrics were tested differentiated by treatment, fibre content and production settings such as twist level, concentration of finishes, etc.

Objective evaluation – FTT

- FTT is a device to measure thermal-mechanical properties of fabrics.
- Output of the touch tests analysis reveals the sensations of fabric-skin touch.
- 13 indices are measured consist of compression, bending, thermal and surface properties, also comfort indices of smoothness, softness, warmth, total hand and total touch are computed by the FTT software.

Subjective evaluation – human panels

- Trained panel of 30 people was established
- A set of procedures for assessment were outlined
- The method used is based on questionnaire-rating with blindfolded assessors



Fabric handle assessment by a blindfolded panel member



FEM of textile-skin

The model is created to understand the touch behavior of a finger onto textile fabrics.



Key findings/results

- FTT is able to distinguish between samples with small differences in treatment, fiber content, production settings and most suitable for clothing fabrics.
- A good correlation was found for thickness and bending between the measurement using common methods and the FTT index.
- Customized models are required for some technical fabrics as the FTT results can then deviate from the panel judgement.



Other related research

Ergonomic comfort, thermal comfort, modelling of heat and moisture through clothing ensembles.







Coi Atiy	Contact Atiyyah.BintiHajiMusa@UGent.be	
f	Universiteit Ghent	
1	@ugent	
n	Ghent University	

9. Laurens Bogaert, Gunther Roelkens & Johan Bauwelinck

Electro-optic co-design for radio-over-fiber 5G applications: beamforming and amplification

laurens.bogaert@ugent.be

Next-generation wireless communication will require increasingly faster data links. To achieve those higher data rates, the shift towards mmWave frequencies and smaller cell sizes will play a major role. Radio-over-Fiber has been proposed as a possible architecture to allow for this shift. In my work, I mainly focus on two major functionalities in such a Radio-over-Fiber link. Firstly, beamforming is looked at. Main benefits are the increase in power efficiency and decrease in interference between different users. The latter effectively allows for spatial multiplexing which will increase achievable data rates even further. A second important functionality is signal amplification, for which two possible variants are being explored. On the one hand, electrical amplification of the RF signal can be performed in between the opto-electronic conversion and the antenna. On the other hand, optical amplification at the base station can be exploited. This has the advantage that it allows for a more centralized architecture where the signal for multiple antenna units can be amplified simultaneously. A drawback of this method is the fact that high linearity opto-electronic conversion is required. To cope with the high optical powers arriving at the antenna unit, a traveling wave photodiode has been constructed.



Electro-optic co-design for radio-over-fiber 5G applications: beamforming and amplification



How to boost weak signals?

Electrical amplification after opto-electronic (O/E) conversion

• Co-design of electronics and photonics



Optical amplification at base station

- o Centralized amplification possible
- o But, requires high power O/E converter
- Solution: traveling wave photodiode
 - Multiple photodetectors (divide and conquer)
 Embed parasitics in transmission line structure
 - Embed parasitics in transmission line structure

unec

	Linearity	Bandwidth
Single PD	Low	High
Parallel PD	High	Low
Traveling wave PD	High	High

10. Jarich Braeckevelt, Jon Wiggins, Pieter Mertens, Jeroen Dierckx & Steven Verstockt

Effect Of Position On Aerodynamics In Cycling

jarich.braeckevelt@bioracermotion.com

In recent years, the amateur cycling community is looking towards the highest-cost segment of cycling gear to improve their performance. A lot of investments are done in aero wheels and frames, however there are numerous other things to optimize and positioning on the bike is often neglected within this segment of amateur cyclists. The total resistance a rider needs to overcome is split in three components: air resistance, rolling resistance and gravitational resistance. For this experiment we consider the gravitational resistance to be zero as we only work with flat roads. Air resistance gets more important in comparison to rolling resistance at high speeds. This is due to the speed influencing air resistance (power of three) much more than rolling resistance. When a cyclist doubles its speed, the air resistance is 8 times larger, from 40 km/h the air resistance is even over 80% of your total resistance. The purpose of this study is to prove that an aerodynamic cycling position, which mainly is determined by your frontal area, will save you more watts than any other change in configuration. Therefore, wind tunnel tests are conducted and the frontal area is analysed with the Bioracer Aero system.





Jarich Braeckevelt^{**}, Jon Wiggins^{*}, Pieter Mertens^{*}, Jeroen Dierckx^{*}, Steven Verstockt^{*} Ghent University - imec, IDLab, AA Tower, Technologiepark-Zwijnaarde 122, 9052 Gent Bioracer Motion, Industrieweg 114, 3980 Tessenderlo E-mail: jarich.braeckevelt@bioracermotion.com

Research Question

Cycling resistance can be split into three components: air, rolling and gravitational resistance. This research focuses on how we can reduce the resistance and which parameters can be optimised most.

Proposed methodology

- Simulations using the **power formula** with regard to the various parameters and their effects.

- Test different cycling positions on frontal area (A) using Bioracer Aero, i.e, virtual wind tunnel software that measures the frontal area of a rider by using image processing and a green screen.



- Wind tunnel testing (BikeValley, Beringen, Belgium). To prove the simulations' findings, CdA was measured, which are the controllable variables in the air resistance formula (air density is a fixed, location dependent variable). The A was measured with Bioracer Aero, to conduct a value for Cd.

Power formula: P = ($\frac{1}{2} \rho C_d A v^3 + C_{rr} m g v$) ϵ^1 [Watt]

 ϱ : air density, C_{d} : coefficient of drag, A: frontal area, v : velocity, C_{rr} : coefficient of rolling resistance, m: mass of rider and equipment, g: gravitational constant, ϵ : mechanical efficiency



Graph 1: Components of resistance

Graph 2: Effect of different adjustments to the riding condition

Graph 3: Comparison of different riding positions

Graph 1 proves that **air resistance** is the biggest part of the total resistance. An aerodynamic cycling position can **save up to 20% on frontal area**, resulting in a saving of over **40 Watt** when riding at a constant pace of 40 km/h. Graph 2 shows a comparison with different optimisations. Prior, **frontal area** was an underestimated factor in the equation. However, graph 3 proves that a more aerodynamic **cycling position** has the **largest impact** on the total resistance.

Parameter	Reference	Optimal value	
coefficient of drag "	0,81022727	0,75681818	
frontal area*	0,4116	0,3536	m²
coefficient of rolling resistance°	0,00366	0,00231	
mass	90	80	kg
gravity force	9,81	9,81	m/s
Mechanical ineffiency	4,5	3	%

Remarks

- Power formula is based on flat roads (gravitational resistance not taken into account)

- wind tunnel experiments have been repeated 3 times to improve accuracy

* measured with Bioracer Aero, A in hoods vs A of Time Trial position

° bicyclerollingresistance.com

" CdA values extracted from wind tunnel experiments, divided by A

Conclusion

- Air resistance can be best reduced by optimising the rider's position. An aerodynamic position can save 9 - 11%, from an upright to an aero TT position you can even save up to 30%

- An Aerosuit can drastically change the Cd resulting in a 6% saving in drag force
- Aero frame and wheels save only 3%, which is the least improvement in terms of investment for watts
- Riding without gloves can save you over 1%
- Aero socks can save up to 1.5%

11. Ricardo Cajo, Thoa Mac Thi, Cosmin Copot, Douglas Plaza, Robain De Keyser & Clara Ionescu

Drones Formation Control for Emergency Equipment and Medicines Delivery Based on Optimal Controllers

ricardoalfredo.cajodiaz@ugent.be

In this work, a fractional order proportional derivative (FOPD) control approach is applied to multiple unmanned aerial vehicles (UAVs) based on leader-follower formation for tackling an emergency health case. The controller parameters are tuning based on a multi-objective particle swarm optimization (MOPSO) algorithm with an accelerated update methodology. Its performance is compared against an integer order proportional-derivative (IOPD) control. Finally, the global path planning for the UAVs swarm is found using the Dijkstra's algorithm with quintic polynomial trajectory. This provides an optimal global paths in terms of the path's length and smoothness, considering the physical system dimension and constraints of acceleration and velocity average of the UAV. The simulation tests using the virtual environment demonstrate the proposed controller outperforms the IOPD control.



DEPARTMENT OF ELECTRICAL ENERGY, METALS, MECHANICAL CONSTRUCTION & SYSTEMS

Ricardo Cajo, Thoa Mac, Cosmin Copot, Douglas Plaza, Robain De Keyser, Clara Ionescu

DRONES FORMATION CONTROL FOR EMERGENCY EQUIPMENT AND MEDICINES DELIVERY BASED ON OPTIMAL CONTROLLERS



2.- Goal

- Economic and efficient transportation emergency equipment and medicines delivery
 - Timely delivery, commercial drones, increase payload

Solution:

- Robust controller
- Fractional order proportional derivative (FOPD) control
 Cooperative formation
 - Leader-follower approach

3.- Tuning Methodology





5.- Conclusions

- Simulation tests using the virtual environment demonstrate the proposed controller outperforms the IOPD control.
- FOPD has a better trajectory tracking performance and disturbance rejection during translational movements over x, y, altitude and angle/orientation control.

Contact
ricardoalfredo.cajodiaz@ugent.be www.ugent.be
f Universiteit Gent
🥑 @ugent
in Ghent University



12. Hélène Cervo, Ivan Kantor, Jean-Henry Ferrasse, François Maréchal & Greet Van Eetvelde

Blueprints for Industrial Symbiosis (is) Detection – Chemical Sector

helene.cervo@ugent.be

Industrial Symbiosis (IS) is at the heart of the European Union's (EU) strategy to transition towards a lower carbon and more circular economy. It focuses on the cooperation of large and small enterprises in industrial or district clusters for exchanging materials, energy and waste (co-product) as well as services, technologies or even knowledge and information. However, data confidentiality is still a barrier, preventing the discovery of new IS opportunities. The concept of blueprints, developed in the framework of the EPOS project, is a solution for sharing information across industry sectors. They provide an easy and clear solution for industries to share data and learnings that can lead to better practices, operation optimisation and even new businesses. The case of heat integration between a refinery and a DHN demonstrates that blueprints can be used for the identification and evaluation of new IS opportunities.

GHENT UNIVERSITY, EELAB ECM – ENERGY & CLUSTER MANAGEMENT, GHENT, BELGIUM – <u>ECM@UGENT.BE</u> AIX-MARSEILLE UNIV, CNRS, CENTRALE MARSEILLE, M2P2, MARSEILLE, FRANCE Hélène Cervo, Ivan Kantor, Jean-Henry Ferrasse, François Maréchal, Greet Van Eetvelde

BLUEPRINTS FOR INDUSTRIAL SYMBIOSIS (IS) DETECTION -

CHEMICAL SECTOR

Challenge

How to overcome confidential issues when sharing data & results in and across process sectors?

Solution – sector blueprint

- typical process industry sites (refinery, steam cracking, chemicals)
- systematic methodology to produce blueprints
- 3 profiles summarising the material, thermal and electrical needs of a given industrial sector
- data anonymisation techniques (Parerto approach, aggregation, anonymisation factor) ensure data confidentiality while keeping the realistic nature of the blueprint
- customisable MILP models for identifying and optimising the best IS connections between process sectors





Conclusion

The use of blueprints is a powerful tool for overcoming the burden of industrial data confidentiality. They provide an easy and clear solution for industries to share data and learnings that can lead to better practices, operation optimisation and even new businesses. The case of heat integration between a refinery and a DHN demonstrates that blueprints can be used for the identification and evaluation of new IS opportunities.

[1] H. Cervo et al., 'Virtual Sector Profiles for Innovation Sharing in Process Industry – Sector 01: Chemicals', in Sustainable Design and Manufacturing 2017, 2017, pp. 569–578.

[2] S. Raluca, K. Ivan, B. Hur, G. Luc, and M. Francois, 'Geographically parameterized residential sector energy and service profile', Chem. Eng. Trans. pp. 709–714, 2018008.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 679386. This work was supported by the Swiss State Secretariat for Education, Research and Innovation (SERI) under contract number 15.0217



blueprint life-cycle



Case study - Heat integration between a refinery and a District Heating Network (DHN)

inu a District Heating Netw

Methodology

- use of refinery [1] and DHN [2] blueprints
- thermal energy profiles (level 2 pinch curves)
- refinery capacity = 35'000 t/d, city = 10'000 inhabitants in zone 5 [2]
- objective function: maximise heat integration Results

	Power Business as Usual (kW)	Power after integration (kW)
Refrigeration	200	200
Centralised heating	142.2	0
Electrical heating	47.84	0
Heating District Hot Water	2'031	2'031
Space heating	7'446	7'446
Boiler	9'380	0
TOTAL	19'247	9'677

→ DHN's energy consumption reduced by 50% when integrated with the refinery

→ next step: include OPEX and CAPEX

Contact

- helene.cervo@ugent.be
- Universiteit Gent
- 🥑 @ugent
- in Ghent University

13. Martijn Courteaux & Ruben Verhack

Steered Mixture-of-Experts for Light Field Video Compression

Martijn.Courteaux@ugent.be

3D first-person video games provide six degrees of freedom: three dimensions of translational freedom; and three dimensions of freedom for the head orientation. Movies do not have this freedom. The best there is, are 360° videos which do not provide the ability to move your head. Full 6-DoF for camera-captured content is our goal. This imposes two important problems: how to record all this visual information and how to efficiently compress and decompress it for real-time playback. We work on a compression framework that provides all required functionality, named SMoE. This framework has a long history of different forms, mathematics, and experimentation. The focus of this research is to push SMoE to next level and reach practical feasibility required for real productions, such that it becomes viable for adoption in the industry. SMoE can be described as a sparse and continuous approximation of the original visual data, providing high-quality viewpoint interpolation, temporal upsampling, super-resolution, approximate depth estimation and perceptually high-quality results. All this originates from elegant mathematics and tools adopted from machine learning research.

AND ARCHITECTURE

IDLAB MEDIA

Martijn Courteaux & Ruben Verhack

STEERED MIXTURE-OF-EXPERTS FOR LIGHT FIELD VIDEO

COMPRESSION



VR in entertainment is now mostly used in the form of games; we want to bring it to the movie industry.

 \rightarrow Walk around in the movie!

Light Field Video SD f Plenoptic Function: $(r, g, b) = f(x, y, z, \theta, \phi, t)$

r, g, b: color of the incoming ray
x, y, z: coordinate of the viewpoint

θ, φ; angle of incoming ray

t point in time







<u>Problem</u>: a **lot** of data! 200+ cameras @ 60fps @ 1080p / · 10 Mbps / camera = 15 GB/min

But: All viewpoints are very **similar**! → Compression!



IDLab

- · Light rays travel straight when no obstacles are present.
- The plenoptic function contains a lot of redundancy.
- → A wall of cameras is sufficient!

Option 1 : A real wall of cameras. Option 2 : A virtual wall of cameras in a 3D scene.

> Light fields can be synthetically generated using software raytracing. **Blender** has a plugin that produces a render for every camera in a virtual wall of cameras.



How to save? Steered Mixture-of-Experts (SMoE)!



GHENT

UNIVERSITY

Idea: use versatile **high-dimensional** building blocks (**"kernels"**) to approximate data.



Kernels live in **5D** and can replace millions of pixels. The dense representation using pixels is replaced by a **sparse** representation using kernels. <u>Problem</u>: how to choose kernels? Find redundancies in billions of pixels



Current solution:

- Clustering with Expectation-Maximization (EM)
- Gradient Descent (GD)



Future work

- Improve kernel positioning
- Improve speed and data efficiency
- Explore high frequency color functions for kernels



Contact

Martijn.Courteaux@ugent.be

- Universiteit Gent
- 💅 @ugent
- in Ghent University



Every light ray, observed from everywhere, in every direction.
 Can be used to feed a VR headset!
 How to capture?
 How to save?

14. Brecht De Beelde, David Plets, Emmeric Tanghe & Wout Joseph

Joint Antenna and Channel Modelling for Wireless Communication in Home Kitchen Environments

Brecht.DeBeelde@ugent.be

This poster presents a study on the joint antenna and channel modelling in a home kitchen environment. By characterizing the wireless link from the cooking pot to the kitchen hood, the communication between the pot and hood can be optimized. The channel characteristics are obtained from channel sounding measurements via a broadband channel sounder, resulting in a power delay and angular profile as well as measured path loss values. Antenna modelling is based on radiation pattern measurements or FDTD simulations. Based on the channel model, a two-ray model is proposed consisting of a Line-of-Sight component as well as a reflected component (caused by reflections on the kitchen hood and hob). The antenna and channel models are combined by adding the antenna gain to the measured path loss values in order to obtain a path loss model that does not depend on antenna characteristics. This can be used for link budget calculations to determine the minimally required transmit power needed for reliable wireless communication.
Joint Antenna and Channel Modelling for Wireless Communication in Home Kitchen Environments

Brecht De Beelde, David Plets, Emmeric Tanghe, Wout Joseph

Department of Information technology (INTEC), Ghent University/imec, Technologiepark-Zwijnaarde 126, B-9052, Ghent, Belgium, email: Brecht.DeBeelde@ugent.be

Introduction

In a smart kitchen, data from sensors in the kitchen hob, cooking pots and kitchen hood can support the cook during the cooking process, e.g. by automatically adjusting the hob and hood settings for a perfect dish.

A reliable wireless link is needed to get sensor data from transmitter in the pot to the receiver in the kitchen controller (integrated in the hood). Wireless communication is challenged by the presence of metal in the pots, hob and hood. This introduces reflections of the transmitted signal, causing multipath propagation.

As the metallic pot also influences the antenna performance, a joint antenna and channel model is created which allows optimizing the wireless communication between the pot and kitchen hood. This model can be used for link budget calculations with the goal to determine the transmit power that is minimally required to still guarantee reliable wireless communication.





Channel modelling via broadband channel sounder

- Different configurations
- traditional kitchen with stainless steel back cooking island Different setups
- Line-of-Sight (LoS) between TX and RX LoS obstructed by lid (worst case during cooking) adband: frequency range 500 MHz - 8 GHz Bro
- Averaging
- Temporal: 60 observations Spatial: 55 locations on uniform rectangular grid (URA)
- We consider three different frequency bands; 868 MHz, 2.4 GHz ISM, 5 GHz ISM

Combine antenna and channel model by subtracting antenna gain in the direction of the main peaks of the Power Angular Profile from the measured path loss (PL) values. This results in corrected path loss values PL_{corr} that do not depend on the measurement antenna.

RX

ΤX

IDFT

Averaged Power Delay Profil

Path Loss

waves

Use the corrected path loss value for link budget calculations to obtain the minimum required transmit power to have reliable wireless communication.

 $P_{TX,min}[dBm] = PL_{max}[dB] - G_{TX}[dBi] - G_{RX}[dBi] + P_{RS}[dBm]$

Results



- Delay window small compared to symbol time of BLE
 - · Stainless steel back has no significant influence on PL

Antenna gain increases when placed next to cooking pot • 2-ray model is a good representation of propagation in a cooking environment



15. Jelle De Bock, Florian Vandecasteele & Steven Verstockt

Smarterroutes: A generic data-driven solution for personalized dynamic routing and environmentalcharacteristic driven

jelle.debock@ugent.be

The SmarterROUTES architecture tries to enrich the conventional routing- and navigation experience. Most of the conventional services are providing the fastest, shortest or most ecological route by calculating a (number of) lowest-cost path(s) from A to B using an underlying network of weighted road segments. SmarterROUTES provides end-user customization by post-processing a number of suggested routes which were generated by the previously mentioned routing services. The mechanism calculates additional weights based on a selection of parameters. This route ranking mechanism can rely on various sources of data (governmental datasets, extracts of the OpenStreetmap dataset or data exported from web services such as rest apis or WCF/WMS) and is converted to geographically tagged json (GeoJSON) . The data used to calculate the score is dynamically configurable which is resulting in a scoring mechanism tailored to the needs of the end-user. The next building block of the architecture is the implementation of Level of Detail (LoD) aware navigation. A complexity model provides an indication how complex a certain road scene is. The model is a crucial step to provide the user with personalized and context-aware navigation instructions.

SMARTERROUTES

A generic data-driven solution for personalized dynamic routing and environmental-characteristics driven

Context and problem description

Conventional routing implementation mainly focuses on · Fastest/Shorters/Ecological/.

Traffic info

Objective

Develop an understandable and generic methodology to generate the best route for a user(group) based on their preferences and present the selected route in a contextaware and user-preference driven way.

Methodology

Modular architecture with re-usability and end-user customization in mind.

- 1. Route generation
 - · Initial routes generated by 3rd party routing provider
 - Features are retrieved from various datasets and types (REST, json, csv, ...) converted to geo-tagged json (GeoJSON) for easy feature score calculation
 - Weighing initially generated routes

 - Bring individual feature-scores together
 - impact on final score

2. Route presentation

- Export route to GPX, GeoJSON, ...
- Road complexity estimation
- Level of detail (LoD) aware navigation

Results

- Routing demonstrator
- Built with JavaScript/CSS/HTML
- Using TomTom API for its initial routes
- Ranking of the initial routes based on
 - · Museums nearby (+)
 - · Accidents (in municipality) (-)
 - Elevation (+)

Route presentation

- · Street complexity estimation experiments with
 - Support Vector Regression
 - Transfer Learning (image matching)





Demonstrator: running on https://jelledebock.github.io/smartroute_navigation/

Conclusion

icte

22.

42

- · Relatively simple and customizable way to find the optimal route for end-users
- · Reuse conventional routing algorithms with an additional weighting and ranking to improve user satisfaction
- · Intitial route calculation on powerfull machines and postprocessing on end user device providing an user-specific optimal route
- · Context-aware navigation can further improve the user-customization
 - · Level-of-detail aware routing
 - · User-preference aware routing (number of instructions needed)

Street Complexity Estimator



Contact jelle.debock@ugent.be www.ugent.be/ea/idlab Universiteit Gent f @ugent y Ghent University in



16. Arne De Keyser & Guillaume Crevecoeur

Towards Optimal Exploitation of All-Electrical DualDrive Powertrains in Smart e-Motion Systems

arndkeys.dekeyser@ugent.be

Government institutions and industrial partners are aspiring green alternatives for contemporary transportation systems or industrial processes. All-electric drivetrains demonstrate interesting properties in this perspective, as direct harmful emissions in the atmosphere are eliminated. Optimal exploitation of the associated possibilities requires filling the gaps in state-of-the-art technology in terms of topology design, energy-efficient control strategies and supervisory power flow management agents. First, the design problem is reformulated and tackled using an evolutionary leading to 99,3% less pronounced design time requirements when benchmarked against traditional approaches. Dedicated approximate dynamic programming techniques furthermore reduce the overall operational cost of an isolated drive by up to 57,3%. At the system level, automated regression techniques are engaged to cast the power dissipation of the subsystems into efficient dissipation models. An intelligent supervisory dynamic programming agent, optimizing the power flow paths in the dual drive topology, provides range extensions of approximately 16%. Combining the proposed strategies might thus pave the way for a deeper integration of all-electric vehicles in contemporary society and consequently a more sustainable transportation system.

GHENT UNIVERSITY

ELECTRICAL ENERGY LAB (EELAB)

Arne De Keyser and Guillaume Crevecoeur

TOWARDS OPTIMAL EXPLOITATION OF ALL-ELECTRIC DUAL DRIVE POWERTRAINS IN SMART E-MOTION SYSTEMS



FEA Research Symposium 2019 iGent Tower, Ghent 17. Thibault Degrande, Frederic Vannieuwenborg & Sofie Verbrugge

To IOT or not to OIT

thibault.degrande@ugent.be

Multiple years have passed since the Internet of Things was at the top of inflated expectations at the Gartner Hype Cycle for Emerging Technologies, back in 2014. Gartner predicted that in 5 to 10 years, IoT would be at the plateau of productivity [1]. Indeed, the industry and the technology has matured a lot since then and analysts claim that we are on the brink of mass adoption. This implies a shift from the technologies companies should invest weithin this new technology wave. As IoT technology continues to advance and an increasing numbers of firms planning to adopt the technology, IoT cost-benefit analysis will become increasingly important. My research is concerned with why and how thoroughly assessing such IoT business case (viability). My current project deals with connected cars and includes assessing whether the systems developed by the project are both feasible and financially viable.

GHENT

UNIVERSITY

TO IOT OR NOT TO IOT?

Internet of Things: the shift from the technical to the business challenge



thibault.degrande@ugent.be www.ugent.be www.technoeconomics.ugent.be 18. Luca Donatini

Waves in Ship Manoeuvering Simulators

luca.donatini@ugent.be

Ship manoeuvring simulators are nowadays regarded as invaluable tools in both the design of port infrastructures and the training of maritime professionals. Flanders Hydraulics Research (FHR), located in Antwerp, owns and maintains several ship manoeuvring simulators, mainly focused on inland and confined waters navigation (channels, estuaries, harbours...). Waves and the dynamic behaviour of a ship in waves, called seakeeping, are presently not implemented in ship manoeuvring simulators of Flanders Hydraulics Research. In 2018, the maritime Technology Division of UGent has been commissioned a research project aimed at the implementation of waves and seakeeping in the ship simulators of FHR.

MARITIME TECHNOLOGY DIVISION

Luca Donatini

WAVES IN SHIP MANOEUVRING SIMULATORS

Introduction

Ship manoeuvring simulators are nowadays regarded as invaluable tools in both the design of port infrastructures and the training of maritime professionals.

Flanders Hydraulics Research (FHR), located in Antwerp, owns and maintains several ship manoeuvring simulators, mainty focused on inland and confined waters navigation (channels, estuaries, harbours.). Waves and the dynamic behaviour of a ship in waves, called *seakeeping*, are orsenant not implemented.

In 2018, the maritime Technology Division of UGent has been commissioned a research project aimed at the implementation of waves and seakeeping in the ship simulators of FHR.



360+ simulator @ FHR

Wave description

A first step towards the implementation of seakeeping in a ship manoeuvring simulator is the implementation of a wave climate. The following requirements need to be met by the description of wave climate to be implemented:

- Wave data availability, from different sources
- Possibility to visualize of free surface elevation
 Possibility to calculate wave induced pressure fields

40 30

0.15

Theoretical spectrum (IONSWAP)

High speed algorithms for manipulation (real-time applications)

Wave data sources

Wave huov

Wave directional spectrum

A directional wave spectrum is a representation of a confused sea state in the frequency domain. A confused sea state can be thought as a superposition of elementary regular waves (sines), each with a specific frequency and direction of propagation. A wave directional spectrum describes the amount of energy (or amplitude) associated with each regular wave romonent



Directional wave spectrum from buov measurements

Time domain realizations: IDFTs

A common way to convert a directional spectrum into time domain variables like the free surface elevation at one point is to use an Inverse Discrete Fourier Transform (IDFT), which means that the elevation induced by each single elementary wave is calculated separately and then superposed to the others.

$$\eta = \sum_{i=1}^{n} a_i \cdot \cos([k_i \cos \vartheta_i \cdot x + k_i \sin \vartheta_i \cdot y] - \omega_i t + \varphi_i)$$

If the number of elementary regular waves and/or the number of points where the time domain information is desired are large, IDFTs are too slow to be used in a real time application like a ship manoeuvring simulator. A more efficient solution is needed.

Wavenumber spectrum

A spectral component (regular wave) can be described by its frequency and its direction. The well known dispersion relation creates a link between the angular frequency *a* and the length λ of a regular wave. The wavenumber, defined as k = 2n/4 can be thought as a *spatial frequency* of the wave. Therefore, an elementary wave can alternatively be described by a wavenumber vector, which can be spiil into its two horizontal components. A wave spectrum can therefore be represented as a function of the horizontal components of the wavenumber vector instead of as a function of frequency and direction. A conversion between the two spectral representations can be achieved by an appropriate Jacobian.



Phasors and IFFTs in 2D

Once a 2D wavenumber amplitude spectrum is obtained, and an arbitrary value is assigned to the regular wave components' phases ϕ , an *amplitude phasor* can be calculated, with the form:

$$\hat{P}(\mathbf{k}) = \zeta_a(\mathbf{k}) \cdot e^{i\varphi(\mathbf{k})} \cdot e^{-i\omega(\mathbf{k})t}$$

For a specific time *t*, such a phasor can be very efficiently transformed into a free surface elevation 2D field by means of an **Inverse Fast Fourier Transform**. This algorithm achieves **unch higher performances** than IDT. The resolution and extension of the space realization of the phasor spectrum depend on the minimum and maximum values of the wavenumber, which should be regularly spaced.

Pressure calculations

Following the same logic, a pressure phasor can be calculated, as:

$$\hat{P}_{press} = \rho g \cdot \left[\frac{cosh[k(d+z)]}{cosh(kd)} \right] \cdot \hat{P}$$

By varying the depth 2 as a parameter, different pressure phasors corresponding to different depths can be obtained. Each of these pressure phasors can then be transformed into a 2D pressure fields corresponding to a specific depth. If repeated for several depths, the pressure fields from a 3D matrix which allows easy interpolation. This allows a very fast calculation in real time of the wave induced pressure at arbitrary points below the water surface. This is required to calculate the hydrodynamic forces on a ship hull (*Foude-Krybordroc*E).



Free surface obtained from amplitude phasor



Pressure fields at different depths obtained from pressure phasors

Flanı perfo	Acknowledgement Flanders Hydraulics Research is acknowledged for the opportunity to perform this research in the framework of project 17_013.			
Co	ntact			
Luc	a.donatini@ugent.be			
wy	ww.maritiem.ugent.be/			
f	Universiteit Gent			
V	@ugent			
in	Ghent University			



MARITIME TECHNOLOGY

Results of a numerical wave model (global scale)

parama - 2 - parama - 2

Hs = 6 m To = 12 s

0.35



19. Willem Faes, Ralph Bäßler, Johan Van Bael, Robbe Salenbien, Kim Verbeken4 & Michel De Paepe

Evaluating the Corrosion Resistance of Different Steel Types for Geothermal Applications

Willem.faes@ugent.be

Geothermal energy is an interesting alternative to polluting fossil energy sources. Therefore, in Belgium, two wells have been drilled for a deep geothermal power plant. The environment to which the installations are exposed to is however challenging. The geothermal brine has a high salinity and the production temperature can be up to 130°C. To assess their suitability to be used in a geothermal power plant, the corrosivity of the brine to three common construction materials was investigated with exposure and electrochemical tests. The metals under consideration are a low-alloyed carbon steel (S235JR), an austenitic stainless steel (UNS S31603) and a duplex stainless steel (UNS S31803). The carbon steel was found to corrode uniformly, while the stainless and the duplex steel are susceptible to pitting and crevice corrosion.

APPLIED THERMODYNAMICS & HEAT TRANSFER

Willem Faes*1,2, Ralph Bäßler³, Johan Van Bael², Robbe Salenbien², Kim Verbeken⁴ & Michel De Paepe^{1,5}

EVALUATING THE CORROSION RESISTANCE OF DIFFERENT STEEL TYPES FOR GEOTHERMAL APPLICATIONS

Problem

Geothermal power plants are an interesting alternative to fossil fuels The hot brines are however highly corrosive to the installations The corrosion resistance of three different steel types was evaluated.

- Carbon steel (S235JR), stainless steel (S31603) and duplex steel (S31803)
- Exposure tests & electrochemical tests
- Tested at 80°C and 130°C





Exposure tests

Uniform corrosion rates are determined with exposure tests Samples are submerged in the brine for a certain period

- Results for carbon steel shown in the graph
- Stainless and duplex steel: all below 0.002 mm/v

Electrochemical tests

Applying a potential forces the sample corrode This illustrates the susceptibility of the metal to localized corrosion (such as pitting or crevice corrosion)





Surface analysis

SEM and EDX show FeCO₂ crystals

- Reduces the corrosion rate
- Lower solubility at higher temperatures



Conclusion

- High uniform corrosion rates
 No localized corrosion

This work was done with the support of the EU, ERDF, Flanders Innovation & Entrepreneurship and the Province of Limburg.

Acknowledgements

Contact

- ent of Flow, Heat and Combustion Mechanics, iversity, 9000 Ghent nish Institute for Technological Research,
- stitute for Materials Research and Testing (BAM)
- ny f Materials, Textiles and Chemical Shent University, 9000 Ghent e, Core Lab Ugent-EEDT,

🦟 vito GHENT UNIVERSITY

20. Maria Ghita, Dana Copot & Clara M. Ionescu

LuCan: Engineering Outcome for Personalized Therapy in Lung Cancer Patients

ghitamaria@yahoo.com

Regarding all possible cancer sites, lung cancer is ranked as number 1 cause of deaths and number 2 in cancer incidence in Belgium, reported by World Health Organization (International Agency for Research on Cancer). It is a priority to extend the lung cancer research so that future benefits discovered will be translated into better patients' outcomes and reduced morbidity as soon as possible. The research approach proposed aims to use mathematical models based on lung structures and mechanical properties in order to characterize the lung function in lung cancer patients. Mathematical models of lung mechanics exist already, in part delivered by previous state of art and proof of concept of the UGent-DYSC research group: proposed mathematical model and measurements to reflect the structural changes in COPD lung (Chronic Obstructive Pulmonary Disease). The results have indicated that FOT device has great potential in diagnosis and respiratory mechanisms characterization, therefore it can be further extended to lung cancer research. Therefore, the non-standardized FOT device for low frequencies can be used to improve the targeted, personalized therapy for lung cancer and to predict the risk of radiation induced toxicity in lung cancer.



DYNAMICAL SYSTEMS & CONTROL RESEARCH GROUP

Maria Ghita (PhD student), Dana Copot (Co-Promoter), Clara M. Ionescu (Promoter)

LuCan: ENGINEERING OUTCOME FOR PERSONALIZED THERAPY IN LUNG CANCER PATIENTS

esearch RELEVANCE

Research GOALS

- Lung cancer ranked as #1 cause of deaths and #2 in cancer incidence in Belgium.
- Fractional order impedance model validated as a characterizing tool for the frequency-dependence in human respiratory input impedance.
- FOT in the clinical decision making process of individualized therapy and prediction of late toxicity in lung cancer patients. Extensive research on improved targeted, personalized
- therapies: Stereotactic Body Radiation Therapy (SBRT) → collaboration with GZA Antwerp. ۶
- Efforts to minimize the risk of radiation induced toxicity in lung cancer: Radiation Pneumonitis (RP) → collaboration with UZ Gent & GZA Antwerp.
- have a medication therapy according to the patient's lung tumor.
- Development of an integrated parametric mathematical model for lung cancer prediction and response to specific therapy.

Prediction of late toxicity after radiotherapy in lung cancer, > by predicting the development of fibrosis (radiation pneumatosis)

air out

Research STAGE

- > Correlation between FOT (respiratory function) and SBRT to > Mathematical models of lung mechanics exist already, in part delivered by previous state of art and proof of concept of the UGent-DYSC research group: proposed mathematical model and measurements to reflect the structural changes in COPD lung (Chronic Obstructive Pulmonary Disease).
 - UGent-DYSC team is leader in Web of Science: #1 worldwide in fractional order impedance model for characterizing physiological processes (last time accessed: 31.01.2019)
 - Important evidence for broader utilization in lung cancer changes

The non-standardized FOT device applies oscillations from 0.1 to 4 Hz, close to the breathing frequency of the patients (comparing with commercial FOT devices that measures the frequencies from 4 - 48 HZ).



Fans pushing Fans pulling air in Non-standardized FOT device and instrumentation

Total population

Number of new cases

Tissue damping and tissue hysteresivity

Research projects have been conducted by UGent-DYSC using FOT device in evaluation of COPD patients, in order to distinguish between various degrees of tissue heterogeneity in COPD stages. The results have indicated that FOT device has great potential in diagnosis and respiratory mechanisms characterization, therefore it can be further extended to lung cancer research

INNOVATION:

CLINICAL

ENGINEERING

Added value for specificity and accuracy of treatment therapy in lung cancer with a non-standardized FOT device

A FOT device tailored for lung cancer patients with a related mathematical model

First step: Mathematical

cancer treatment and late toxicity

B. Modeling of Respiratory Impedance for prediction of

modeling of lung structures A. Modeling of Tumor Growth for individualized lung cancer

Second step: Clinical study for cancer lung patients Prepare the Ethical Committee files

- Design a protocol for the clinical trial, using FOT device Determine the optimal number of patients needed
- Measurements of the respiratory function with FOT device before starting the therapy and after finishing the therapy

Third step: Correlation and statistical analysis

· Modeling of Tumor Growth and Respiratory Impedance: Guide for cancer therapy?

Lung cancer in Belgium 2018

Incidence - Mortality - Prevalence

79 931

29 617

11 498 527

Correlation models and statistical analysis for the impedance values in time and frequency in order to describe the patient's response to the medication and radiotherapy

OUTCOMES

therapy

GHENT UNIVERSITY

2	0100111201			
	CLINICAL		Simulation and design of the treatment protocols (SBRT) \rightarrow personalized cancer therapy for lung tumor	
			Evaluation and prediction of the radiation induced toxicity in lung cancer (RP) \rightarrow no or less toxicity induced by radiotherapy	C
			Better outcome for the individuals compared to today's medical protocols	
	ENGINEERING	8	Performance validation of FOT data in lung cancer patients in a personalized manner	
			Physiological based models for Tumor Growth and Respiratory Impedance	
			Engineering background for lung cancer treatment	

ntact

ria.ghita@ugent.be ww.ugent.be/ea/eemmecs/en/research/dvsc/dvnamic stems-and-control

f in Ghent University





21. Mihaela Ghita, Dana Copot & Clara M. Ionescu

Modelling and Sensing of Medicine-Induced Analgesia During General Anesthesia (Mosema)

mihaela.ghita@ugent.be

Automated drug delivery in clinical anesthesia for hypnosis and neuromuscular blockade has been reported by means of multiple control strategies, but not yet integrated in a continuous intravenous infusion computer-based anesthesia system. Analgesia control is missing, as sensing and modelling nociception are yet unavailable, due to its complexity – no direct measure. In this context, the objective of this research is to adapt the existing physiologically based, mathematical model for nociceptor pathway to the effect of analgesia, but from control perspective, in order to be integrated in a fully multivariable anesthesia controller that would act as a clinical decision support system. This allows obtaining a simulation model that includes all the three components of anesthesia (hypnosis, analgesia and neuromuscular blockade), but also the interaction with the hemodynamic system (cardiac output, mean arterial pressure, respiratory rate), integrated in a single controller, with nociception stimulation as a disturbance.

DYNAMICAL SYSTEMS AND CONTROL RESEARCH GROUP Mihaela GHITA (PhD student), Dana COPOT (co-promoter), Clara Mihaela IONESCU (promoter)

MODELLING AND SENSING OF MEDICINE-INDUCED ANALGESIA DURING GENERAL ANESTHESIA (MOSEMA)





22. Kris Hectors, Wim De Waele, Mia Loccufier & Hans De Backer

Fatigue Lifetime Prediction of Complex Welded Structures

kris.hectors@ugent.be

Lifetime assessment of dynamically loaded structures is essential towards decision support for quantification of lifetime extension and optimization of predictive maintenance. Fatigue failures can have catastrophic consequences, both social and environmental. Reliable prediction of fatigue failure will lead to a substantial reduction of operation and maintenance costs for players in different sectors. The core of our current research is the development of numerical tools for structural and fatigue analysis of welded steel structures. Using finite element modeling, stress concentrations in large structures can be located and quantified. A custom developed python framework is then used to estimate the remaining lifetime of the structure.

Material Durability for Off-Shore SIM ICON SafeLife – Lifetime prediction and management of fatigue loaded welded steel structures based on structural health monitoring Program coordinator: Joachim.Antonissen@OCAS.be

Fatigue lifetime prediction of complex welded structures

Kris Hectors

prof. dr. ir. W. De Waele, prof. dr. ir. M. Loccufier, prof. dr. ir. H. De Backer

1. Introduction Lifetime assessment of dynamically loaded structures is essential towards decision support for quantification of lifetime extension and optimization of predictive maintenance. The core of our current research is the development of numerical tools for structural and fatigue analysis of welded steel structures. 2. Global structural analysis (FEA) 4. Fatigue damage accumulation A fatigue damage accumulation model is used to estimate the number Shell + beam structure S, S22 of loading cycles to failure for multi-axial, variable amplitude loading. Static structural analysis (Ava: 75%) Non-linear evolution of damage and block loading interaction effects Localization of stress are taken into account. concentrations Load cycle data Region of interest Number of applied cycles, n10⁵ 10⁶ 10⁷ 1 Fatigue life, Cycles (N) 3. Detailed analysis (FEA) Damage accumulation Submodel boundary conditions are driven by the displacements $\sigma_1 > \sigma_2$ calculated in the global analysis 90.00 79.17 68.33 57.50 46.67 35.83 25.00 14.17 3.33 $D = \sum_{i=1}^{n} \left(\frac{n_i}{N_i}\right)^{i}$ C3D20R elements Damage. Accurate stress field in critical welds for lifetime calculations Cycle ratio, $\frac{n}{N}$ 5. Lifetime assessment framework



ectors@ugent.be

GHENT

UNIVERSITY

in

The authors acknowledge the financial support of Vlaio and SIM through the MaDurOS programme Project number: 179P04718W



MaDurOS

23. Jolan Heyse, Pieter van Mierlo, Charlotte Debbaut & Vincent Keereman

Modelling of the Vascular Accessibility of Human Brain Regions using 7T MRI

jolan.heyse@ugent.be

During the last couple of years there has been a trend towards minimally invasive procedures in clinical practice. Especially in the brain, one of the most fragile structures in the human body, more and more catheter-based procedures are being introduced or are under investigation (e.g. coiling of brain aneurysms and iv-EEG respectively). However, navigation in the intricate cerebral vascular network is extremely complex and may involve passages through small, twisted blood vessels and sharp turns. This study aims to investigate which brain regions are accessible and hence are potential candidates for transvascular therapies. From a segmented MRI image of the cerebral arterial circulation, we generated a skeleton-based graph. We propose two new methods to calculate the curvature and intersection angles based on the vertex positions. Using a weighted combination of these parameters, and also the radius and edge length, a weighted version of the graph was calculated. Dijkstra's algorithm allowed to determine the optimal path towards user-specified target vessels. A vascular accessibility map was also created by dilating a masked version of the graph with a 3D spherical structuring element of specified range. The results show the significant influence of catheter dimensions on the accessibility of brain regions.

IN FACULTY OF ENGINEERING



Modelling of the Vascular Accessibility of Human Brain Regions using 7T MRI

Jolan Heyse¹, Pieter van Mierlo¹, Charlotte Debbaut², Vincent Keereman¹

¹MEDISIP, Ghent University; IBiTech, Ghent University, ²BIOMMEDA, Ghent University; IBiTech, Ghent University

Background and goal

During the last couple of years there has been a trend towards minimally invasive procedures in clinical practice. Especially in the brain, one of the most fragile structures in the human body, more and more **catheter-based procedures** are being introduced or are under investigation (e.g. embolization of aneurysms and intravascular EEG respectively). However, navigation in the intricate cerebral vascular network is extremely complex.



This study aims to investigate which brain regions are accessible and, hence, could be potential candidates for transvascular therapies. Furthermore, we wish to develop the framework for a tool that can help the neuro-interventional surgeon during preoperative planning.



Conclusion

In this study we developed a processing pipeline that's capable of generating vascular accessibility maps and determining the optimal path towards a user-specified region, starting from a segmented image of the vasculature. This way, we obtained an **initial framework for pre-operative planning of minimally invasive procedures**, inside the human brain.

Furthermore the accessibility maps for minimal intraluminal radii of 0,45 mm and 1 mm show the significant impact of the catheter radius on the accessibility of brain regions and highlight the need for smaller vascular interventional tools.

Future work will include testing of this framework on new datasets trom a larger cohort of patients and different modalities, as well as inclusion of new parameters (e.g. blood flow) and fine-tuning of the implemented methods. Vessel segmentation could also be included in the processing steps to have an end-to-end pipeline.

References

[1] Lüsebrink F. et al., 2012, Cortical thickness determination of the human brain using high resolution 3T and 7T MRI data [2] Selle D. et al., 2000, Mathematical methods in medical imaging: analysis of vascular structures for liver surgery planning [3] Peeters G. et al., 2017, A multilevel framework to reconstruct anatomical 3D models of the hepatic vasculature in rat livers [4] Oljkstra E. et al., 1959, A note on two problems in connexion with graphs



24. Joris Heyse, Maria Torres Vega, Femke De Backere & Filip De Turck

Contextual Bandit Learning-Based Viewport Prediction for 360 Video

joris.heyse@ugent.be

Accurately predicting where the user of a Virtual Reality (VR) application will be looking at in the near future improves the perceive quality of services, such as adaptive tile-based streaming or personalised online training. However, because of the unpredictability and dissimilarity of user behavior it is still a big challenge. In this work, we propose to use reinforcement learning, in particular contextual bandits, to solve this problem. The proposed solution tackles the prediction in two stages: (1) detection of movement; (2) prediction of direction. In order to prove its potential for VR services, the method was deployed on an adaptive tile-based VR streaming testbed, for benchmarking against a 3D trajectory extrapolation approach. Our results showed a significant improvement in terms of prediction error compared to the benchmark. This reduced prediction error also resulted in an enhancement on the perceived video quality.



GHENT

UNIVERSITY

CONTEXTUAL BANDIT LEARNING-BASED VIEWPORT PREDICTION FOR 360 VIDEO



Bandit Prediction

----- 3D-Extrapolation

25. Luthffi Idzhar Ismail, Fazah Akhtar Hanapiah, Joni Dambre, Tony Belpaeme & Francis Wyffels

Leveraging Deep Learning for Eye Contact Analysis in Child-Robot Interaction

Luthffiidzharbin.ismail@ugent.be

Children with cognitive impairments are known to have difficulties with social interaction skills. Literature suggests that a robot could be a useful tool to practice eye contact in child-robot interaction. We expect long-term child-robot interaction to have a positive impact on human eye contact. This study proposes a deep learning technique to quantify eye contact in child-robot interaction. We measure (1) frequency of eye contact and (2) duration of overall eye contact. This is very useful for a therapist to see the improvement of eye contact in child-robot interaction as well as its long-term transferability to human-human interaction. The video data of child-robot interaction has been collected in Malaysia and is being manually annotated for deep learning.

IDLAB. GHENT UNIVERSITY. BELGIUM

Luthffi Idzhar Ismail, Fazah Akhtar Hanapiah, Joni Dambre, Tony Belpaeme, Francis wyffels

LEVERAGING DEEP LEARNING FOR EYE CONTACT ANALYSIS IN CHILD-ROBOT INTERACTION

Children with cognitive impairments are known to have difficulties with social interaction skills. Literature suggests that a robot could be a useful tool to practice eye contact in child-robot interaction. We expect long-term child-robot interaction to have a positive impact on human eye contact. This study proposes a deep learning technique to quantify eye contact in child-robot interaction. We measure (1) frequency of eye contact and (2) duration of overall eye contact. This is very useful for a therapist to see the improvement of eye contact in child-robot interaction as well as its long-term transferability to human-human interaction. The video data of child-robot interaction has been collected in Malaysia and is being manually annotated for deep learning.

DEMOGRAPHICS OF PARTICIPANTS

Inclusion Criteria

- 1) Diagnosed as having cognitive impairment
- 2) Age 6-12 years old
- 3) No self injury or aggressive behaviour
- Able to speak English or Malay
 Able to follow simple commands
- **Exclusion Criteria** 1) Unwillingness to participate (child)
- 2) Child with mutism
- 3) Uncorrected hearing deficit
- Uncorrected vision deficit

EXPERIMENTAL FRAMEWORK

Interaction Module

- 1) Introduction to robot
- 2) Facial expression game
- 3) Song with facial expression
- 4) Attention task
- 5) Free style interaction

Flow of child-robot interaction





INTRODUCTION

- Lack of eve contact is one of the characteristics of cognitive impairment in children
- Child-robot interaction is very exciting and could promote eye contact between child and robot
- · In quantifying eye contact duration in child-robot interaction, a deep learning technique could achieve a high accuracy of detection compared to conventional methods







RESULTS

The child-robot interaction experiments have been performed in Putrajaya, Malaysia. The experiment was done after the approval of the research ethics committee and consent was received from the participant's parents or legal guardians.

- Collected data (approximately 3,000 minutes video files)
- In progress of annotating data for deep learning experiments

CONCLUSION

- The robot can be a useful tool to encourage eye contact in child-robot interaction
- Deep learning could be leveraged to provide eye-contact information to the medical personnel and can be used as a screening / diagnostic tool.

Contact

- Luthffiidzharbin.ismail@ugent.be www.ugent.be
- f Universiteit Gent
- 🥑 @ugent
- in Ghent University



26. Pankaj Jaiswal, Rahul Iyar & Wim De Waele

Enabling Qualification of Hybrid Structures for Lightweight and Safe Maritime Transport

Pankaj.Jaiswal@ugent.be

Introduction There is an increasing need for reducing the weight of heavily loaded structures, demanding the development of durable and lightweight solutions that can withstand such loads under extreme environmental conditions. For the application of marine vessels, hybrid composite-to-metal adhesive joints can reduce weight while preserving strength, leading to lighter and stronger structures. 10% weight reduction can lead to 8% less fuel consumption and less environmental pollution. Ambition Currently No certification guidelines exist to certify new ship designs using adhesively bonded hybrid joints in primary structures. QUALIFY aims to provide the necessary knowledge to remove these technological and regulatory barriers. UGent tasks Develop experimental tools to evaluate the long term structural performance of the adhesively bonded hybrid joint under representative operational and environmental conditions.



Enabling Qualification of Hybrid Structures for Lightweight and Safe Maritime Transport



Less Fuel

Less Weight

AIM

Less pollutio

More Mileage

Authors: Mr. Pankaj Jaiswal, Mr.Rahul Iyar, Prof. Wim De Waele

Soete Laboratory, Department EEMMeCS, Ghent University E-mail address: Pankaj.Jaiswal@ugent.be, Rahul.Iyar@ugent.be, Wim.DeWaele@ugent.be

Introduction

- Need for weight reduction of heavily loaded structures → development of durable and lightweight solutions that can withstand such loads under extreme environmental conditions.
- For marine vessels, hybrid composite-to-metal adhesive joints can reduce weight while preserving strength, leading to lighter and stronger structures.

Ambition

Problem & Motivation

Multidisciplinary

- No certification guidelines for new ship designs using adhesively bonded hybrid joints in primary structures.
- QUALIFY aims to provide the necessary knowledge to remove these technological and regulatory barriers.

UGent tasks

Develop experimental tools to evaluate the long term structural performance of the adhesively bonded hybrid joint under representative operational and environmental conditions.

Development and Evaluation of Testing Methodology for Single Lap Adhesive Joints







Fatigue testing of Double Lap Hybrid Adhesive Joints & Screening of Failure Mechanisms



27. Ádám Kalácska, Jacob Sukumaran & Patrick De Baets

Tribological Investigation of Tillage Tools

adam.kalacska@ugent.be

In agricultural applications especially in soil engaging tools (e.g. goosefoot tines) severe wear is expected during operation. To determine a better performing material the first step is to identify the dominant wear mechanism on the real component. Optical 3D profilometry and microscopy of the worn surface were performed and degree of penetration from the wear scratches was calculated to verify the wear micro-mechanisms. A segment specific wear mechanism was identified and microcutting was observed to be dominant hence the ideal new candidate material has good wear resistance against micro-cutting. Lab-testing conditions were set to reproduce the same wear micromechanisms as identified from the in-field. The connection link between the micro scale testing of single-asperity, the macro scale of multi-asperity and the in-field tests was the same wear mechanism. In the lab-tests the same material ranking was confirmed regarding wear rate and the material response was investigated in detail for each wear micro-mechanism. As an outcome of the tests a tempered martensitic steel was the best performing material and was proposed for the application.

SOETE LABORATORY - EEMMECS (EA08)

Ádám Kalácska

promoters: Dr. Jacob Sukumaran, Prof. Dr. Patrick de Baets

TRIBOLOGICAL INVESTIGATION OF TILLAGE TOOLS

1. Identify dominant wear mechanisms on real component



Fig. 1 – Tillage tools during operation

In-field investigation of agricultural tines (Köckerling) Operating

- distance: 145 km
- speed: 8-12 km/h
- depth: 5-8 cm deep
- soil: loam and sand
 - >Severe wear (large mass and dimension losses) >Goal: determine a more wear resistant material



Fig. 2 – Wear of agricultural tine after 145 km

Wear mechanism identification



characterization of wear grooves with degree of penetration (Dp) Dp(tip radius R [µm], load W [N], hardness) >tine regions segmented (top, cutting side)



2. Define and relate representative lab tests to in-field investigation

"The worn surface features of the tillage test specimens were observed to be closer to those produced by the pin-on-abrasive disk test than produced by the rubber wheel tests" Control and Disc

>Dominant wear mechanism: micro-cutting (Fig. 3)

Lab testing conditions were set to reproduce the same wear micro-mechanisms as identified from the in-field investigation. >Connection link between in-field, single-asperity and multi-asperity contact tests was the same abrasion wear micro-mechanism (characterized by Dp of the resulted grooves/scratches)

Single-asperity test

GHENT

UNIVERSITY

Fig. 4 - Single-asperity test set-up



Multi-asperity test

- >variables: load, abrasive particle size >Investigations: hardness, surface morphology, microstructure

ig. 5– Multi-asperity test set-up

Figure 6 -Wear rate in function of grit size

Grit size [um]

neasurement

Pin holder

Multi-asperity

contact: pin

3. Choose the best material for application (more wear resistant)

Wear rate [mg/m]

8.0

7.0

60

5.0

4.0

3.0

2.0

1.0

0.0

(SiC)

ed a

ids: (17,3-11,4 N)

50

Conclusion and material selection

Results shows the different material responses given for each micro-mechanism (micro-ploughing, wedge formation and micro-cutting)

- Ranking candidate materials considering wear rate: Multi-asperity tests (Fig. 6)
- Tempered martensitic steel (blue lines) performed the best resulted the lowest wear rate in both conditions
- Single asperity test (Fig. 7) confirm these findings and show, that the other two materials suffer more deep scratches during the tests, hence more material is removed.



Fig. 7 - Single-asperity test results with 90° indenter cone angle: groove depth in function of load and abrasive paper (grit) size





R² = 0.9997 R² = 0.9938 R² = 0.9988 R² = 0.9987

200

28. Mojtaba Khayatazad, Wim De Waele, Mia Loccufier & Hans De Backer

Structural Health Monitoring of Welded Steel Structures

Mojtaba.khayatazad@ugent.be

Several catastrophic collapses of modern structures have been reported in recent years. These accidents result from undetected fatigue cracks and corrosion degradation. To avoid them, some health monitoring techniques such as traditional visual inspection, modal methods and fibre optics which have their own drawbacks have been applied. Piezoelectric materials are widely used in different fields including structural health monitoring, these smart materials which are low cost and low weight can be easily surface mounted on structures for online monitoring. Application of Piezoelectric material is also followed by some challenges. In the current work, some methods are proposed to solve these problems.

Material Durability for Off-Shore

SIM ICON SAFELIFE _ Lifetime prediction and management of fatique loaded welded steel structures based on structural health monitoring

Program coordinator: Joachim.Antonissen@OCAS.be

Structural Health Monitoring of Welded Steel Structures

M. Khayatazad, Prof. W. De Waele, Prof. M. Loccufier, Prof. H. De Backer 1@LIGENT P

Structural Health Monitoring

Traditional visual Inspection

- · Periodic inspections
- · Uneconomical for large and complex structures

Modal methods

· Negligible effect of damage on structural behavior before critical conditions are met

Fibre optics

Surface mounted

Online monitoring

- · Monitoring of global deformations of structures
- · No direct measurement of damage

Crack Monitoring using Electro-Mechanical Impedance Sensors

Sensor types

PZT Ceramic

Smart material (sensor + actuator) Low cost and light weight

Impedance signatures



Research challenges and approach

Composite

#1: Damage versus environmental influences

· Temperature, moisture and load change impedance signatures \rightarrow false alarms to be avoided





Effective Frequency Shift

GHFNT

UNIVERSITY



#2: Threshold value of damage index

- · Large number of impedance measurements and RMSD values
- Threshold value based on predefined level of confidence



#3: Frequency range & damage localization

Experiments and finite element simulations



The authors acknowledge the financial support of Vlaio and SIM through the MaDurOS programme (grant HBC.2017.0606)



Clusters for Growth

u±3a

MaDurOS

Undetected fatigue cracks and/or corrosion

Sudden collapse

degradation



Mixture Effects on Alkane and Cyclo-Alkane Hydroconversion Over PT/USY Catalyst

nebojsa.korica@uGent.be

Hydroconversion over bifunctional catalysts is one of the most common ways to convert both oil cuts and alternative feedstocks into more valuable products. The reaction mechanism comprises of metal-catalyzed (de)hydrogenation and acid-catalyzed reactions of isomerization and cracking. These reactions occur on a bifunctional catalyst, which usually consists of Pt deposited on a zeolite. The isomer yield is maximized when the reactions on the acid sites are rate determining, i.e. when so-called ideal hydrocracking occurs. Realistic feeds are complex mixtures of alkanes, cycloalkanes, and aromatic molecules. Cycloalkanes have already been observed to exert a negative impact on conversion and isomer selectivity in n-alkane hydroconversion, when they are fed together in mixture. Therefore, cy-cloalkanes in mixture are expected to disturb metal-acid balance and lead to non-ideal hydrocracking, where dehydrogenation becomes kinetically relevant step, too. The effect of cycloalkanes seems to qualitatively be attributed to physisorption, dehydrogenation, or/and protonation steps. The Single-Event MicroKinetic (SEMK) methodology has manifested itself as a particularly convenient tool for simulating hydroisomerization and hydrocracking reactions as it accounts for all elementary steps employing parameters with a precise physico-chemical meaning. This methodology will enable us to assess experimental data and quantify phenomena which are impacted by different molecules.

MIXTURE EFFECT ON ALKANE AND CYCLOALKANE HYDROCONVERSION OVER PT/USY CATALYST

Nebojša Korica, Pedro S.F. Mendes, Guy B. Marin, and Joris W. Thybaut

Laboratory for Chemical Technology Technologiepark 914, 9052 Ghent, Belgium https://www.lctugent.be

<u>Justification</u>

- > Hydroconversion (isomerization and cracking) occurs over bifunctional catalyst with metal and acid function.
- > Ideal behavior of catalyst (well-balanced catalyst) The rate depends on acid catalyzed reactions only.
- Process conditions dependency (temperature, pressure, H₂/HC, and C number)¹
- > How does the presence of different type of hydrocarbon (cycloalkane) impact ideal catalytic behavior?
- > State-of-the-art: Cycloalkanes impact conversion and selectivity in the reaction of n-alkane hydrocracking ².





Concluding remarks and future work

- > Ideal hydrocracking acid catalyzed reactions are rate-determining.
- Catalyst ideal behavior is dependent not only on process conditions including the type of co-fed hydrocarbons.
- Cycloalkane impact might be related to competitive adsorption to zeolite (physisorption) or to acid site (protonation), or to dehydrogenation activity of metal site.
- Research approach : Combined experimental and modeling (SEMK) approach to understand complexity of the system



Goals:

- 1º To identify the phenomena impacted by cycloalkane in mixture
- 2° To quantify the effects described under 1° by use of SEMK model
- 3° To evaluate the relationship between the observed phenomena and ideal behavior of bifunctional catalyst

<u>References</u>

- 1 Thybaut,J.W., Laxmi Narasimhan,C.S., Denayer,J.F., Baron,G.Y., Jacobs,P.A., Martens,J.A., and Marin,G.B., Ind. Eng. Chem. Res. 2005, 44, 5159-5169
- 2 Sanchez, P., Dorado, F., Ramos, M.J., Romero, R., Jimenez, V., and Valverde, J.L., Applied Catalysis A: General 2006, 314, 248-255
- 3 Thybaut,J.W., Marin,G.B., Baron,G.V., Jacobs,P.A., and Martens,J.A., Journal of Catalysis 2001, 202, 324-339
- 4 Chavarria-Hernandez, J.C., Ramirez, J., and Baltanas, M.A., Catalysis Today 2008, 130(2), 455-461

E-mail: Nebojsa.Korica@ugent.be

30. Srdan Lazendíc, Aleksandra Pizurica & Hendrik De Bie

Hypercomplex Algebras for Dictionary Learning

Srdan.Lazendic@ugent.be

This work presents theoretical and practical results of the recently introduced quaternion and octonion algebra models for sparse representation of multichannel images. Opposed to the classical dictionary learning techniques that concatenate image patches from collocated windows of the given multispectral image and then threat them by classical K-SVD, hypercomplex algebra models treat all the spectral bands simultaneously by assigning spectral channels to different imaginary units. This approach better preserves interchannel dependencies and leads to better preservation of spectral fidelity in false color images of the reconstructed multispectral image. Apart from the theoretical results for the newly introduced model, the potential of the octonion based model is demonstrated by conducting experiments for image reconstruction and denoising of color images.



Srđan Lazendić, Aleksandra Pižurica and Hendrik De Bie

Clifford Research Group and Group for Artificial Intelligence and Sparse Modelling, UGent-imec Faculty of Engineering and Architecture, Ghent University, Belgium

GHENT UNIVERSITY

{Srdan.Lazendic; Aleksandra.Pizurica; Hendrik.DeBie}@UGent.be

FACULTY OF ENGINEERING



Selected publications:

S. Lazendić, H. De Bie, and A. Pižurica, "Octonion sparse representation for color and multispectral image processing," in *Proceedings of the 26th European Signal Processing Conference (EUSIPCO 2018)*. EURASIP, 2018, pp. 608–612.

S. Lazendić, A. Pižurica, and H. De Bie, "Hypercomplex algebras for dictionary learning," in Early Proceedings of the AGACSE 2018 Conference. Unicamp/IMECC, 2018, pp. 57–64.

0

31. Marija Lazova & Michel De Paepe

Determining the Heat Transfer Phenomena of Supercritical Fluids Under Orc Condition

Marija.Lazova@ugent.be

Determining the Heat Transfer Phenomena of Supercritical Fluids under ORC Condition The aim of this work is to show that there are possibilities for increasing the performance of the Organic Rankine Cycle. Transcritical ORC is introduced as promising technology for low grade waste heat recovery (with main focus on industry processes) within temperature range of 90°C and 200°C. The advantage of this cycle is a better thermal match between the heat source and the working (organic) fluid temperature profiles in the supercritical heat exchanger. This leads into improvement of the overall cycle efficiency. Moreover, at supercritical state there are strong variations of the thermophysical properties of the fluid. As the value of the heat transfer coefficient depends on these properties of the working fluid, it is important to study and understand the behaviour of the thermophysical properties of the fluid going from subcritical to supercritical state. Hence, there are many challenges in the design process of components of such cycles. For instance, for designing heat exchangers suitable to work at relatively high pressure and temperature and at strong properties variations of the fluid further research has to be conducted. Therefore, a new test facility was designed and built.

APPLIED THERMODYNAMICS AND HEAT TRANSFER Marija Lazova, Michel De Paepe DETERMINING THE HEAT TRANSFER PHENOMENA OF SUPERCRITICAL FLUIDS UNDER ORC CONDITION



GHENT UNIVERSITY

32. Haolin Li

100-GS/s Sigma-Delta All-Digital Radio-over-Fiber Transmission for Millimeter-Wave Communications

Haolin.li@ugent.be

The 5G wireless networks drives research in the direction of massive device connectivity, high data rates and decreased latency. Cloud radio access networks (C-RANs) in combination with radio-over-fiber (RoF) can be a key-enabling technology to realize this. Three different realizations of the radio-over-fiber link, including digitized radio-over-fiber (DRoF), analog radio-over-fiber (ARoF) and sigma-delta-over-fiber (SDoF), have been discussed in prior works. SDoF simplifies RRHs by oversampling the signal and translating it to a bi-level signal, leveraging the benefits of both the DRoF and ARoF. However, moving to higher frequency bands such as >24 GHz bands, SDoF has not been reported owing to the limited sampling rate of the state-of-the-art SDMs. Our recent work eliminates the sampling rate limitation of SDMs and shifts high-frequency operations to a single-bit multiplexer, making the realization of a real-time SDoF transmission for >24 GHz band feasible. In this work, we have successfully extended the SDM's sampling rate from 21 GS/s to 100 GS/s (~5x increase), which is the fastest SDM ever reported. As an upgrade of sub-6 GHz SDoF systems, we present the first demonstration of a real-time 100-GS/s all-digital SDoF transmission at 1562 nm covering the 22.75-27.5 GHz band.
unec

GHENT

UNIVERSITY



Haolin Li Haolin.li@ugent.be



IDLab, INTEC, Ghent University - imec – Technologiepark-Zwijnaarde 15, B-9052 Ghent

33. Bo Kang, Jefrey Lijffijt & Tijl De Bie

Knowledge Discovery from High-dimensional Data

jefrey.lijffijt@ugent.be

Representation learning (RL) methods enable the analysis of high- dimensional data by constructing a low-dimensional embedding that represents the relevant factors of variation in the data as well as possible. RL methods are often used to derive 2-D embeddings to visualize in a scatter plot, in order to uncover previously unknown patterns. However, a single static 2-D visualization typically represents only part of the data structure. We present the concept of subjectively interesting representation learning, where we embed data conditioning on an informative prior. By inserting information in a prior, we can discount the corresponding factors or structure that we already know about, enabling the 2-D embedding and visualization to show complementary information. In the poster we discuss several tools that we have developed using this concept.

FACULTY OF ENGINEERING III AND ARCHITECTURE

Knowledge Discovery from High-dimensional Data

Bo KANG. Jefrev LIJFFIJT. Tiil DE BIE*

AIDA Group, IDLAB, ELIS

*In collaboration with many others

WHY

is this important?

- Breadth of collected data is increasing
- Creates potential to discover more complex patterns
- is this difficult?
- Cannot read
- Don't know how to visualize

SOTA

Project data into 2-D space [jargon: dimensionality reduction, renresentation learning

- Tens of methods

Problem with SOTA

Provides single static view

- Which shows limited information

Does not account for what we know about the data

- Most obvious patterns may be expected

How we address this

Methods for subjectively interesting representation learning

- 1. Encode a prior
- 2. Compute representation
- Explore

Naturally allows for iterative analysis process

Subjectively Interesting Component Analysis



Fig. 1: German voting data, (a) Principle Component Analysis. (b) SICA (our method) with 'east vs. west' prior. Top component while accounting for east vs. west highlights a very different pattern in the data.

References

- Conditional Network Embeddings In Proc of International Conference on Learning Representations (ICLR) 2019
- Controlling interview interview of the original content of the original content of the original original content of the original content ori
- Conference on Data Engineering (ICDE), 2018. - CLIPPR: Maximally Informative CLIPped PRojections with Bounding Regions. Poster paper at IEEE Visual Analytics in Science and
- Technology (VAST), 2018. Subjectively Interesting Component Analysis: Data Projections that Contrast with Prior Expectations. In Proc. of ACM SIGKDD
- International Conference on Knowledge Discovery and Data Mining (KDD), 2016. Interactive Visual Data Exploration with Subjective Feedback. In Proc. of The European Conference on Machine Learning and
- Principles and Practice of Knowledge Discovery (ECML-PKDD), 2016. A Constrained Randomization Approach to Interactive Visual Data Exploration with Subjective Feedback. *IEEE Transactions of Knowledge and Data Engineering*, under review.



Fig. 2: Synthetic dataset with points that can be clustered in two different ways. (a) Scatter plot based on t-SNE embedding. (b) embedding accounting for clusters as colored in Fig. a: four new clusters become apparent that are complementary, as shown by the mixed colors in each cluster, (c) accounting also for the four clusters found in Fig. 2h no substantial structure remains

Conditional Network Embedding



Fig. 3: Network connecting students, courses, teachers, etc., in a CS department. (a) Plain network embedding, (b) Embedding with prior on the number of connections for every node (i.e., object) in the network. The degree of nodes is difficult to embed in a Euclidean space, because nodes with higher degree need to be closer to more nodes than those with a lower degree, on top of any cluster or other structure present in the data. Allowing the embedding not to care about degree, allows other interesting structure to become more visible. Here the study programs emerge.

Auto-zoom



Fig. 4: 2-Dimensional scatter plots based on linear dimensionality reduction methods (such as SICA, here on the left) are often ineffective in showing the data, due to the data containing outliers. (a) plot based on top two principal components, (b) automatically selecting an appropriate bounding box reveals the dinosaur.

Subjective Interactive Visual Data Exploration



Fig. 5: Interface of our prototype tool SIDE that enables interactive exploration of data

ĪTITI GHENT UNIVERSITY

The research leading to these results has received funding from the European Research Council under the European Union's Seventh Framework Programme (FP7/2007-2013) / ERC Grant Agreement no. 615517, from the FWO (project no. 6091017M, G0F9816N), and from the European Union's Horizon 2020 research and innovation programme and the FWO under the Marie Skidowska-Curie Grant Agreement no. 66501.



34. Azer Maazoun, Stijn Matthys, David Lecompte & John Vantomme

New Technique to Protect RC Structures against Explosions

azer.maazoun@ugent.be

In recent years, numerous explosions related to terrorist attacks and industrial accidents have occurred all over the world. These explosions directed towards vulnerable structures cause considerable damage and loss of life. In consequence, the emerging challenge of critical infrastructure protection has been recognized and nowadays there is a desire to upgrade the blast resistance of existing reinforced concrete (RC) structures. The present research proposes a new technique to increase the flexural resistance of RC hollow core slabs using carbon fiber reinforced polymer (CFRP) as externally bonded reinforcement (EBR) against explosions. Experimental and numerical results are discussed to highlight the efficiency of this technique for blast protection.



MAGNEL LABORATORY FOR CONCRETE RESEARCH & MILITARY AND PROTECTIVE ENGINEERING DEPARTMENT

Ir. Azer Maazoun, Prof. Stiin Matthys, Prof. David Lecompte, Prof. John Vantomme

NEW TECHNIQUE TO PROTECT RC STRUCTURES AGAINST EXPLOSIONS

PROBLEM

In recent years, numerous explosions related to terrorist attacks and industrial accidents have occurred all over the world. These explosions directed towards vulnerable structures cause considerable damage and loss of life.







Industrial accident in Tianiin. China 2015





Terrorist attack at Zaventem Airport, Belgium 2016

Upgrading of structural robustness is necessary ! How can we improve the resistance of existing RC structures?

Composite Materials in Civil Engineering

One of today's state-of-the-art techniques for strengthening of reinforced concrete structural elements is the use of Carbon Fiber Reinforced Polymer (FRP) composite strips as Externally Bonder Reinforcement (EBR) This is justified for quasi-static loads by the high strength, light weight and excellent durability characteristics of FRR EBR in comhanient with their ease of application.





The use of FRP as EBR has been demonstrated as a very efficient technique mainly for static load conditions Time to test EBR under explosion !

EFFECTIVENESS OF STRENGTHENING

1. Blast tests

GHEN1 UNIVERSITY

A simply supported hollow core slabs with a span of 6m are tested under an explosion of 1,5Kg of C4 at a distance of 0,5m from the target. One of the slabs is used as a reference and the remaining slabs were strengthened with different ratios of CFRP







Simply supported hollow core slab

2. Non linear finite element modelling

Numerical analysis is carried out using the finite element software LS-DYNA. The hollow core slabs are modeled with Lagrangian formulation. Due to the symmetry of the geometry and the blast loading, taking into account the time cost of the simulations, a quarter model is adopted.



3. Experimental and numerical analysis

Distribution of cracks at mid span of the slab is well predicted by both applied concrete material models. Compared to experimental data, both model variants yield a good prediction of the maximum deflection at the mid span of the slab.





Deflection time history at the mid span of the RCHC slab

Concrete Damage Release 3 model (MAT-072R3)

Tests	CFRP reinforcement ratio (mm²/m)	Exp max deflection (mm)	Num max deflection (mm)	Exp/Num
Slab A1	-	65,5	67,4	0,97
Slab A2	200	55	58	0,95
Slab A3	250	46	49	0,94

CONCLUSIONS

CFRP strips as EBR are an efficient technique to upgrade the blast resistance of the hollow core slabs and increase significantly the flexural strength and the stiffness of the slabs under blast loads. The maximum upward deflections are reduced by 16 to 30 % when using CFRP reinforcement ratio equals 200mm²/m and 250mm²/m, respectively.





35. Mohsen Sharifi, Rana Mahmoud, Josué Borrajo Bastero, Eline Himpe & Jelle Laverge

Development of Hybridgeotabs Design Methodology

Rana.mahmoud@ugent.be

GEOTABS is a combination of a geothermal heat pump with thermally activated building systems. TABS is a radiant heating and cooling system when combined with a geothermal heat pump, it allows to make efficient use of low-grade renewable energy sources. TABS has high thermal inertia and if sud-den fluctuations happen in the heat demand, thermal comfort should not be provided by TABS alone. For solving this problem a secondary system is used to assist TABS in compensating heat demand. Therefore, GEOTABS will compensate parts of the heat demand which are smooth enough, called baseload, and the secondary system will take care of fluctuations. We are developing an automated methodology to calculate dynamic heat demand of buildings starting from general building data and to size the main hybridGEOTABS components using these heat demand curves. This automated process will assess the sizing of numerous cases in Europe in an automated process. Easy-to-use design guidelines will be derived from the analysis and meta-analysis of the obtained sizes for a variety of buildings and climates considering the effects of optimized control. We are going to validate the credibility of the whole design methodology by applying it on a validated building simulation model.

BUILDING PHYSICS, CONSTRUCTION AND CLIMATE CONTROL

Mohsen Sharifi, Rana Mahmoud, Josué Borrajo Bastero, Eline Himpe, Jelle Laverge <u>DEVELOPMENT OF HYBRIDGEOTABS DESIGN</u> <u>METHODOLOGY</u>

hybridGEOTABS

GEOTABS refers to the combination of a geothermal heat pump with thermally activated building systems, and is applied in low temperature heating and high temperature cooling of buildings. TABS is a radiant heating and cooling system and is beneficial in terms of thermal comfort and energy efficiency. When combined with a geothermal heat pump, it allows us to make efficient use of low grade renewable energy sources.

Encenic date of our grade renewable energy sources. TABS has a high thermal inertia and if sudden fluctuations happen in the heat demand, thermal comfort should not be provided by TABS alone. For solving this problem a secondary system is used to assist TABS in compensating heat demand. Therefore, GEOTABS will compensate parts of the heat demand which are smooth enough, called baseload, and secondary system will take care of fluctuations.

The design of hybridGEOTABS requires the sizing of both the GEOTABS and the secondary energy sources which make the design procedure complicated and increases the design cost. We are developing an automated methodology to (1) calculate dynamic heat demand of buildings starting from general building data and (2) size the main hybridGEOTABS components using these heat demand curves. This automated process will be used to assess the sizing of numerous cases representing the EU building stock, since the whole process is automated. Easy-to-use design guidelines will then be derived from the analysis and meta-analysis of the obtained sizes for a variety of buildings and climates, taking into account the effects of optimized control. We are going to validate the credibility of the whole design methodology by applying it on a validate building simulation model.



BES-model of Haus M

A model of a building have been developed in Modelica using Dymola. The data was obtained from a real building located in Zurich called Haus M. The model considers more than 10 parameters related to weather conditions in the location of the building Haus M is a residential block, which means that the use of the building cannot be modeled with precision as other buildings -such as offices blocks, for example-. Nevertheless, general occupation profiles have been defined and included. It also includes all characteristic parameters related to materials, heating and ventilation systems. The validation process consisted in simulations of the model of Haus M and comparing the results with the measured data in the real building in the years 2016 and 2017.

Load duration curves

The building stock data contains general information about the different population at the stock level. The data are one-dimensional general data such as building volume, gross floor area and U-values. If we are able to model the building stock we can generate heating and cooling demand curves, and the related load duration curves. Thus, facilitating the process of sizing the hybrid GEOTABS components. We developed a methodology that first allows fitting one dimensional data into a three dimensional geometry that can be modeled, second generates heating and cooling load duration curves in an automated way.



Baseload concept

After looking at the performance of IABS and its limitations, it is possible to find a general definition for the for power of TABS as the baseload. If fast changes happen and if TABS is supposed to compensate them, in some moments power of TABS will be higher or lower than heat demand. (region C in Figure) We need an optimal control of the system for minimizing the total energy use by calculating regions A, B, and C. To sum up, the "baseload" is the maximum power that the TABS can provide without resulting in energy wasting in the near future.





Contact

Rana.mahmoud@ugent.be www.hybridgeotabs.eu www.architectuur.ugent.be Universiteit Gent @ @ugent Ghent University



Funded by the European Commission under the Horizon 2020 Programme: project number 723649 36. Marc Mansuy, Maxim Candries, Katrien Eloot & Bernard Wéry

Optimization of a Ship Turning Basin Using Manoeuvring Simulators

marc.mansuy@ugent.be

The capacity requirements of a berthing area may increase significantly over the years and inland waterways should be prepared to accommodate larger ships. This may involve adjustments such as extending locks or providing larger turning basins. This problem is illustrated here by the improvement of turning possibilities of big ships in front of the berthing area "Quai des Trois Fontaines" on the river Meuse (France). In a first phase, real time simulations have been executed at Flanders Hydraulics Research to identify the manoeuvring difficulties of ships of 80m, 85m and 90m long in the actual situation. The current flow has been implemented using a 3D hydraulic model developed by IMDC (International Marine and Dredging Consultants). In a second phase, low cost modifications of the waterway have been proposed and simulated. The accessibility is evaluated based on different safety criteria and pilots experience.

OPTIMIZATION OF A SHIP TURNING BASIN USING MANOEUVRING SIMULATORS

Marc Mansuy¹, Maxim Candries¹, Katrien Eloot², Bernard Wéry³

Maritime Technology Division, Ghent University¹, Flanders hydraulics research (FHR)², IMDC³

1. Introduction

A turning basin is located in front of the Quai des 3 Fontaines (Chooz, France) to allow ships of 80m to turn before loading at the quay. Strong currents are expected in this area and some skippers do not feel confident about the safety of turn, especially because of the shallow zone present on the right bank. With a diameter of 95m, the turning basin does not comply with any of the guidelines found in the literature. Therefore a manoeuvring simulator specifically developed for inland navigation (Flanders Hydraulics Research) has been used to study the possibilities to accommodate bigger ships.



Ship trajectory

3. Analysis based on safety criteria and skippers opinion

	Reserve main propeller	Reserve bow- thruster	Reserve rudder	Rudder variations	Min distance to isolines
Inacceptable	< 10%	< 10%	< 10%	> 4°/s	0 m
	10% - 25%	<30%	<50%		< 1 m
Acceptable	10% - 50%	<100%	50% - 70%	2° – 4°/s	1 – 3 m
No constraints	> 50%	100%	>70%	< 2°/s	>3 m

5. Proposition of low cost modifications









Solution 3: use of a dolphin



6. Conclusion

The final dimensions and equipment of the turning basin were derived from the simulations to accommodate ships of 90m long. Finally, the costs of each solution have been estimated and a risk analysis has been carried out by IMDC to help the stakeholders with the decision making (including the local community, industrial companies, VNF - Voies Navigables de France,...).

7. Acknowledgements

The	content	of	this	poster	is	based	on	а	project
com	missione	d by	Voie	s Naviga	able	es de Fr	ance) ÷	/NF).

The results of the analysis were discussed with representatives and stakeholders of the inland navigation sector and other users of the French waterways, whose valuable input is acknowledged. Contact

Marc Mansuy Research Staff

marc.mansuy@ugent.be www.shallowwater.ugent.be







KNOWLEDGE CENTRE MANOEUVRING IN SHALLOW AND CONFINED WATER





37. Samie Mabpool, Jens Baetens & Greet Van Eetvelde

Agent Based Model of a Virtual Power Plant

Samie.maqbool@ugent.be

The poster provides the preliminary results of an agent-based model of a virtual power plant. The model helps to gain insight into the unharnessed potential of consumer flexibility and provides answers to the concerns of each actor on the grid. With the rapid increase of renewable energy injection in the grid, the unpredictability of produced power is a great concern for all actors. Hence, this model helps to find the best strategy that will not negatively affect any of the actors and provide a sustainable and clean source of power to all agents. Especially, the large process industry provides an untapped resource for balancing the grid and controlling extreme market prices of electricity.

EELABB ECM - ENERGY AND CLUSTER MANAGEMENT GROUP

Magbool A.S., Baetens J., Van Eetvelde G.

AGENT BASED MODEL OF A VIRTUAL POWER PLANT

Challenge:

RE (Renewable Energy) provision is prone to unpredictability, however, the Tradable Green Certificate system provides windfall profits to the RE producers [1]; and even results in negative electricity market prices.

Solution :

The unharnessed potential of consumer flexibility is explored by the help of agent-based modelling (ABM) by providing support for each decision making agent to balance the grid and avoid extreme market prices.

The model answers questions for each actor:

- Process Industry : How does being part of a VPP increase profit? Policy makers : Should the net-metering be replaced by real-time metering? Should the subsidy for the renewable energy producers be taken away?
- Windfarm owners : Is it more profitable to be flexible in production (storage + curtailment)?
- Households / SMEs : Between real-time metering and net-metering, which fulfils the demand for the least bill?

Industrial Symbiosis and VPP (LESTS aspects)

Pooling the resources of process industries provides a sustained response to unpredictable RE production.



Extending the model

To include the effect of different market environments: Day ahead market and Intra-day market Comparing flexibility of producers against flexibility of consumers (large industries).



Flowchart of an industrial agent's decision making process in Day ahead market and the Intra-day market

Conclusion

Contact

Samie.magbool@ugent.be www.ugent.be/ea/eemmecs/en/research/eelab/ecm/epos

- f Universiteit Gent
- y @ugent
- in Ghent University

References

no of industries

- [1] A. Verbruggen, "Tradable green certificates in Flanders (Belgium)," Energy Policy, vol. 32, no. 2, pp. 165-176, Jan. 2004.

ion of co

GHENT UNIVERSITY



Output of the model (6 months)

Agents and their interaction

Preliminary results

shore a

38. Alexandru Mara, Jefrey Lijffijt & Tijl De Bie

EvalNE: A Framework for Evaluating Network Embeddings on Link Prediction

alexandru.mara@ugent.be

In this paper we present EvalNE, a Python toolbox for evaluating network embedding methods on link prediction tasks. Link prediction is one of the most popular choices for evaluating the quality of network embeddings. However, the complexity of this task requires a carefully designed evaluation pipeline to provide consistent, reproducible and comparable results. EvalNE simplifies this process by providing automation and abstraction of tasks such as hyper-parameter tuning and model validation, edge sampling and negative edge sampling, computation of edge embeddings from node embeddings, and evaluation metrics. The toolbox allows for the evaluation of any off-the-shelf embedding method without the need to write extra code. Moreover, it can also be used for evaluating link prediction methods and integrates several link prediction heuristics as baselines. Finally, demonstrating the usefulness of EvalNE in practice, we conduct an extensive analysis where we replicate the experimental sections of several influential papers in the community.

EvalNE: A Framework for Evaluating Network Embeddings on Link Prediction

 $\widehat{}$

GHENT UNIVERSITY



Alexandru Mara, Jefrey Lijffijt, and Tijl De Bie

Research Interest	Evaluation choices	Experimental Results
Address the reproducibility crisis in the field of Network Embeddings (NE) for Link Prediction (LP).	f Network Preprocessing Train/test fraction	Reproducing Node2vec [1] experiments:
 Facilitate evaluation of NE methods and compariso to existing ones. 	n Edge splits Non-Edge sampling	Facebook PPI artitiv Som of
Motivation	Node to Edge embeddings LP heuristics	Centrem Ringhest 6.3491 0.0417 0.1377 0.3465 Jacorati Coefficient 0.0511 0.0262 0.046 0.2381 Adverse Adar 0.3537 0.0461 0.127 0.1398 Markense Adar 0.3537 0.0461 0.127 0.1398 Park Amatoment 0.3141 0.327 0.1399 0.0119 0.3111 Unit 0.0417 0.1399 0.0119 0.3111 0.0166 0.244
Non-standard evaluation LP a complex task Current libraries	Binary classifiers Evaluation metrics	meth2ver 0.0349 0.0405 0.0005 0.0609 Despiration 0.0107 0.0007 0.0007 0.0007 Link 0.0004 0.0007 0.0007 0.0007 ende/cover 0.0013 0.0108 0.0007 0.0007 ende/cover 0.0013 0.0006 0.0007 0.0007 ende/cover 0.013 0.0006 0.0007 0.0007 ende/cover 0.013 0.0006 0.0006 0.0006 ende/cover 0.013 0.0006 0.0006 0.0006
Network Embeddings	Our Framework	Deciminal 0.0064 0.1319 0.0706 0.2311 LINE 0.0717 0.1212 0.0441 weak-base 0.022 0.0905 0.0226 Sam of dHs 0.0298 1.3467 1.2001
A mapping of network nodes to <i>d</i> -dimensional vector representations	Eval	Reproducing CNE [2] experiments:
Node embeddings and edge embeddings After embedding a network, standard machine learnir tasks can be performed (e.g. clustering, link predictio	g Command line tool and API. Easily replicate any evaluation setup. Automate the method evaluation process. Run NE method scode in any language - Ende-End Predots [UPI] Proposessing + Data Sgr1 - Edge Endeding	Teach 170 1000 Berg-chuig Weight of the second seco
Notwork Node Embeddings	• Node Emb. → Node-to-Edge ¹ Dass	Reproducing PRUNE [3] experiments:
Clustering Node Classification Node Importance Community Detection	Toolbox usage 1. Fill the conf file 2. Run: \$ python evalue conf.ini	Hop-Pri Webgam Sont 82 Develvalit 0.379 0.334 0.279 Little 0.2240 0.2240 0.2384 Velocian 0.3240 0.2797 0.3332 real-back 0.3260 0.370 0.3332 Seature 0.3200 0.3324 0.2299 Seature 0.3200 0.3242 0.2294 Seature 0.5495 0.9425 0.2394
e e se se	U_2002 - Septilingension D_202002 - Septilingension D_202002 - Septilingension B002002 - Septilingension B002002 - Train B002002 - Septilingension B002002 - Septiling	Scalability experiments:
Link Prediction	[ITEADR5] [TRADITS] AVX5 = Fastock P93 ArX5 = Tradits = 0.5 DPX50 = - //ArX7/redox1/facebook_combined_txt = PA5_97(1) = Free	*
 Estimate the likelihood of the existance of edges. between pairs of nodes. Both true edges and non-edges required for evaluation 		
	(MELTER) (MELTER) (J.MELTER) (J.MELTER) (J.MELTER) Second confliction short characterized short characteriz	10** -
Train edges Test edges	CONVERSION IS NOT (DECENTIONS) WHIN, DVF A readow depends line METEORY, DVF a plane a speer a restrict reactor 200 plane a speer a restrict for another 100 June plane a speer a restrict for a restrict 100 June Plane a speer a restrict for a restrict 100 June Plane a speer a restrict for a restrict 100 June Plane a speer a restrict for a restrict 100 June Plane a speer a restrict for a restrict 100 June Plane a speer a restrict for a restrict 100 June Plane a restrict 100 June 100 June 100 June Plane a restrict 100 June 100 Ju	Figure 1: Scalability plots showing the evolution of the execution time w.r.t. a) the number of node in a graph and b) the proportion of train and test edges requested.
Original network	<pre>com/_statutes - v_; com/_statutes - v_; c</pre>	Acknowledgements: This work was supported by the ERC under the EU's Seventh Framework Programme (P77/2007/2011) / ERC Grant Agr. no. 615517, FWO (project no. 6091017M, 6099816M), the EU's Horiton 2020 research and innovation programme and the FWO under the Marie Süddowska-Curie Grant Agr. no. 665501.

39. Hannes Mareen, Johan De Praeter, Glenn Van Wallendael & Peter Lambert

Fast Compression of Watermarked Videos

hannes.mareen@ugent.be

Video watermarking is a well-established technology to help identify digital pirates when they illegally re-distribute videos. To securely distribute videos, every person receives a unique, watermarked version of the video. When numerous watermarked versions of a video are created, they should all be compressed before distributing them. Unfortunately, compressing a single video requires a lot of resources, let alone thousands of videos. Therefore, this poster presents a novel method to speed up the compression of watermarked videos. That is, only the unwatermarked video is compressed with a traditional video encoder. Then, the optimal coding decisions from this compressed video are reused during the compression of the watermarked videos. In contrast, state-of-the-art architectures re-calculate the optimal coding decisions for every watermarked video. Due to a high correlation of the re-used coding information with the optimal coding information, the compression efficiency and watermark robustness decrease only slightly. Most importantly, the proposed fast encoder speeds up the compression process with a factor of about 120. Consequently, video distributors can use the proposed architecture to deliver high-quality watermarked videos on a large scale without requiring an excessive amount of resources. IN FACULTY OF ENGINEERING

FAST COMPRESSION OF WATERMARKED VIDEOS



Contact: 🖙 Hannes.Mareen@UGent.be

GHENT

UNIVERSITY

IDLab

40. João Costa Mateus, Dieter Claeys, Veronique Limére, Johannes Cottyn & El-Houssaine Aghezzaf

Human-Robot Collaborative Assembly Design Methodology

Joao.CostaMateus@ugent.be

The evolution of cobots and workplace monitoring hardware over the last years have made direct human-robot collaboration a possibility. While the inherent safety of light weight cobots renders them human friendly, their operation still imparts some risks to the collaborative work. The aim of this methodology is to provide a comprehensive analysis tool that takes into account work elements, human factors, hazard analysis, product and robot characteristics in order to determine feasible and safe modes of human-robot collaboration. Via a CAD model information extraction procedure and a work disaggregation structure, lower level work elements comprising the whole assembly operation are identified. Each of these work elements is subjected to a group of procedures for the assessment of resource capabilities and work related hazards. Based on this analysis, a number of safe collaborative modes are identified.

UNIVERSITY

DEPARTMENT OF INDUSTRIAL SYSTEMS ENGINEERING AND PRODUCT DESIGN

Author: João Costa Mateus Supervisors: Dieter Claeys, Veronique Limére, Johannes Cottyn, El-Houssaine Aghezzaf

HUMAN-ROBOT COLLABORATIVE ASSEMBLY DESIGN METHODOLOGY



41. Claudia Matos Veliz, Kris Demuynck & Veronique Hoste

Comprehensive Integration of Linguistic Features in a Human Inspired Speech Recognition Architecture

Claudia.MatosVeliz@ugent.be

Despite the fact that speech recognition involves a fair amount of natural language processing, there has been very little collaboration between linguists and speech recognition engineers. Nowadays, both domains use similar techniques such as log linear models and graphical models. Moreover, the advent of new powerful algorithms allows the deployment of probabilistic models that are no longer limited by the oversimplifications present in most of today's speech recognition systems and should allow successful integration of rich linguistic knowledge in automatic speech recognition systems. In this project, a novel speech recognition framework and a set of accompanying, contemporary linguistic models is co-developed. The envisioned layered architecture combines local inference with inter-layer message passing, similar to what is believed to underlay human speech recognition. Compared to the current architectures, such layer-wise structure facilitates the incorporation of additional knowledge (linguistic or other), and hence is better equipped to model the fine nuances and complex inter-dependencies in speech.



LANGUAGE AND TRANSLATION TECHNOLOGY TEAM - LT³

Claudia Matos Veliz, Kris Demuynck & Veronique Hoste

COMPREHENSIVE INTEGRATION OF LINGUISTIC FEATURES IN A HUMAN INSPIRED SPEECH RECOGNITION ARCHITECTURE

Project Goal

Despite the fact that speech recognition involves a fair amount of natural language processing, there has been very little collaboration between linguists and speech recognition engineers. In this collaborative research effort, we aim to co-develop a novel speech recognition framework and a set of contemporary linguistic models that plug into this framework. The incorporation of rich linguistic knowledge is expected to help in closing the gap in accuracy between automatic speech recognition (ASR) and human speech recognition (HSR).



GHENT UNIVERSITY 42. Tianlong Mei, Manasés Tello Ruiz, Evert Lataire, Marc Vantorre & Zoajian Zou

Numerical Study Of Ship Wave Interaction Based on Potential Flow Theory

Tianlong.Mei@ugent.be

An accurate prediction of hydrodynamic forces and motions of a ship moving in waves is of critical importance in early ship design. Wave-induced motion not only lead to added resistance, but the wave induced drift force can also affects the manoeuvrability, leading to potential safety issues. An original code, based on potential flow theory, is currently being developed in order to assess ship-wave interaction problems. The code shows its potential as a useful tool for the analysis of the seakeeping behaviour of a ship. The poster shows the numerical model, with focus on seakeeping and the wave making problem

MARITIME TECHNOLOGY DIVISION, GHENT UNIVERSITY

Tianlong Mei^{1,2}, Manasés Tello Ruiz², Evert Lataire², Marc Vantorre², Zaojian Zou¹

Shanghai Jiao Tong University, China¹, Maritime Technology Division, Ghent University²

NUMERICAL STUDY OF SHIP WAVE INTERACTION BASED ON POTENTIAL FLOW THEORY

Introduction: An accurate prediction of hydrodynamic forces and motions of a ship moving in waves is of critical importance in early ship design. Wave-induced motion not only lead to added resistance, but the wave induced drift force can also affects the manoeuvrability, leading to potential safety issues. An original code, based on potential flow theory, is currently being developed in order to assess shipwave interaction problems. The code shows its potential as a useful tool for the analysis of the seakeeping behaviour of a ship.





43. Timo Meireman, Lode Daelemans, Wim Van Paepegem & Karen De Clerck

Nanofibres for composite toughening

Timo.Meireman@ugent.be

Fibre reinforced composites are widely used in industry due to their light weight, high stiffness and strength. They are certainly used in high-end products such as in aerospace and windmills. However, the susceptibility to delamination of composites is still an important issue in many applications. Nanofibres are a novel material class that allow for an easy straightforward toughening of composites. With the aid of nanofibre toughening, increases in composite fracture toughness of up to 100% can be obtained. Careful examination of the composite's fracture surface and crack path discloses the toughening mechanisms which are nanofibre bridging and yielding of the nanofibres.

Nanofibres for composite toughening

FEA RESEARCH SYMPOSIUM 2019

Timo Meireman, Lode Daelemans, Wim Van Paepegem and Karen De Clerck

Centre for Textile Science and Engineering (CTSE), Department of Materials, Textiles and Chemical Engineering, Faculty of Engineering and Architecture, Ghent University Timo.Meireman@UGent.be

Fibre reinforced composites are widely used in industry due to their light weight, high stiffness and strength. They are certainly considered for high-end applications, such as in the aerospace industry and wind turbines.

However, the susceptibility to delamination of composites is still an important issue in many applications.



Composite preparation

Nanofibres can be easily interleaved between the glass or carbon layers of the composite.



Examination of the fracture surface

Careful examination of the fracture surface shows that the delamination crack frequently transverses through the nanofibre toughened interlayer. The nanofibres deform upon crack propagation. The yielding of the nanofibres causes the energy to dissipate leading to an increased toughness of the composite

AND ARCHITECTURE



Extensive weathering caused a windmill tip to break. Delaminated plies are visible at the fracture zone

Solvent electrospinning

Nanofibres are a novel material class that allow for an easy straightforward toughening of composites.

Thermoplastic nanofibres have a diameter below 500 nm and can be created by electrospinning, for which a polymer is dissolved and pushed through a hollow needle, which is placed in a strong electric field which causes thin nanofibres to be deposited onto a collector.





Nanofibre toughened composite

Improved fracture toughness

The composites increase up to 100% in fracture toughness and thus nanofibre toughening proves to be a successful technique to increase the fracture toughness of composites



Nanofibres can successfully be used for composite toughening

[1] C. Yi-tung and S. Hsu. Taipower says it will x broken turbine. http://www.taipeitimes.com/News/taiwan



DEPARTMENT OF MATERIALS, TEXTILES AND CHEMICAL FACULTY OF ENGINEERING **ENGINEERING – MATCH CENTRE FOR TEXTILE SCIENCE AND ENGINEERING - CTSE**

Interleaving

44. Darya Memon & Stijn Matthys

Impact Resistance Increment of Contrete by External Strengthening via Fibre Reinforced Polymers

Darya.Memon@ugent.be

The behaviour of concrete under impact loads has not been widely discussed and there is a gap of understanding about the behaviour of concrete under impact. The objective of the study is to understand the behaviour and failure of concrete strengthened with fibre reinforced polymer under impact loading. Twelve concrete prisms of size 500 mm x 50 mm x 50 mm, with or without carbon FRP strengthening will be casted. Casting includes prisms of plain concrete and reinforced concrete. The specimens will be impacted using a low-velocity drop-weight test at A constant weight of 7.64 kg with 50 mm, 100 mm and 200 mm drop-height. The experiments are validated using finite element modelling using simulation software. A parametric study is conducted with respect to the material concrete model and mesh size of elements in order to study the effect of these parameters on the dynamic response of the beam under low-velocity impact load. The numerical model shows promising results.

Impact Resistance Increment of Concrete by External Strengthening via Fibre Reinforced Polymers

DARYA MEMON¹ (darya.memon@ugent.be), STIJN MATTHYS¹ (stijn.matthys@ugent.be) ¹Magnel Laboratory for Concrete Research, Department of Structural Engineering, Faculty of Engineering, Ghent University, Belgium.

FACULTY OF ENGINEERING AND ARCHITECTURE

INTRODUCTION

- The reaction of concrete under impact has not been extensively studied and there is a gap of understanding about the behaviour of concrete under impact.
- Concrete piers on the motorways and highways are at risk from the vehicles and can seriously damage the structure. or can collapse the bridge completely. (Fig. 1)



Fig. 1 Damage of bridge due to vehicle collision [1].

- Fibre reinforced polymer (FRP) materials are being widely used from aeroplanes to helmets. Concrete industry has taken interest in FRP possibilities to protect and enhance the load-carrying properties of concrete (Fig 2.).
- FRP is one of the potential materials that can be used to strengthen concrete [2].

Why FRP ?

-Can be applied to any irregular surface -Easy to install without any special equipment.

-Short execution time.

Less disrupt in use of the structure.

OBJECTIVES

Fig 2. FRP Application.

- To understand the behaviour and failure of concrete beams under impact loading using drop-weight tests considering the parameters of a drop-height and type of strengthening the material.
- Establish a finite element model with the help of simulation software to predict the behaviour of concrete under impact load and compare results with experimental results [Fig.3].



Fig. 3 Finite element model of beam impacted by drop-weight

SCHEDULED FIRST EXPERIMENTS

Ī

GHENT UNIVERSITY

Twelve concrete prisms of size 500 mm x 50 mm x 50 mm, with or without carbon FRP strengthening will be casted as shown in Fig 3. Casting includes prisms of plain concrete and reinforced concrete.



Fig.4 (a) drop-weight test setup (b) impactor parts.

The specimens are tested using a small-scale drop-weight test setup which consists of three parts (a) rigid support (b) impactor (c) guiding rails (Fig.4). The weight of the impactor is 7.64 kg. Failure of plain concrete by generally brittle, in this respect a high-speed camera will be used to observe cracking patterns of the concrete specimens.

NUMERICAL STUDY

A numerical model (FEM) created by two materials models i.e. concrete damage release 3 (MAT_72R3) for concrete and plastic kinematic material (MAT_3) for steel impactor & supports is used. Reaction loads are calculated using FEM model (Fig 5) with the help of multiple mesh sizes and are compared with experimental data taken from an existing study [3]. The numerical model shows promising results. Further calculations are going on.



Fig.5 Reaction load of different drop-height and mesh size of concrete model.

REFERENCES

- 1. Eugene Buth, William F. Williams, Michael S. Brackin, Dominique Lord, Srinivas R. Geedipally, and Akram Y. Abu-Odeh "Analysis of large truck collisions with bridge piers: phase 1, report of guidelines for designing bridge piers and abutments for vehicle collisions" Texas Transportation Institute The Texas A&M University System College Station, Texas.
- 2. Matthys, S., "Structural Behaviour and Design of Concrete Members Strengthened with Externally Bonded FRP Reinforcement", in Faculty of Engineering, 2000, Ghent University.: Ghent, Belgium D M Jerome, C.A.R., "Simulation of the dynamic response of concrete beams externally reinforced with 3

This work was supported by the Higher Education Commission, Pakistan [HRDI-UESTP (Batch-V)]

carbon-fiber reinforced plastic". Computers and Structures, 1997. 64(5): p. 1129-1153.



45. Giles Miclotte, Pieter Audenaert & Jan Fostier

Iterative Seeding for Sequence to Graph Alignments

Giles.Miclotte@ugent.be

Several tools have been developed for aligning long third generation DNA sequencing reads to a genome assembly graph, with the aim of correcting errors in long reads or producing better assemblies. These methods rely on the seed-and-extend paradigm using only exact matches as seeds. Due to the high error rate in long reads, only short exact seeds can be identified. In large, repeat-rich genomes, this leads to an overabundance of uninformative seeds. We propose the use of longer, inexact seeds in combination with a reseeding scheme to find additional smaller, exact seeds in sparsely seeded regions. We found that this approach can be as fast as traditional exact seeding, while resulting in fewer uninformative seeds and covering a significantly larger portion of the reads. We applied these concepts to a proof-of-concept error correction tool, which resulted in high quality assemblies, with a significantly lower run time than current state-of-the-art software.

Giles Miclotte, Pieter Audenaert, Jan Fostier

ITERATIVE SEEDING FOR SEQUENCE TO GRAPH ALIGNMENTS

Abstract

Several tools have been developed for aligning long third generation DNA sequencing reads to a genome assembly graph, with the aim of correcting errors in long reads or producing better assemblies. These methods rely on the seed-and-extend paradigm using only exact matches as seeds. Due to the high error rate in long reads, only short exact seeds can be identified. In large, repeat-rich genomes, this leads to an overabundance of uninformative seeds.

We propose the use of longer, inexact seeds in combination with a reseeding scheme to find additional smaller, exact seeds in sparsely seeded regions. We found that this approach can be as fast as traditional exact seeding, while resulting in fewer uninformative seeds and covering a significantly larger portion of the reads. We applied these concepts to a proof-of-concept error correction tool, which resulted in high quality assemblies, with a significantly lower run time than current state-of-the-art software.



Figure 1: Seed type recall for inexact seeds for various identity levels. A seed is a tuple of start and end positions. The alignment identity of the seed is the percentage of nucleotide matches in the alignment of the implied subsequences. Typically, one is interested in seeds with high identity. This is reflected in the widespread use of exact *k*-mer matches in literature. However, longer inexact seeds contain more information than shorter exact seeds. Additionally, inexact seeds are more likely to occur than exact seeds of the same size, especially in the case of a high error rate in the reads.



Figure 2: (1) Long inexact seeds between the long read and the graph are found. A flow graph between these seeds on the graph is identified. (2) Long seeds can not be found in short nodes. A new seed finding procedure is performed with a shorter seed size, and restricted to the subgraph. Performing this search on the entire graph would result in too many false positives, but by restricting the search to the subgraph, this is not an issue. These new seeds between the read and the nodes of the subgraph, guide the alignment between the initial long inexact seeds.



Figure 3: (1 - 4) pipeline from short and long reads to seeds. (1) Short reads are used to construct a de Bruijn graph; (2) long reads are aligned to the nodes of the de Bruijn graph producing long, inexact seeds; (3) between consecutive seeds a flow graph is constructed; (4) for each flow graph additional short, exact seeds (MEMs) are detected between the flow graph's nodes and the corresponding subsequence of the read; (3-4) this process can be repeated using flow graph between the newly found seeds, (5) seeds are used to align the read to the de Bruijn graph

Results

Initial assembly results obtained with our iterative seeding approach on small genomes had higher contiguity than the state of the art assemblers (Canu, Unicycler). Additionally, our pipeline is an order of magnitude faster on these data. We are currently improving the implementation of these ideas to obtain similar results on larger genomes.

Contact

Giles.Miclotte@ugent.be www.IDLab.ugent.be www.IDLab.technology **ID**Lab

46. Nguyen Dang Phuc Nguyen & Johan Lauwaert

Energy Yield Calculations

dangphucnguyen.nguyen@ugent.be

The design and optimization of solar cells are very much performance driven, which is often measured as the efficiency under standard illumination. To go beyond the state-of-the art silicon based solar cells, tandem solar cells might be very promising. However, for a monolithic tandem solar cell the variation in the solar spectrum has a stronger effect on the performance than for a single junction solar cell. Therefore, the tendency lives in the photovoltaic community to evaluate the performance on the energy yield and not purely on the efficiency. The major drawback is that weather conditions play an important role, and recording solar spectra in different orientations is an expensive and time consuming business. We present a model to calculate the energy yield of photovoltaic installations. This methodology will be used to evaluate the benefit of potential new technologies for domestic and building integrated applications. The first advantage of the model is that the orientation of the solar panel as well as the properties of the solar cell can be easily varied without extra experiments. The second advantage is that this method can be transferred to other locations since it is based on a minimum of input parameters.

LIQUID CRYSTAL AND PHOTONICS GROUP

Nguyen Dang Phuc Nguyen, Johan Lauwaert

ENERGY YIELD CALCULATIONS

Introduction

The design and optimization of solar cells are very much performance driven, which is often measured as the efficiency under standard illumination. To go beyond the state-of-the art silicon based solar cells, tandem solar cells might be very promising. However, for a monolithic tandem solar cell the variation in the solar spectrum has a stronger effect on the performance than for a single junction solar cell. Therefore, the tendency lives in the photovoltaic community to evaluate the performance on the energy yield and not purely on the efficiency. The major drawback is that weather conditions play an important role, and recording solar spectra in different orientations is an expensive and time consuming business.

In this poster, we present a model to calculate the energy yield of photovoltaic installations. This methodology will be used to evaluate the benefit of potential new technologies for domestic and building integrated applications. The first advantage of the model is that the orientation of the solar panel as well as the properties of the solar cell can be easily varied without extra experiments. The second advantage is that this method can be transferred to other locations since it is based on a minimum of input parameters.

Comparision with PVGIS

To find out how accurate the model's results are, a comparison was made between the solar energy output of a real installation and by other model calculated energy output for this installation. The difference between the calculated and the real annual solar energy yield is nearly 5%, which is better than for PVGIS, a model of the European Commission.



Annual yield (kWh)	Deviation
Real installation: 4123.2	This work and Real installation: 4.62%
This work: 3972.0	CMSAF and Real installation: 3.67%
CMSAF: 4323.0	SARAH and Real installation: 6.61%
SARAH: 4415.0	ERA5 and Real installation: 11.86%
ERA5: 4678.0	COSMO and Real installation: 8.62%
COSM0: 4512.0	

Tandem solar cell



Solar energy yield estimation



- Most tandem cells yield larger energy than the Single-junction Silicon cell.
- Except 2-Wire 1.5 eV tandem solar cell exhibits a lower energy output than Singe-junction Silicon solar cell.
- To compare with scaling AM1.5G spectrum calculation, real weather conditions were added into our model to make it more precise.



The energy yield of the 2-w 1.5 eV tandem cell once again is the lowest result, while the energy output of the 2-w 1.9 eV is just 17% larger than that of Single-junction Silicon solar cell.

Conclusion

This model is capable of accurately calculating the energy yield of tandem solar cell in various conditions in Belgium. As our future work, the external quantum efficiency of materials and other location in the world will be taken into account for the calculation.

References

 S. A. M. Maleki, H. Hizam, and C. Gomes, "Estimation of hourly, daily and monthly global solar radiation on inclined surfaces: Models re-visited," *Energies*, vol. 10, no. 1, 2017.

 Steve Reynolds, Vladimir Smirnov, Modelling performance of two- and fourterminal thin-film silicon tandem solar cells under varying spectral conditions, Energy Procedia 84 (2015) 251 - 260.

3. https://ec.europa.eu/jrc/en/pvgis





47. Duc-Khanh Nguyen, Louis Sileghem & Sebastian Verhelst

"Dangerous Fuels" for Cars - A Way to Save the World

duckhanh.nguyen@ugent.be

Flame or combustion gave humans healthy food, protection, heat, light, and so on. The combustion also gave the power for a car to move from point A to point B. Most of the vehicle in the world now are powered by the internal combustion engines. The engine converts the chemical energy stored in the reactant, i.e. mixture of fuel and air, into thermal and mechanical energy. Engines and fuel technology are scalable, cheap and compact. They are also can be produced in a sustainable way or in a carbon-neutral cycle. Therefore, internal combustion engines are still the main power source for the current and for future transport systems. Renewable methanol (or synthetic methanol) is a great fuel for internal combustion engines thanks to its interesting properties and high fuel production efficiency. Methanol is also considered as a hydrogen carrier fuel, which can be easily generated on-board using engine exhaust heat. The present work focuses on the thermochemical recuperation for methanol reforming to further improve the engine efficiency and reduce harmful emissions.

TRANSPORT TECHNOLOGY RESEARCH GROUP

Duc-Khanh Nguyen, Louis Sileghem, Sebastian Verhelst

"DANGEROUS FUELS" FOR CARS – A WAY TO SAVE THE WORLD



IC engines?

Internal combustion engines

- Scalable, high power density, cheap
- Sustainable (close CO₂ cycle)
- Fuel flexible (fossil fuels, biofuels, synthetic fuels)
- Efficiency improvement possible



KEEP THE ENGINE, CHANGE THE FUEL

Methanol as an alternative fuel

- Produced in a carbon-neutral cycle
- Hydrogen is generated using renewable energy
- CO_{2} is captured directly from the air or from the combustion
- H₂ and CO₂ are employed to create synthetic methanol

Methanol is the simplest type of liquid synthetic fuel

Methanol is a great fuel for internal combustion engines

- Low CO₂ emissions from the combustion
- High engine efficiency



future automotive powertrain



batteries?











48. Ksenija Nikolic, Kim Verbeken & Roumen Petrov

Microstructural Features Controlling White Etching Cracks in Roller Bearing

ksenija.nikolic@ugent.be

The wind industry faces tough challenges to reduce the cost of wind energy, particularly high operating cost. Wind turbine maintenance can cover a wide variety of activities but one of the major issues concerns repair or replacement of wind turbine gearboxes, which fail prematurely before they have completed their 20-year lifespan. Some wind projects experience failure rates of up to 50 percent within the space of a few years. This increases costs through increased downtime, increased maintenance and gearbox rebuilding and replacement. A characteristic feature of many premature failures is the extensive subsurface crack networks that have a "white etching appearance", referred to commonly as white etching cracks (WECs). Such cracks typically propagate to the surface, causing spalling of the raceway, which has commonly been observed on field returns from applications such as wind turbine gearboxes, automotive drivelines, alternators and peripheral auxiliaries paper mills and marine propulsion systems. In this poster, drivers and microstructural changes associated to the WEC'S formation are presented.

Material Durability for Off-Shore SIM SBO MaSiWEC Materials and signal processing based prediction of WEC

Program coordinator: Joachim.Antonissen@OCAS.be Project coordinator: Jan.Helsen@vub.be

Microstructural Features Controlling White Etching Cracks in Roller Bearings

Ksenija Nikolic, Kim Verbeken, Roumen Petrov

Introduction

A characteristic feature of many premature failures in wind turbine gearboxes is the extensive subsurface crack networks that have a "white etching appearance" referred to commonly as white etching cracks (WEC). Such cracks typically propagate to the surface, causing spalling to the raceway, which has commonly been observed on field returns from applications such as wind turbine gearboxes, automotive drivelines, alternators marine propulsion systems.

Objective

The purpose of this study is to characterize the microstructural changes associated to the WEC formation in through hardened bearing steels and provide quantitative microstructural data for modeling of this phenomenon.



MaDurOS programme (grant HBC.2017.0606).

driving industry by technology

UNIVERSITY

Clusters for Growth

MaDurOS

49. Askhat Nuriddinov, Wouter Tavernier, Didier Colle & Mario Pickavet

Functional testing of virtualized network functions

Askhat.Nuriddinov@ugent.be

5G as the new generation of cellular mobile communication aims to provide higher data rates, reduced latency and massive device connectivity. A key enabler of 5G networks is Network Functions Virtualization (NFV). This architecture leverages virtualization technologies to decouple the software implementation of network functions from the underlying hardware. Resulting services can now be rapidly composed based on software-based Virtual Network Functions (VNF). In order to translate this to shorter time-to-market of 5G/NFV-empowered services, developers and network operators need mechanisms to adequately test Virtualized Network Functions (VNF). To this end, we introduce the new library for light-weight functional testing of VNFs. It helps the developers to write tests in Python and run tests even on low-performance machines such as laptops. Using the library the developers choose which infrastructure to use, which VNFs to launch, how to interconnect VNFs, how to trigger the test process and inspect, verify and validate the output against the expected values and conditions. The latter provides a reproducible test outcome.

TANGOTEST

Functional testing of virtualized network functions

Askhat Nuriddinov, Wouter Tavernier, Didier Colle, Mario Pickavet

NFV

GENT

UNIVERSITEIT

Network functions virtualization (NFV) is a network architecture concept that uses the technologies of IT virtualization to decouple network functions from proprietary hardware appliances so they can run in software.







- •new devices consume more traffic
- •new technologies require higher speed
- •new services require higher SLA



Current approach: cumbersome, proprietary, manual NFV approach: agile, standard, automated

Automated deployment + testing = DevOps



unec

TANGOTEST



Workflow



Mininet	Base emulation platform
Containernet	+ Docker containers
vim-emu	+ Gatekeeper + API
tangotest	+ Test automation + API + Helpers



50. Wito Plas, Michel De Paepe & Kathy Steppe

Coupled Modelling of a Plant and Its Phylloclimate

wito.plas@ugent.Be

Vegetable production has greatly evolved over the years and crops can be produced without being dependent on external cllimatic conditions simply by moving soil-based production into greenhouses. A current evolution that is taking place is going up and growing vertical. To be succesful in this approach, knowledge about the dynamic plant-climate interactions and its implications towards production and gradients in these resources to produce high quality vegetables on a limited space. Many questions still remain about how dynamics in microclimate (phylloclimate) during crop development and growth, affect crop production. This is challenging because of the tight coupling between plants and climate, but our proposed approach should be able to push frontiers in this topic. The climate around a plant is strongly influenced by the plant itself. Computational Fluid Dynamics (CFD) is at the current state of the art able to solve transport equations for mass, momentum and energy with high accuracy. The target therefore is to develop and validate a 3D coupled FSPM plant - Phylloclimate (CFD) model, accurately describing the interaction in energy and mass transfer between the plant and its surrounding climate.
APPLIED THERMODYNAMICS AND HEAT TRANSFER

Wito Plas¹, prof. Michel De Paepe¹, prof. Kathy Steppe² Ghent University, ¹Department of Flow, Heat and Combustion Mechanics, ²Laboratory of Plant Ecology

COUPLED MODELLING OF A PLANT AND ITS PHYLLOCLIMATE

Problem

By 2050 global population will hit 9,7 billion people and 70% will live in cities. If we want to keep feeding these people in a more sustainable way, we will have to drastically change the way our food is grown. A solution for this is vertical farming. By stacking multiple plant factories on one another and building these in dense urban areas, a more efficient, less resources consuming environment is built.

Modelling approach

Numerical model that is able to calculate the heat and moisture balance over plant, **lettuce**

-Build 3D plant model for four different growing stages in the plant's life Start with one leaf and further extend to calculate heat and moisture balance over entire plant -Perform 3D steady and unsteady calculations



Experimental Validation

In collaboration with the laboratory of Plant Ecology -Obtain 3D geometry of lettuce -Define Boundary Conditions for simulations -Validation of numerical model



Research activities

- vestigate Time-Scale modelling of the problem n-site validation of experimental work

What is a plant factory?

A plant factory is a closed environment system, where all ambient climatic conditions are kept constant in the right spot for plant growth, Plants interact with their climate however, and an active climatic control is required to insure plants are growing adequately and avoid tip burn





Phylloclimate

Investigate the heat and moisture balance over plant

Photosynthesis (CO2) and transpiration model included in CFD calculations Evapotranspiration and stomatal transpiration, calculated on a micro scale, model of stomatal transpiration What are the convective sensible, latent and moisture fluxes?





Heat and mass transfer processes in a lear

Time-scale modelling

Four different growing stages of lettuce are investigated (establishment, rapid growth, maturation)

What is the influence of sudden changes in climatic behaviour on the plants transpiration behaviour? How does the local climate change and how long does it take before steady-state is reached again?



Goals:

-From Numerical and experimental work make a lower order model industry and farm designers can use -Further extend the knowledge on how plants interact with their local climate



GHENT UNIVERSITY 51. Ajie Pridadi, Luca Donatini, Evert Lataire, Marc Vantorre, Nancy Nevejan & Peter Bossier

Mussel Cultivation in the Belgain North Sea

ajiebramakrishna.pribadi@ugent.be

In 2017 a research project to examine the feasibility of mussel aquaculture within the Belgian North Sea Wind Farms was established under the name of Edulis. Two test set ups are already deployed in two Belgian wind farms to investigate both the forces on the system and the biological properties of the mussels. These semi-submerged system consists of a long backbone line, connecting several buoys and support the long rope with the mussels. Due to the sensitivity of the location, it is important that the position of mussel line system, under all circumstances, will not interfere with wind farms activities. Hence, a mathematical model is needed to predict the behaviour of mussel line system (forces and positions) under environmental induced load. This model will help to design the anchor system as well as the park layout.

Ajie Pribadi¹, Luca Donatini¹, Evert Lataire¹, Marc Vantorre¹, Nancy Nevejan², Peter Bossier²

Maritime Technology Division, Ghent University¹, Laboratory of Aquaculture & Artemia Reference Center, Ghent University²

MUSSEL CULTIVATION IN THE BELGIAN NORTH SEA

Introduction: A research project to examine the feasibility of growing mussels off the coast was initiated within the project named Edulis. The partners of Edulis project are: ILVO, UGent, OD Nature, C-Power, Belwind, DEME, Sioen Industries, Colruyt Group, Brevisco and Lobster Fish. In this collaboration, Maritime Technology Division of Ghent University takes part in the numerical modelling of the mussel line system.





Illustration of a semi submerged longline system that is considered for the study. (length not drawn to scale)



Numerical model

A **lumped-mass approach** is used to model the mooring lines, which divides a line into N number of segments with N+1 number of nodes. Forces and weight properties of each segment are equally transferred to its extremity nodes.

The system reacts to the current, wave induced velocities and accelerations by taking into account hydrodynamic forces calculated using the **Morison Equation**.

Two experimental test setups were installed for the purpose of data gathering.



In May 2017, **Bio Line** was installed in the area of C-Power park, which focuses on the study of the **growth of mussels. Force Line** was later installed in November 2017 within the Belwind park for the purpose of almost real time **data gathering**.

Physical parameters: wave and current



<u>Wave</u> orbital velocities and accelerations decrease along the depth. By using <u>linear Airy theory</u>, these properties can be calculated.

This information will be useful to determine the optimized depth to positioned the longline.



<u>Idal current</u> changes direction and magnitude over time during the tidal cycle. Current magnitude decreases along the depth, which is modeled using power law profile. Displacement of a mussel line system is highly influenced by this parameter.

<u>As a result of the project</u>, an optimized array of multiple longline system is proposed. The calculations are done with an in-house code, which is an adapted version of MoorDyn by Mathew Hall. Modifications to the code are mainly done to include wave and current induced loads in the calculation. The physical parameters of wave and current within the location of C-Power and Belwind wind farms are taken as input for the optimization process.









 Mohammad Rahimi Gorji, Charlotte Debbaut, Margo Steuperaert, Christian Vanhove, Patrick Segers & Wim Ceelen

CFD Model of the Interstitial Fluid Pressure (IFP) in Realistic Tumor Geometries of Peritoneal Metastases from Ovarian Cancer

Mohammad.Rahimigorji@ugent.be

Ovarian cancer (OC) is an important cause of death in women. Over the past decades, intraperitoneal (IP) chemotherapy has been introduced in the treatment of stage III OC. The efficacy of IP chemotherapy is limited by elevated tumor tissue interstitial fluid pressure (IFP), which hampers convective drug transport from the peritoneal cavity into the tissue. Accurate, non-invasive measurements of tumor tissue IFP would allow to tailor IP therapy to the physical characteristics of the tumor. Therefore, we aimed to estimate IFP in OC xenografts using a computational fluid dynamics (CFD) model based on dynamic contrast enhanced magnetic resonance imaging (DCE-MRI) data. Based on the results, the maximal IFP values were 11.43 mmHg and 11.09 mmHg in the right and left tumor, respectively. Obviously, the IFP distribution is strongly dependent on the irregular tumor geometries. Consequently, the IFP in the central tumor regions is higher, while decreasing towards the peripheral regions. The model will be validated by comparison with invasive pressure measurements.

IBITECH- BIOMMEDA, FACULTY OF ENGINEERING AND ARCHITECTURE/ EXP. LABORATORY, FACULTY OF MEDICINE AND HEALTH SCIENCE, GHENT UNIVERSITY Mohammad Rahimi Gorii. Charlotte Debbaut. Margo Steuperaert. Christian Vanhove. Patrick Segers. Wim Ceelen

CFD MODEL OF THE INTERSTITIAL FLUID PRESSURE (IFP) IN REALISTIC TUMOR **GEOMETRIES OF PERITONEAL METASTASES FROM OVARIAN CANCER**

Ovarian cancer (OC)

- The ovaries are a pair of small organs located low in the abdomen that are connected to the womb and store a woman's supply of eggs.
- Ovarian cancer (OC) is an important cause of death in women. -

Treatment

- -Intravenous (IV)
- Intraperitoneal (IP) \rightarrow Direct contact between drug and the tumor noddle surface.



- The CFD problem was solved by using Darcy's law, Starling's law and mass conservation equations.
- As for boundary conditions, a fixed drug concentration was maintained (i.e. 0.8 mol/m³), mass source and reaction (using Starling's law) at the inlet boundary and the outlet pressure was set to 0 Pa [3].

Pressure distribution

bioMeda

UNIVERSITY

Department of Surgery

Experimental surgery Lab

The maximal IFP values were 11.43 mmHg and 11.09 mmHg in the right and left tumor, respectively. Obviously, the IFP distribution is strongly dependent on the irregular tumor geometries. The model will be validated by comparison with invasive pressure measurements.



FACULTY OF MEDICINE

AND HEALTH SCIENCES



[OCRF.org]

Goal

>

Estimation of IFP in OC xenografts using a computational fluid dynamics (CFD) model based on dynamic contrast enhanced magnetic resonance imaging (DCE-MRI) data.

- Peritoneal metastases from human OC (SKOV-3 cell line) were created by IP injection in FOXn1-nu female athymic mice.
- MRI imaging (Bruker- Infinity Lab-UGent) allowed obtaining the necessary anatomical information of the tumors.
- Two tumor geometries were reconstructed using Mimics Research software (Materialise, Belgium).
- STL-files were imported in COMSOL Multiphysics (Inc., Burlington, VT) to setup both a steady state and transient mass transport model.
- Based on IP chemotherapy time, the transient model encompassed 1800 s. solved with a time step of 30 s.

53. Dhanraj Rajaraman, Dieter Fauconnier & Stijn Hertelé

Damage Modelling of Scratch Abrasion Resistance

Dhanraj.Rajaraman@ugent.be

Abrasion wear is the most severe wear mechanism. There exist different governing mechanisms (Cutting, Wedging, Ploughing mode) to characterize and understand the abrasion wear. But, there is a lack of understanding of the governing mechanisms. Various current abrasion models are uniquely based on hardness as a governing material parameter. Yet, metals with similar hardness may show different abrasion resistance. The objective of this research work is the numerical modelling of scratch abrasion. We focus on predicting the governing mechanism for a given set of condition. In order to predict the wear realistically, determining the suitable material model is a key. The different governing mode can be identified by an accurate characterization of the stress state. After successful numerical modelling of the scratch abrasion, We focus on identifying involved material parameters additional to hardness.

SOETE LABORATORY - EEMMECS (EA08)

Dhanraj Rajaraman, Prof. Dieter Fauconnier, Prof. Stijn Hertelé

DAMAGE MODELLING OF SCRATCH ABRASION RESISTANCE

PROBLEM STATEMENT

Abrasion wear – The most severe wear mechanism

- Lack of understanding of different governing mechanisms
- Current abrasion resistance models are uniquely based on hardness as a governing material parameter
- Yet, metals with similar hardness may show different abrasion resistance

OBIECTIVE

Numerical modelling of scratch abrasion

- Predicting the governing mechanism for a given set of conditions
- Suitable material model for realistic wear prediction
- Stress state characterization to identify abrasion modes
- Identify involved material parameters additional to hardness

PRESENT STUDY

1. Scratch Abrasion modelling







- Ploughing mode
 - Repeated sliding for wear particles





Abrasive wear in gear [4]

Abrasive wear in a screw [3]



2. Stress state characterization and damage calculation





FURTHER STUDY

3. Damage model implementation



1. Hokkirigawa and Kato - ploughing, cutting and wedge formation during abrasive wear 2. Y. Bai, T. Wierzbicki / International Journal of Plasticity 24 (2008) 1071-1096

Mohr-Coulomb damage model

- Developed originally for rocks
- Validity for for brittle materials
- Includes effects of stress triaxiality and Lode angle

Modified Mohr Coulomb damage model

 Adapted model, allowing for ductile failure prediction - Cut-off region: infinite strain region can be controlled with damage model constants

When does failure occur?

- When the applied (equivalent) plastic strain reaches the failure strain, set forward by the damage model
- Translated into a damage parameter that reaches unity upon material failure

4. Determination of scratch resistance parameters



Parametric study . To determine the material parameters other than hardness, influencing scratch abrasion resistance

Cont	act	
Dhar http:	Dhanraj.Rajaraman@ugent.be http://eemmecs.ugent.be	
f	Universiteit Gent	
y	@ugent	
in	Ghent University	



REFERENCES

3. Reiloy Westland corporation company website 4. https://www.mechgrid.com/gear-failure.html







54. Gopalakrishnan Ravi, Stijn Hertelé & Wim De Waele

Initiation and propagation modelling of white etching cracks (WEC) in roller bearings

Gopalakrishnan.Ravi@ugent.be

Roller element bearings (REB) are amongst the most commonly used engineering components in a variety of machinery such as turbines, engines, transmissions etc. The conventional failure mode of REBs is rolling contact fatigue, resulting in pitting or spalling of the raceway surfaces. Harsh conditions (such as peak contact pressures and the introduction of hydrogen from the environment) may lead to premature bearing failures at 5-10% of the foreseen lifetime, due to the development of white etching cracks (WEC). WEC has been the most expensive and least understood REB failure mode in the past decade. Understanding WEC requires detailed multi-physics knowledge of bearing operation and dynamics. This Ph.D. is part of an SBO project within the SIM MaDurOS programme, focussing on lifetime prediction of wind turbine gearbox bearings. It involves UGent, VUB, SIRRIS, NREL (USA) and an extensive industrial consortium.

Material Durability for Off-Shore

SIM SBO MaSiWEC – Materials and signal processing based prediction of WEC

Program coordinator: Joachim.Antonissen@OCAS.be Project coordinator: Jan.Helsen@vub.be

Initiation and propagation modelling of white etching cracks (WEC) in roller bearings

Gopalakrishnan Ravi, Prof. Stiin Hertelé, Prof. Wim De Waele

Roller element bearings (REB) are amongst the most commonly used engineering components in a variety of machinery such as turbines, engines, transmissions etc. The conventional failure mode of REBs is rolling contact fatigue, resulting in pitting or spalling of the raceway surfaces. Harsh conditions (such as peak contact pressures and introduction of hydrogen from the environment) may lead to premature bearing failures at 5-10% of the foreseen lifetime, due to the development of white etching cracks (WEC). WEC has been the most expensive and least understood REB failure mode in the past decade. Understanding WEC requires detailed multi-physics knowledge of bearing operation and dynamics.

This PhD is part of an SBO project within the SIM MaDurOS programme, focussing on lifetime prediction of wind turbine gearbox bearings. It involves UGent, VUB, SIRRIS, NREL (USA) and an extensive industrial consortium.

sirris

ing industry by technology

GHENT

UNIVERSITY

FLANDERS INNOVATION & ENTREPRENEURSHIP

Clusters for Growth

the financial support of

MaDurOS programme

(grant HBC.2017.0606).

Vlaio and SIM through the







55. Sander Rijckaert, Lode Daelemans & Karen De Clerck

Combining Fibre Reinforced Composites and 3D printing: the Best of Both Worlds

Sander.Rijckaert@ugent.be

Composites are an often used material combining high mechanical performance (strength, stiffness, ...) with low weight. This makes them the ideal material for applications ranging from sports equipment to wind turbines and even aerospace engineering. However, they do have one disadvantage: they are hard to produce in certain shapes (such as double curvatures) and costly when made in small sizes. Combining the core concept of composites, incorporating strong fibres in a tough matrix, with a technology such as 3D printing allows us to efficiently produce composites in all shapes and sizes. This could prove a winning strategy for the future!

Combining fibre reinforced composites and 3D printing: the best of both worlds 2019

Sander Rijckaerta, Lode Daelemansa, Karen De Clercka

^a Centre for Textile Science and Engineering (CTSE), Department of Materials, Textiles and Chemical Engineering, Faculty of Engineering and Architecture, Ghent University

Sander.Rijckaert@UGent.be



Composites are **lightweight**, **high strength** materials combining strong fibres with tough polymer matrices. They are used in **airplanes**, **wind turbines**, ...

> However, small, complex objects are hard and expensive to produce using existing composite

production methods.

Introducing continuous fibre reinforcement to 3D printing creates a strong, versatile and easily shapeable material.

A versatile printer set-up allows for study of **different material combinations** and testing of **various printing parameters.**





Combining mechanical testing and microscopic analysis will yield the insight needed to optimize this novel material.



Combining the high mechanical performance of fibre reinforced composites with the ease of production and shapeability of 3D printing makes for an exciting new material for the future!



FACULTY OF ENGINEERING AND ARCHITECTURE DEPARTMENT OF MATERIALS, TEXTILES AND CHEMICAL ENGINEERING – MATCH CENTRE FOR TEXTILE SCIENCE AND ENGINEERING - CTSE 56. Bavo Robben, Filip Beunis, Kristiaan Neyts & Filip Strubbe

Towards Fast Reflective Displays: the Effect of Inverse Micelle Countercharges

bavo.robben@ugent.Be

Towards fast reflective displays: The effect of inverse micelle countercharges. Reflective displays based on electrophoresis contain charged pigment particles. Electrophoresis of a single particle in nonpolar liquids is based on drift and diffusion. Extending this model to higher concentrations, we show that the counter charges, in the form of charged inverse micelles, have an important effect on the switching behavior. We show a two-stage switching of electrophoretic ink which cannot be explained by pigment electrophoresis alone. The switching is strongly influenced by inverse micelles at short time scales, resulting in a 'two-stage switch'. This effects of inverse micelle countercharges are of upmost importance in the field of nonpolar electrophoresis, more specifically in the development of novel video-speed electrophoretic displays which rely on fast switching.

LIQUID CRYSTALS AND PHOTONICS GROUP

Bavo Robben, Filip Beunis, Kristiaan Neyts, and Filip Strubbe

TOWARDS FAST REFLECTIVE DISPLAYS: THE EFFECT OF INVERSE MICELLE COUNTERCHARGES

We show a two-stage switching of <u>electrophoretic ink</u> which cannot be explained by pigment electrophoresis alone. The switching is strongly influenced by inverse micelles at short time scales, resulting in a <u>'two-stage switch</u>'. This effects of inverse micelle countercharges are of upmost importance in the field of nonpolar electrophoresis, more specifically in the development of <u>novel video-speed electrophoretic displays</u> which rely on <u>fast switching</u>.

Measurement setup

An electrophoretic ink, containing charged pigment particles in fluorocarbon solvent is inserted in a glass sample with a thickness of 10-20 µm. We measure the reflectivity at the glass flight refractive index) – liquid (low refractive index) interface at a skew angle. No transmission of light to the liquid accurs due to total internal reflection though an evanescent electromagnetic field extends into the ink. When giment particles approach the interface closer than about 100 nm the evanescent field gets frustrated, meaning that electromagnetic power will leak into the cell and get adsorbed by the pigment particles. In this way, based on the total internal reflectivity measured with a photodetector, we can probe the surface particle concentration.



To drive the sample electrically, both glass surfaces are covered with an ITO electrode. ITO electrodes are covered with parylene. The external current is measured simultaneously with the reflectivity.

Electrophoresis

The electrophoretic ink examined in this study contains pigment particles and surfactant in a fluorocarbon solvent. Pigment particles are sterically stabilized and positively charged by the surfactant molecules giving the ability to move them under an electric field. Excess of surfactant molecules will stabilize the counter charges in univalent charged inverse micelles. A small concentration of positively charged inverse micelles (cocharges) can exist. In an electric field, positive pigment particles will move with the direction of the electric field while countercharges will move against II. The accumulated charge at the interface will form a diffuse double layer from the balance between drift and diffusion. This charge accumulation at a non zero distance from the electrode acts as a capacitor reducing the bulk electric field, which results in screening the bulk from the electric field.



Due to the high particle and micelle concentration, the bulk concentrations remains practically constant during this process.

B. Robben, F. Beunis, K. Neyts, R. Fleming, B. Sadlik, T. Johansson, L. Whitehead, and F. Strubbe, Electrodynamics of Electronic Paper Based on Total Internal Reflection, *Phys. Rev. Appl* 10, 34041 (2018).

Transient current measurement

Electrophoresis and screening can be examined from transient current measurements. When applying a polarizing voltages step from OV the external current is measured and related to buik properties of the cell. For low voltages, the initial current when applying a voltage step is proportional to the conductivity of the electrophoretic bulk and is directly related to the charge concentration. Exponential decays of the current are related to the KC constants sample based on the resistive bulk and capacitive parylene coating.



Two-stage switch

Driving from a negative voltage (a diffuse double layer of countercharges at the detection surface) towards a higher voltage (a compacted particle layer at the surface) occurs in a two-stage switch:

- Pigment particles are driven by the electric field towards the detected surface reducing the reflectivity. Instead of forming a compact particle layer at the surface, the diffuse double layer of countercharges keeps the particles away.
- The present diffuse double layer charge is larger than the arriving pigment particle charge. The excess of countercharges will diffuse together with the pigment particles leaving a reduced diffuse double layer of countercharges and resulting in a high reflectivity.
- III) The arriving pigment particle charge exceeds the present diffuse double layer charge. The excess of pigment particles will diffuse with the countercharges (small increase in reflectivity). When all countercharges are diffused, pigment particles will compact at the surface resulting in a larger decrease in reflectivity.

FDTD simulations based on drift, diffusion, electric field and adsorption match nicely with the measurements.



Contact bavo.robben@ugent.be			
f	Universiteit Gent		
¥	@ugent		
in	Ghent University		



FEA Research Symposium 2019



Research Foundation Flanders Opening new horizons Grant 1S67017N 57. Giorgia Rocatello, Gianluca De Santis, Sander De Bock, Matthieu De Beule, Peter Mortier & Patrick Segers

Optimization of a Transcatheter Heart Valve Frame using Patient-Specific Computer Simulation

giorgia.rocatello@ugent.be

This study proposes a framework to optimize the design of a transcatheter aortic valve through patient-specific finite element and fluid dynamics simulation. Two geometrical parameters of the frame, the diameter at ventricular inflow and the height of the first row of cells, were examined using the central composite design. The effect of those parameters on postoperative complications was investigated by response surface methodology, and a Nonlinear Programming by Quadratic Lagrangian algorithm was used in the optimization. The performance of the optimal and initial devices, in terms of contact pressure on the atrioventricular conduction system and paravalvular regurgitation were then compared in 12 patients. Results suggest that large diameters and high cells favor higher anchoring of the device within the aortic root reducing the contact pressure and favor a better apposition of the device to the aortic root preventing regurgitation. Compared to the initial device, the optimal device resulted in almost 3-fold lower predicted contact pressure and limited paravalvular regurgitation in all patients. In conclusion, patient-specific modelling and simulation could help to evaluate device optimization, could help to develop better devices in a shorter period.

INSTITUTE BIOMEDICAL TECHNOLOGY - BIOMMEDA, FACULTY OF ENGINEERING AND ARCHITECTURE, GHENT UNIVERSITY G Rocatello¹, G De Santis², S De Bock², M De Beule², P Mortier², P Segers¹

OPTIMIZATION OF A TRANSCATHETER HEART VALVE FRAME USING PATIENT-SPECIFIC COMPUTER SIMULATION

Background

- Aortic regurgitation and new conduction abnormalities are major complications related to transcatheter aortic valve replacement (TAVR).
- Geometrical parameters at the inflow portion of the device frame play a crucial role in the anchoring and apposition to the aortic root as well as in the above-mentioned clinical outcomes.
- The design phase of a device is a tedious and time consuming process, based on benchmark tests and animal experiments. Furthermore, it remains unclear how the final device will perform in actual patients.
- Patient-specific computer simulations can predict TAVR complications [1,2] and can be used to optimize and speed up the device design.

Study goal

To propose a new framework to optimize the design of a transcatheter aortic valve through patient-specific finite element and fluid dynamics simulation.

Flow Chart



DoE Study

- Factors: two geometrical parameters the frame diameter at the ventricular inflow and the height of the bottom row of cells.
- Objectives to minimize the predicted paravalvular leakage, the maximum contact pressure exerted by the device on the atrioventricular conduction system and relative area of contact (i.e. contact pressure index).
- Method: central composite design (CCD).





Results

The response surfaces were modelled using quadratic polynomial functions.



Model Fitting Plots



Optimization Results

The Nonlinear Programming by Quadratic Lagrangian algorithm was used in the optimization.



Conclusions and Future Work

- · Larger diameters and higher cells at the ventricular inflow of the TAVR device seem to
- improve the predicted clinical outcomes (i.e. minimize the predicted complications).
- In future, further optimization of the TAVR device design will be based on a larger cohort of
 patients representative of the TAVR population.











This research is supported by the European Commission within the Horizon 2020 Frameworl through the MSCA-ITN European Training Networks (project number 642458). 1. De Jaegere P et al. (2016), JACC Cardiovascular Interventions 9:508-512. 2. Rocatello G et al. (2018), Circulation: Cardiovascular Intervention 11:e005344

giorgia.rocatello@ugent.be

 Hicham Saaid, Jason Voorneveld, Christiaan Schinkel, Frank Gijsen, Patrick Segers, Pascal Verdonck, Nico de Jong, Johan Bosch, Sasa Kenjeres, Jos Westenberg & Tom Claessens

Validation Of 4d Flow MRI in a Left Ventricle Phantom

Hicham.Saaid@ugent.be

Previous works have defined clinical parameters based on left ventricle (LV) flow dynamics as potential early-stage indicators for cardiac health. These parameters were derived from interdisciplinary flow studies relying on medical imaging methods, in vitro experiments using optical flow measurement techniques and/or computational fluid mechanics simulations. Until now, flow measurements were primarily 2D, while it is well agreed that LV flow analyses would highly benefit from 3D (volumetric) measurement techniques to capture the complex spatiotemporal behavior of the LV flow. In view of this, the goal of our work is twofold: (i) showing the feasibility of a full-volumetric particle image velocimetry (PIV) technique to reconstruct the 3D flow topology in a realistic and dynamic LV model; (ii) using the 3D PIV technique as a gold standard to validate and further improve emerging medical imaging technique such as 4Dflow MRI.

VALIDATION of 4D FLOW MRI in A LEFT VENTRICLE PHANTOM

Hicham Saaid, J. Voorneveld, C. Schinkel, F.Gijsen, P. Segers, P. Verdonck, N. de Jong, J.G. Bosch; S. Kenjeres, J. Westenberg, T. Claessens

hicham.saaid@ugent.be



Erasmus MC

1 Introduction

- · The left ventricular (LV) flow may play an active role in cardiac function [1]. The evaluation of LV flow properties provides a different insight into the LV hemodynamics and may predict cardiac abnormalities before structural changes appear [2]
- · 4D Flow MRI has recently emerged as a novel tool for in vivo assessment of intraventricular blood flow [3]. However, the 4D flow MRI has not yet reached broad clinical practice, in part due to lack of validation studies against independent techniques
- · Particle image velocimetry (PIV) is an optical method of flow visualization and it is recognized as a gold standard technique for fluid velocity measurements. Tomographic-PIV is considered the first volumetric PIV technique [4].



Create an anatomically realistic left ventricle shaped membrane

Design and build of an MRI compatible LV phantom

Perform in vitro 3D velocity vector field measurements using Particle image velocimetry technique

Validate multiple accelerated 4D flow MRI sequences against independent technique (tomographic-PIV)



· The evolution of volumetric kinetic energy agrees very well with tomographic-PIV

Acknowledgement

We acknowledge Michiel Manten and Geert Springeling of Erasmus medical center for their assistance in fabricating the phantom, and Pieter van den Boogaard of LUMC for helping rith the MR acquisitions. This work was supported in part by ZonMw within the Innovative Medical Devices Initiative (IMDI) program (project Heart Failure and 4D Flow)

References

[1] Muñoz et al. (2013) Intracardiac flow visualization: current status and future directions. Eur Heart J Cardiovasc Imaging, 14, 1029-1038. Bermejo et al. (2015)The Clinical Assessment of Intraventricular Flows. Annu. Rev. Fluid Mech. 47:315-342. [3] Dyverfeldt et al.(2015) 4D flow cardiovascular magnetic resonance consensus statement. J Cardiovasc Magn Reson 17:72.
 [4] Elsinga et al.(2005) Tomographic particle image velocimetry. 6th Int Symp Part Image Velocim 1–12.

 Bram Steenwinckel, Pieter Heyvaert, Dieter De Paepe, Olivier Janssens, Sander Vanden Hautte, Anastasia Dimou, Filip De Turck, Sofie Van Hoecke & Femke Ongenae

Automated Extraction of Knowledge from Risk Analyses

bram.steenwinckel@ugent.be

Assessing upfront the causes and effects of system failures is an essential aspect of system manufacturing. Nowadays, these analyses are performed by a large number of experts, resulting in a lot of less useful, incomplete and unadaptable documents. To enable unification and easy operationalization of these risk analyses, this poster demonstrates an approach to automatically map all captured expert information into a domain-specific expert model or ontology, together with a set of fault detection rules. With the expert model, experts can get a high-level view of the whole system application. The rules can analyse the system based on the generated model. The whole approach is demonstrated with a use case to identify anomalies and their causes within a ventilation unit.



televic

🔄 Cumul.io

Automated extraction of knowledge from risk analyses

Bram.Steenwinckel@ugent.be, Pieter Heyvaert, Dieter De Paepe, Olivier Janssens, Sander Vanden Hautte, Anastasia Dimou, Filip De Turck, Sofie Van Hoecke and Femke Ongenae

Problem: Domain experts incorporate risk analyses in FMEA and FTA documents, resulting in inconsistencies, duplicates and fragmentation. **Goal**: Automate the extraction of ontology and rules, to enable consolidation of risk analyses without overburdening the domain experts.



60. Aranka Steyaert, Pieter Audenaert & Jan Fostier

Accurate Determination of Node and Arc Multiplicities in De Bruijn Graphs Using Conditional Random Fields

Aranka.Steyaert@ugent.be

Many bioinformatics tools rely on the analysis of next-generation sequencing data to reconstruct a genome of interest. This sequencing data comprises millions of short reads (i.e. genome subsequences) that may contain errors. To aid the reconstruction of the original genome, subsequences of length k of the reads, k-mers, and their overlap are represented as nodes and arcs respectively in a 'de Bruijn graph'. The number of occurrences of a k-mer or an overlap in the set of reads, called the read coverage of the corresponding node or arc in the graph, is a reflection of the number of occurrences of that k-mer or overlap in the original genome, called the multiplicity of the node or arc. Determining these multiplicities is important for the reconstruction of the genome, however, coverage variability and coverage biases render this determination ambiguous. Current methods base their decisions solely on the information in nodes and arcs individually, underutilising the information present in the sequencing data. We developed a conditional random field model to efficiently combine the coverage information within each node/arc individually with the information of surrounding nodes and arcs. Multiplicities are thus collectively assigned in a more consistent manner, resulting in a higher accuracy.

IDLAB – INTERNET TECHNOLOGY AND DATA SCIENCE LAB - IMEC

Aranka Steyaert, Pieter Audenaert and Jan Fostier

ACCURATE DETERMINATION OF NODE AND ARC MULTIPLICITIES IN DE BRUIJN GRAPHS USING CONDITIONAL RANDOM FIELDS

Background Genome sequencing Produces millions of short reads (50-250 bp length). Origin in genome sequence unknown. → "hillion pieces genomic puzzle" Extra difficulty: reads contain errors (1-2%) Determine overlan hetween reads → all to all comparison inefficient → obtain 'k-mers' from all reads: sub-sequences of equal length k count occurrence and occurrence of k-1 overlap De Bruijn Graph ACATAGCATGCAG ATAGCT Representation of the k-mers and their overlap ACATAG nodes: k-mers ATACAG arcs: overlap of k-1 AGCATG read support: occurrence of k-mer/overlap in read set multiplicity: occurrence of k-mer/overlap in original sequence - original sequence present as walk through graph CATGCT conservation of flow of multiplicity: if the full original genome is represented by de Bruijn graph: NODE MULTIPLICITY = **S** INCOMING ARC MULTIPLICITIES = Σ OUTGOING ARC MULTIPLICITIES

Motivation

State of the art methods assign multiplicities based on cut-off values in k-mer spectrum Incorporating the conservation of flow of multiplicity property enforces more correct multiplicity assignments



Conditional Random Fields

Probabilistic framework that allows us to combine k-mer spectrum based probabilities with probabilities on neighbourhoods of nodes that enforce the conservation of flow. CRFs are a proved technique in image segmentation to incorporate information embedded in neighbourhoods of superpixels. A whole spectrum of efficient inference techniques has already been developed.



K-mer spectrum

Histogram of read support of all k-mers

- Fit mixture model to these counts
- → One distribution per multiplicity
- → Determine cut-off values and create intervals of multiplicity

Issue: different multiplicity distributions overlap



Results

Fraction of correctly assigned multiplicities in the de Bruijn graph (Illumina data, 30x coverage)

	SOTA	Our approach
S. enterica	87%	95%
P. aeruginosa	73%	96%
B. dentium	78%	97%
E. coli	96%	97%
C. elegans	50%	61%
H. sapiens	69%	77%
D. melanogaster	66%	73%

Contact

aranka.steyaert@ugent.be www.idlab.ugent.be, www.imec-int.com

- f Universiteit Gent
- 🎔 🛛 @ugent @IDLabResearch
- in Ghent University



61. Charlotte Thyssen, Roel Van Holen & Stefaan Vandenberghe

Development of an Ultra-High Resolution Time-of-Flight PET Detector

cathysse.thyssen@ugent.be

PET imaging is used in clinics to visualise processes that happen inside the body. The patient is inject with a molecule that will send out radiation from inside. PET imaging has two important challenges: 1) The emitted radiation from inside the patient is sent out in random directions. The PET scanner is composed of a short ring around the patient and a large fraction of emitted radiation will not be detected. For this reason we have to give a high amount of radioactive labeled molecules to the patient (which is not without risk) in order to obtain enough information. 2) The obtained resolution ('sharpness') of the images is not very good. Small lesions that are smaller than the resolution will not be seen by the doctor. For this reason, we will build a new PET detector that is able to catch radiation more efficiently and precisely so the resolution is improved and radioactive dose to the patient can be reduced. A highly reduced activity to the patient will allow the doctor to use a PET scan more frequently and to do PET scans even on vulnerable patients such as children.

MEDICAL IMAGE AND SIGNAL PROCESSING (MEDISIP)

Charlotte Thyssen¹, Roel Van Holen^{1,2}, Stefaan Vandenberghe¹



- REFERENCES
- [1] E. Rustel and a structure mediation imaging of patton-netwo-parameteric transmosterior transmosterior. The key role of cellular differentiation and tumor grade. From theory to discutal parates², Charter imaging, onl 2, no. 1, pp. 172-1832, 2022.
 [2] E. Berg and S. R. Cherry, "Immorations in Instrumentation for Positron Imasian Tamography," *semin, Nucl. Med.*, 2018.
 [3] S Vanderbergher, E. Mithalyou, G. Lino, P. Moltz and J. S. Kary, "Recent developments in time-off hyper FT," *LIMMAP* Phys., vol. 3, no. 1, 2025.
 [4] S. Langet et al., "GATE Vie: a major enhancement of the GATE simulation platform enabling modelling of C1 and radiotherapy," *Phys. Med. Biol.*, vol. 56, pp. 881–901, 2011.
 [5] C. Thypes, "Molter Carlo simulation of call-aboy FTE" simulation platform enabling modelling of C1 and radiotherapy," *Phys. Med. Biol.*, vol. 56, pp. 881–901, 2011.
 [5] C. Thypes, "Molter Carlo simulation of call-aboy FTE" simulation platform enabling modelling of C1 and radiotherapy," *Phys. Med. Biol.*, vol. 56, pp. 881–901, 2011.

- y @ugent
- in Ghent University



detector based on monolithic crystals with:







62. Granch Berhe Tseghai, Wouter Dujardin, Serge Rijssegem, Brecht Tomme, Benny Malengier & Lieva Van Langenhove

Functional Shoe Construction for the Detection of Walking Pattern Anomalies in Parkinson's Disease Patients

granchberhe.tseghai@ugent.be

Parkinson's disease (PD) is one of the common and disabling pathologies affecting millions of people of all races and cultures globally, ranked the second most common neurodegenerative disease next to Alzheimer's disease. It affects about 1% of the population over the age of 60 years and is expected to double by 2020. There are more than 1,200,000 peoples suffering from PD in the Europe continent, among them 30,000 -35,000 are Belgians. In this research work, we introduce a systematic approach to detect the walking pattern of human being. We first developed a flexible resistive pressure sensor from electroconductive textile fabric. Then, a time of flight height sensor was synchronized with and integrated into an ordinary shoe. The constructed shoe detects the pressure between the shoe and foot of the user and the gap between shoe and ground which both give a trace of walking pattern. Thus, the shoe has a functional application for the detection of walking pattern anomalies with PD patients.

SMART TEXTILES

Granch Berhe Tseghai, Benny Malengier, Wouter Dujardin, Serge Rijssegem, Brecht Tomme, Lieva Van Langenhove

FUNCTIONAL SHOE FOR PD PATIENT **FERN ANOM ECTION** KING PA

- PD is a deficiency of dopamine due to degeneration of
- neurons in the substantia nigra.
- Worldwide 10x106 People
- Europe 1.2x106 People
- Belgium 35 x 103 People





CONSTRUCTION OF FUNCTIONAL SHOE









Ready made time of flight distance sensor





Height sensor - middle of sole ssure sensor - sole underneath heel Pr Arduino module - encapsulated by plastic container Mobile phone – power source and display LED – Pressure signal

RESULT AND DISCUSSION

- When Pressure/Load is not applied
- When Pressure/Load is applied
- Displays Risk Resistance in Ohm LED Lights up

 - Shoe on Ground
 - ✓ Displays Distance 20 mm
- Lifting up of shoe
 - ✓ Displays Distance More than 20 mm



- . Red LED dimed
- Normal

FUTURE PROSPECTS

- Pressure sensor under the ball of foot to detect abnormalities in rolling of foot
- . Software to keep track of measured values
- . Actuator, e.g. tightening of the shoe grip, giving electrical impulses to skin
- · App to display walking pattern or risk of falling on a smartphone
- · Antenna to regulate dopamine production levels in brain



Red LED Lighted up Risk - 14Ω

Contact

granchberhe.tseghai@ugent.be f Universiteit Gent Y @ugent

in Ghent University



63. Tim Valkenier, Wim Ceelen & Stefaan Vandenberghe

Hyperspectral Imaging in Medical Fields to Assess Oxygen Saturation

Tim.Valkenier@ugent.be

The achievement of surgical procedures is dependent on examining different tissue parameters, predominantly good tissue oxygen saturation, water content and the hemoglobin concentration. In oncological surgery, reconstructive surgery, as well as transplant surgery, tissue hypoxia can give rise to important morbidity such as sinus leakage, loss of a transplant and anastomotic leaks, the latter being one of the most serious complications in gastrointestinal surgery. There is a necessity for a noninvasive technique showing tissue oxygenation during surgery. Therefore, hyperspectral imaging (HSI) has become a new member of the biomedical imaging technology, which makes use of unique optical properties and allows to assess tissue oxygenation in a non-invasive way during surgery. The scope of this project is to develop a HSI technique, applied to laparoscopic surgery, to image at near-video rate, the tissue oxygen saturation. First the HSI setup will be performed and tested on microscopic level, in vitro/in vivo. Next, the combination with the laparoscopic equipment will be executed. The prototype will be eventually tested on experimental animals and humans.

Hyperspectral imaging in medical fields to assess oxygen saturation



Tim Valkenier^{1,2}, Wim Ceelen¹, Stefaan Vandenberghe²

¹Experimental surgery lab, University Hospital, Ghent, Belgium ²MEDISIP, Ghent University, IBiTech, Ghent, Belgium



= FACULTY OF MEDICINE AND HEALTH SCIENCES

E-mail: Tim.Valkenier@UGent.be

Introduction and Goal -

The achievement of surgical procedures depends on different tissue parameters, predominantly good tissue oxygen saturation and hemoglobin concentration, which cannot be reliably assessed by the human eye. New biomedical imaging technologies are emerging of which Hyperspectral imaging (HSI) is promising:

- \rightarrow Assessment and quantification of tissue oxygenation
- \rightarrow Surgery guided

- \rightarrow Minimal invasive surgery
- → Real-time imaging









64. Willem Van De Steene, T Van Waeleghem, Kim Ragaert & Ludwig Cardon

Additively Manufactured Continuous Fibre Composites Really Taking Off?

Willem.Vandesteene@ugent.be

Extrusion based additive manufacturing (AM) techniques for thermoplastic materials have been developed during the last thirty years. In order to avoid limitations in mechanical properties such as strength, stiffness and toughness of additively manufactured products compared to their injection moulded counterparts, short fibre filled AM materials have been introduced more recently. To expand the possibilities of the extrusion based AM materials even further, a process which incorporates continuous fibres into the polymers was developed: Continuous Fibre Additive Manufacturing (CFAM). This process combines a thermoplastic polymer matrix and a continuous fibre bundle into a wellimpregnated composite material right before its deposition, forming a 3D object. This process enables the manufacturing of complexly shaped parts that cannot be produced using traditional subtractive production technologies and gives the possibility to fully tailor and control fibre orientation, which is not always possible using the classic composite lay-up processes. These two advantages could lead to lighter, stronger and stiffer parts for use in high-end applications in aeronautics, aerospace, medicine and sports.

CENTRE FOR POLYMER AND MATERIAL TECHNOLOGIES W. Van De Steene, T. Van Waeleghem, K. Ragaert, L. Cardon

ADDITIVELY MANUFACTURED CONTINUOUS FIBRE COMPOSITES REALLY TAKING OFF?

Intro

Continuous fibre composites consist of a (thermoplastic) polymer matrix (Figure 1, beige) and a reinforcing material, e.g. carbon fibres (gray). Composites have important advantages compared to classical materials such as metals:

- high stiffness and strength
- high fatigue strength
- anisotropy tailoring
- low density

Using additive manufacturing (aka 3D-printing) techniques, labour intensive manual composite lay-up processes can be avoided. Also, these techniques enable the production of innovative and more complex shapes.

Applications

Load bearing components where weight reduction is critical for ${\rm CO_2}$ emission reduction, fuel saving or ergonomics:

UGent

- Aeronautics (Figure 3)
- aerospace
- transport on land
- Medicine (orthesis, tools)
- high-end sport equipment



Figure 3: the feasibility of CFAM door hinge brackets will be researched

Material characterisation

Material properties such as intra- and inter-layer cohesion, yield strength, stiffness, maximum fibre fraction, void fraction, fibre dispersion and distribution in the matrix are determined and compared to the values of classically produced composites.

.

...



Outlook

Currently, the CFAM impregnation and on-line printing process is being fine-tuned for standardised samples. The samples' mechanical properties are being evaluated and compared to those of classically produced materials. In the future, 3D curved layer prints will be produced, tested and evaluated.

Contact	
willem.vandesteene@ugent.be	
f Universiteit Gent	
🥑 @willem_vds	
in Willem Van De Steene	

UGent



65. Brecht Van De Vyvere

A Study of Real-Time Open Data Publication Strategies

Brecht.Vandevyvere@ugent.be

Cities are increasingly investing in sensors to attain data-driven policies, yet there is no clear strategy how this public sector information should be published as live Open Data. Studies suggest to keep the data moving by using a publish/subscribe model instead of traditional HTTP polling, however, more research is required to know whether this should become the standard method for every use case. Therefore, we are categorizing streams of sensor observations based on the (1) minimum time between two observations, (2) acceptable end-user latency, (3) expected network latency and (4) amount of end-users. A benchmark of streams with different characteristics gives Open Data publishers better insights which strategy to choose. An action plan will be created and disseminated with the 13 biggest cities of Flanders through the Smart Flanders program.

A STUDY OF REAL-TIME OPEN DATA PUBLICATION STRATEGIES



66. Casper Van Gheluwe, Angel J. Lopez & Sidharta Gautama

Error Sources in the Analysis of Crowdsourced Spatial Tracking Data

casper.vangheluwe@ugent.be

Governments are increasingly interested in the use of crowdsourced spatial tracking data to gain information on the travel behaviour of their citizens. This approach requires that the accuracy and the reliability of the data and transformation processes are clearly characterized. To improve the reliability of reporting in such mobility studies, this paper systematically analyses the propagation of errors from low level operations to high level indicators, such as the modal split and travelled distances. Studies have shown that errors that occur in early stages of the data processing can have drastic consequences on the accuracy of later stages. We find that most existing metrics in literature are insufficient to fully quantify this evolution of data quality. The propagation channels are presented schematically and a new approach to quantify the spatial data quality at the end of each processing stage is proposed. This procedure, within the context of Smart Cities, ensures that the data analytics and resulting changes in policy are sufficiently substantiated by credible and reliable information.

DEPARTMENT OF INDUSTRIAL SYSTEMS ENGINEERING AND PRODUCT DESIGN

Casper Van Gheluwe, Angel J. Lopez and Sidharta Gautama

ERROR SOURCES IN THE ANALYSIS OF CROWDSOURCED SPATIAL TRACKING DATA

Modal split

Travel

EVEL 4

EVEL

EVEL 2

EVEL

LEVEL 0

Cold, warm and hot starts

Travelled tim

O/D matr

d net

ΖЪ

 \land

Transport made classifient

Trip segmentation

 $\langle \rangle$

GNSS

Activity d

Context as

Speed map

Intensity map

Region

Incorrect link

Incorrect context

0

Positioning errors

innal recention error

rent errors

Con

Filtering

Missed and/or

Governments are increasingly interested in the use of crowdsourced spatial tracking data to gain information on the travel behavior of their citizens. To improve the reliability of reporting in such mobility studies, this paper systematically analyses the propagation of errors from low level operations to high level indicators, such as the modal split and travelled distances.

Existing quality metrics focus primarily on the evaluation of data quality within one process. However, as errors propagate these metrics are not sufficient. The error propagation channels are presented schematically in the figure to the right. Red arrows indicate how errors propagate to lates tages, while green arrows show how certain processes can be applied to reduce the impact of errors in previous stages. This model allows systematic analysis of mobility indicators and visualizations based on crowsbourced spatial tracking data. Within the context of Smart (Lites, this approach ensures that the data analytics and resulting policy changes are sufficiently substantiated by credible information, especially if the data is unreliable or messy. To accurately characterize the quality of the reported transport indicators, we calculate quality measurements for each step in the processing chain separately. A provenance tracker, along with aggregated metrics for instances where multiple measurements are combined into higher-eyele entities (eg. when a group of points are combined into a trip segment by the segmentation algorithm, allows researchers to capture the evolution of the data quality throughout the processing chain. Looking at individual trips instead of the full dataset enables disceriming differences in data quality due to the context (eg. undwn sr. una).

IS CROWDSOURCED SPATIAL DATA RELIABLE?

Because of the large variety in sensor devices and spatial location sensing methods (GPS, WiFi, cell towers, ...), crowdsourced spatial tracking data is quite messy and prone to outliers. This means that special care needs to be taken when dealing with this data.



Level O	Raw (unprocessed) data, gathered from data sources (smartphones, sensors, etc.) at full resolution.
Level 1	Annotated data, the original data that is annotated with ancillary information, time referenced and transformed to a standardized format.
Level 2	Derived data from automated processes, including quality improvements where possible.
Level 3	Augmented data, L2 data that is enriched by means of inference, data mining techniques and external data sourced
Level 4	Aggregated data as insights and analytics.

MINOR MISTAKES CAN LEAD TO MAJOR ISSUES DOWNSTREAM

Low-level errors can propagate to higher levels and thereby affect derived information, such as modal split statistics, average distances or trip durations. In the figure below, a trip consisting of consecutive segments of foot, car and foot transportation is oversegmented, introducing superfluous short waiking and driving segments. These oversegmentations and mode micicasifications lead to vasity different travel statistic and modal split outputs. Further steps in the processing chain can exacerbate this issue if the map matching fails because the raw locations are too distant from the network, it can create a gap in the matched trajectory. The points could also be linked to the wrong type of network, or the misclassifications could lead to gaps if there is no network for the incretity chosen transport mode.



Conclusion

Research has shown that errors that occur in the early processing stages can have profound effects the final results. Traditional metrics such as accuracy and recail are useful in many cases, but care must be taken to interpret those metrics correctly. They may hide subtle issues, which can have a serious impact on the validity of common mobility indicators. We have analyzed the propagation of spatial data quality in a processing chain for mobility campaians.

Acknowledgement

This work is funded by the Flanders Agency for Innovation and Entrepreneurship through the FLAMENCO project (FLAnders Mobile ENacted Citizen Observatories)

Cont	act
casp http:	er.vangheluwe@ugent.be s://ea18.ugent.be
f	Universiteit Gent
y	@ugent
in	Ghent University





67. Lukas Van Iseghem, Jeroen Beeckman & Wim Bogaerts

Programmable silicon photonic circuits with liquid crystal

lukas.vaniseghem@ugent.be

Integrated photonic circuits, where nanostructures are used to create optical circuits, have been developed past decades where several application specific chips have been demonstrated. These perform dedicated tasks such as bio-sensing (detection of certain chemicals, measuring of concentrations) and data-communication (everything you see on the internet passes through photonic integrated circuits). Analogue to the electronic market, developers can benefit by chip architectures designed for flexibility, to perform more than one specific task. These are called programmable chips, where the task of the chip can be altered according to the needs of the developer. This could be done by combining liquid crystal technology (applying a voltage to influence optical properties locally) and the already developed silicon photonic integrated circuit technology.

Programmable silicon photonic circuits with liquid crystal GHFNT Lukas Van Iseghem, Jeroen Beeckman and Wim Bogaerts UNIVERSITY

first.author@ugent.be



Today the progress of integrated photonics has enabled new on-chip functionalities in bio-sensing, data-communication and computing applications. Similar to electronics the functionality of each chip can be application specific or with reconfigurable elements they can be designed for more generic applications





Photonics Research Group, INTEC-Department, Ghent University-IMEC Center for Nano- and Biophotonics (NB-Photonics), Ghent University http://photonics.intec.ugent.be





68. Tim Van Mullem

Self-healing concrete a new and promising material but how to accurately test its potential?

tim.vanmullem@ugent.be

Concrete cracks easily. As a result, water can come into contact with the reinforcement steel which will then start to corrode. This can result in pieces of debris falling down like e.g. the tunnels in Brussels. To prevent this from happening the cracks have to be manually repaired. However, this is expensive and often requires a temporary closure of the structure. Self-healing concrete has the ability to close its own cracks, without the need for manual repair. To test the healing potential of self-healing concrete it has to be cracked. The efficiency of the healing and the accuracy of the test methods strongly depend on the created crack width. Yet, this is a parameter which is very difficult to control. It is proposed to implement an active crack width control technique in the test procedures. Experimental results, as well as mathematical calculations, demonstrate that this can strongly reduce the variability of the test results. Furthermore, the ideal sample size was investigated by comparing the reduction in variability to additional cost. The implementation of the proposed recommendations will make international comparison of experimental results much more straightforward, resulting in the end in greener and more durable concrete structures.
Self-healing concrete a new and promising material but how to accurately test its potential?



Tim Van Mullem

Magnel Laboratory for Concrete Research Department of Structural Engineering

FACULTY OF ENGINEERING AND ARCHITECTURE

Concrete cracks!



Aesthetics Steel corrosion Debris Traffic jams Costly repair

Self-healing concrete to the rescue!

Cracks are able to close themselves thereby resulting in a regain in liquid tightness (permeability). As a result, the reinforcement steel is protected against corrosion. This increases the service life, without the need for expensive manual repair, which saves a lot of money!

But how to test self-healing concrete?



To test the effectiveness of self-healing concrete it has to be cracked. The resulting crack width determines both the effectiveness of a self-healing concrete and its permeability. BUT it is very difficult to control the crack width. As a consequence there is a large variation on the test results making a comparison difficult. → Need for standardised method!

Test methods: active crack control & water flow

Mortar mix design: 450 g CEM | 42.5 N 225 ml water 1350 g DIN EN sand





Unreinforced prism (40x40x160 mm³) with hole Ø5 mm

Carbon Fibre Reinforced Polymer (CFRP) is glued on the top

Cracked in 3-point bending, CFRP keeps 2 halves together but crack width w is too large

Crack width w is restrained using screw jacks

Sides are sealed using 2. component adhesive



Recommendations for testing procedures

In order to have coherent results with regard to the sealing performance of self-healing concrete/mortar it is important to take the following points into account:

- The cracking method should result in similar, stable cracks. Large variations of the crack width within a series will result in ambiguous permeability results
- Instead of testing 3 specimens, testing 6 specimens will significantly reduce the variation on the mean flow.



Results: variation on permeability has 2 causes

Series	1	2	3	4	5
Mean <i>w</i> [µm]	161	154	222	305	307
Max(<i>w</i>)-min(<i>w</i>) [µm]	10	10	17	24	22
CV_ <i>w</i>	2.9%	2.8%	2.8%	3.2%	2.3%

Use of an active crack width control technique gives a low variation on the crack width. Yet the variation on the flow is a magnitude higher!

Series	1	2	3	4	5
Mean q [g-min]	13.9	11.6	33.6	96.6	97.1
CV_q	20.5%	16.4%	16.5%	14.3%	9.5%

The variation on the permeability is mainly influenced by 2 factors: the crack width and the internal crack geometry.

CV...



Small changes in crack width







Internal crack geometry

Internal parameter of crack; cannot be directly determined

The specimens in both group 1 (\overline{w} =157 µm) and group 2 (\overline{w} =306 µm) have a nearly identical w (CV<1%). Yet they can have a variation in flow of up to 50%!

10% If the variation on the crack width 8% stavs limited, the variation on the 6% 4% flow will be mainly dependent on the ----- 2% variation of the internal crack 0% geometry which cannot be controlled.

Acknowledgements

This research was supported by a grant (19SCIP-B103706-05) from Construction Technology Research Program funded by Ministry of Land, Infrastructure and Transport of Korean government.



69. Anton Vasiliev, Muhammad Muneeb, Jeroen Allaert, Joris Van Campenhout, Roel Baets & Gunther Roelkens

Integrated Spectrometer with Single Pixel Readout for Mid-Infrared Spectroscopy

anton.vasiliev@ugent.Be

Spectroscopy in the mid-infrared wavelength range (e.g. 2-4 µm wavelength) is of great value for various (bio)medical- and gas sensing applications. The state-of-the art in the industry uses large and expensive systems to achieve the required performance. Silicon-on-Insulator (SOI) waveguide technology offers a way to miniaturize the different components of the spectrometer. However, the development of on-chip detectors for this wavelength range has not caught up yet and the performance is currently not equal to the existing discrete (cooled) alternatives. In this work, a compact and cheap system is realized by integrating a SOI Arrayed Waveguide Grating (AWG) dispersive spectrometer in the 2.3 µm wavelength range together with a high performance mid-infrared photodetector. For demonstration, the absorption spectrum of a 0.5 mm thick polydimethylsiloxane sheet (PDMS) is measured and compared to a benchtop golden standard spectrometer to good agreement.

GHENT UNIVERSITY

Integrated Spectrometer with Single Pixel Readout for Mid-Infrared Spectroscopy

A. Vasiliev, M. Muneeb, J. Allaert, J. Van Campenhout, R. Baets and G. Roelkens

Anton.Vasiliev@ugent.be



- Integrated photodetectors are not (yet) on par with their discrete cooled counterparts



Solution: use a single high-performance mid-infrared photodetector off-chip and modulate the output channels of the spectrometer in time



Photonics Research Group, INTEC-Department, Ghent University-IMEC Center for Nano- and Biophotonics (NB-Photonics), Ghent University http://photonics.intec.ugent.be





70. Lynn Verkroost, Hendrik Vansompel, Frederik De Belie & Peter Sergeant

Active Fault Compensation Based on Online Reconfiguration of Modular Axial Flux Drives

Lynn.Verkroost@ugent.be

Sustainable energy applications require electrical machines with high reliability in extreme circumstances. Due to their high efficiency, low weight, numerous degrees of freedom and inherent redundancy, modular axial flux permanent magnet synchronous machines (AFPMSMs) are perfectly suitable for this purpose. In this project, it will be investigated how the additional degrees of freedom of modular AFPMSMs can be used efficiently, in order to increase the reliability of these drives, i.e. to keep them operating as well as possible in case of defects. The main focus will be on the online reconfiguration of the stator winding connections and current waveforms of the modules.

ELECTRICAL ENERGY LAB

Lynn Verkroost, Hendrik Vansompel, Frederik De Belie, Peter Sergeant

ACTIVE FAULT COMPENSATION BASED ON ONLINE RECONFIGURATION OF MODULAR AXIAL FLUX DRIVES

Abstract

Sustainable energy applications require electrical machines with high reliability in extreme circumstances. Due to their high efficiency, low weight, numerous degrees of freedom and inherent redundancy, modular axial flux permanent magnet synchronous machines (AFPMSMs) are perfectly suitable for this purpose. In this project, it will be investigated how the additional degrees of freedom of modular AFPMSMs can be used efficiently, in order to increase the reliability of these drives, i.e. to keep them operating as well as possible in case of defects. The main focus will be on the online reconfiguration of the stator winding connections and current waveforms of the modules.

Methodology



Optimal stator winding arrangement

E.g. is it more efficient to connect the stator windings in: (a) one single star, (b) multiple stars,



power stator electronic windings su



(c) multiple deltas?

E.g. must the modules be connected to the DC bus in:

(b) series?



Supply electronic states rectronic states rect

Preliminary results

Benchmark: 15-phase PI-control when stator windings are connected in 5 stars.



Modular AFPMSM: (1) rotor disc with permanent magnets, (2) power electronics per stator module, (3) motor housing and heatsink, (4) stator core element with concentrated winding.

GHENT UNIVERSITY 71. Olivier Verschatse, Lode Daelemans, Wim Van Paepegem & Karen de Clerck

Understanding the small scale to predict the large scale

Olivier.Deschatse@Ugent.be

Light-weight fibre reinforced composites are the material of choice for energy-efficient wind turbines, cars or airplanes. Although these materials are being used more and more, we still do not fully comprehend their behavior. As a result, designing composite parts is a time and money consuming job. Through an advanced micromechanical analysis, we will comprehend the fundamental mechanisms that determine the bulk behavior of composites. In our research, we study the individual constituent behaviour as well as their interactions. By combining scanning electron microscopy with in-situ mechanical testing, we uncover the microscale deformation mechanisms in composite materials. Our results will lead to a better understanding of the composite's microstructure and will allow for more accurate predictions by finite element modelling.

Understanding the small scale to predict the large scale

FEA RESEARCH SYMPOSIUM 2019

Olivier Verschatse^a, Lode Daelemans^a, Wim Van Paepegem^b, Karen de Clerck^a ^a Centre for Textile Science and Engineering (CTSE), Department of Materials, Textiles and Chemical Engineering, Faculty of Engineering and Architecture, Ghent University ^b Mechanics of Materials and Structures, Department of Materials, Textiles and Chemical Engineering, Faculty of Engineering and Architecture, Ghent University

Olivier.Verschatse@UGent.be

Light weight fibre reinforced composites are the material of choice for more energy efficient wind turbines, cars and airplanes. Their bulk behaviour is however very different from ordinary engineering materials and not fully understood yet. Our micromechanical analysis is focused on understanding the fundamental mechanisms that determine the composite's bulk behaviour.



Figure 1: Cross section of damaged a glass fibre composite



Composites are build up out of fibres and a matrix. Only a **good interaction** between them will lead to optimal composites.



The deformation behavior of epoxy is very different **at microscale**! Research indicates **higher strengths** and **more ductility** then expected from bulk testing.



During fracture a composite undergoes **deformation**, this requires energy. The more energy needed, the **tough**er the composite will be.

All these aspects need to be researched in detail to understand the behaviour at microscale

Micromechanical research via in-situ SEM mechanical testing



Figure 2: Our table top SEM with insitu mechanical testing stage





Figure 6: Comparison between model and experimental observations

Our results will lead to a **better understanding** of the composite's microstructure and will allow for more accurate predictions by finite element modelling.



Figure 3: Epoxy fibre





Figure 4: Carbon fibre in epoxy matrix

Figure 5: Carbon fibre

In our research, we study the **individual constituent** behaviour as well as their **interactions**. By combining scanning electron microscopy with in-situ mechanical testing, we uncover the microscale deformation mechanisms in composite materials.



IN FACULTY OF ENGINEERING

DEPARTMENT OF MATERIALS, TEXTILES AND CHEMICAL ENGINEERING – MATCH CENTRE FOR TEXTILE SCIENCE AND ENGINEERING - CTSE 72. Ehsan Yadollahi, El-Houssaine Aghezzaf, Joris Walraevens & Birger Raa

Inventory Routing Problem and Stochastic Demands

ehsan.yadollahi@ugent.be

The inherent uncertainty in supply chain systems compels managers to be more perceptive to the stochastic nature of the systems' major parameters, such as suppliers' reliability, retailers demands and facility production capacities. To deal with the uncertainty inherent to the parameters of the stochastic supply chain optimization problems and to determine optimal or close to optimal policies many approximate deterministic equivalent models are proposed. In this paper we consider the periodic stochastic inventory routing problem modelled as chance-constrained optimization problem. We then propose a safety stock-based deterministic optimization model to determine near-optimal solutions to this chance-constrained optimization problem. We investigate the issue of adequately setting safety stocks at the supplier's warehouse and at the retailers so that the promised service levels to the retailers are guaranteed, while distribution costs as well as inventory throughout the system are optimized. The proposed deterministic models strive to optimize the safety stock levels in line with the planned service levels at the retailers. Different safety stock models are investigated and analyzed and the results are illustrated on two comprehensively worked out cases.

DEPARTMENT OF TELECOMMUNICATIONS AND INFORMATION PROCESSING (TELIN) AND DEPARTMENT OF INDUSTRIAL SYSTEMS ENGINEERING AND PRODUCT DESIGN

Ehsan Yadollahi, El-Houssaine Aghezzaf, Joris Walraevens, and Birger Raa

INVENTORY ROUTING PROBLEM AND STOCHASTIC DEMANDS

Inventory Routing Problem (IRP)

What is IRP?

Inventory Routing Problem (IRP) is an underlying optimization problem for a warehouse replenishing multiple retailers to satisfy their demands while minimizing transportation and inventory within the system. A fleet of vehicles is available for the replenishment of the retailers from the warehouse Why?

The objective of the IRP is to minimize the transportation and inventory costs over a given planning horizon without causing stock-out at any of the retailers



Stochastic Non-stationary Demand

demand grows from period to period on different rates. Stochastic non-stationar demands make it challenging for decision makers to allocate the optimum level o products to be delivered to the retailers.

To be taken into account

- Routing selection Inventory and safety stock level Service level

Stochastic Non-stationary Demand



Stochastic Periodic Inventory Routing Problem (SPIRP) Planning Horizon and Stochastic Demand

The planning horizon is the length of time into the future that is accounted for in a particular plan, assumed in this paper consisting of several periods.

Retailers' demands are usually stochastic in nature. The stochasticity added to the problem creates a probability that shortages occur. Unsatisfied demand is either considered as lost-sales or backlog. Shortage minimization as well as inventory and transportation costs optimization, are the critical issues to be considered in IRP models



The Proposed Models

- SAA-SPIRP: Sample Average Approximation SPIRF FTSS-SPIRP: Fine-tuned safety stock-based SPIRP

an item held on top of the cycle inventory to reduce the risk that the item will be out of stock. Safety stock-based SPIRP deals with the unexpected demands coverage by adding safety stock on to of the inventory, while Sample Average Approximation mechanism finds an average of the optimur offered a fine-tuned safety stock based solution model to optimize the level of safety stock at th retailers among the periods.











- Y @ugent
- in Ghent University



73. Iman Zand, Banafsheh Abasahl & Wim Bogaert

MEMS-based Zero-Power Reconfigurable Photonic Integrated Circuit

iman.zand@Ugent.be

In MORPHIC, we provide a novel silicon-based technology platform for generic Field Programmable Photonic Integrated Circuits (FP-PICs) scalable to volume manufacturing. This technology enables multifarious applications on a single platform of architected optical circuit. For this goal, tunable MEMS-based optical components, as programmable building blocks, will be designed and fabricated to form a sea of connections called circuit mesh. Proper algorithms and analysis methods will also be applied to design highly flexible and stable circuits with enhanced performances (e.g. energy efficiency, footprint, speed, ...). Proposed technology is analogous of Field-Programmable Gate Arrays (FPGAs) in electronics, and paves the way for Si-based chip integration technologies. PHOTONIC RESEARCH GROUP

Iman Zand, Banafsheh Abasahl, Wim Bogaerts

MEMS-BASED ZERO-POWER RECONFIGURABLE PHOTONIC INTEGRATED CIRCUITS

Introduction

In NOBHIC, we provide a novel silicon-based technology platform for generic Field Programmable Photonic Integrated Circuits (FP-PIC) scalable to volume manufacturing. This technology enables multifarious applications on a single platform of architected optical circuit. For this goal, tunable MEMS-based optical components, as programmable building blocks, will be designed and Sabricated to form a sea of connections called circuit speed analysis methods will also be applied to design highly flexible and stable circuits with enhanced performances (e.g. encyre yfficiency, footprint, speed, _____). Proposed technology is analogous of Field-Programmable Gate Arrays (FRGAs) in electronics, and paves the way for S-based chyin integration technologies.









imec









74. Shiquan Zhao, Sheng Liu, Robain De Keyser & Clara Ionescu

Optimal Sliding Mode Controller with AGA for Drum Water Level of Ship Boiler

Shiquan.Zhao@ugent.be

Due to the strong load disturbance, model uncertainties and parameters mismatch, it is usually difficult to control drum water level of the boiler. A sliding mode controller with adaptive genetic algorithm (AGA) was proposed. Taking the error of drum water level, its velocity and its accelerated speed into s-function, the sliding mode controller was designed. And by using Lyapunov stability theorem, its stability was proved. On this basis, sliding mode controller parameter was optimized with AGA. The proposed method was applied to the drum water level control, and PID controller was also applied to drum water level control. The results prove that sliding mode controller with AGA leads to better performance than PID controller, and it's a valid and feasible method.





Optimal Sliding Mode Controller with AGA for Drum Water Level of Ship Boiler

Shiquan Zhao, Sheng Liu, Robain De Keyser, Clara Ionescu

Abstract

Due to the strong load disturbance, model uncertainties and parameters mismatch, it is usually difficult to control drum water level of the boiler. A sliding mode controller with adaptive genetic algorithm (AGA) was proposed. Taking the error of drum water level, its velocity and its accelerated speed into s-function, the sliding mode controller was designed. And by using Lyapunov stability theorem, its stability was proved. On this basis, sliding mode controller parameter was optimized with AGA. The proposed method was applied to the drum water level control, and PID controller was also applied to drum water level control. The results prove that sliding mode controller with AGA leads to better performance than PID controller, and it's a valid and feasible method.

Key Words: Boiler unit, Drum water level, Sliding mode, AGA

Introduction of the System







Results and conclusions



From the results obtained, it is believed that the sliding mode controller with AGA has faster response speed, smaller overshoots and better steady-state performance than PID controller. From the simulation, sliding mode control method with AGA can effectively solve the problem of parameter uncertainty and strong disturbance, and results in a comprehensive performance.

References

- Deepa Thangavelusamy, Elimination of Chattering Using Fuzzy Sliding Mode Controller for Drum Boiler Turbine System, Control Engineering and Applied Informatics
- [2] Lu Cao, The design of nonsingular terminal sliding-mode feedback controller based on minimum sliding-mode error, Journal of Aerospace Engineering



How will AI shape our future

By Raphaël Weuts

Where is our relation with technology headed? Some recent events can give us hints: Uber's self driving car accident and the development of autonomous cars in general for example. The evolution of industrial robots from operating behind fences to working next to you, standing at the same table, collaborating with us humans, not being called 'robots' anymore, but 'cobots'; leading to de new field of cobotic safety. More abstract, socially intertwined examples like *Cambridge Analytica* hint at the more fundamental issue of unwanted consequences of the implementation of complex systems and more philosophical questions like the value alignment problem lead us further in that direction.



Uber self driving

car accident





Cobotic safety



Cambridge

Analytica

align



The last one, the value alignment problem has the potential to have more impact than global warming, be more dangerous than nuclear war and yet is less understandable than financial crises. A big name in the research on this topic is Nick Bostrom, Philosophy professor at Oxford. The issue researchers like Bostrom focus on here is the issues that might occur when we specify the goal function a powerful future artificial intelligence would be given imperfectly. The problem comes from the difficulty of specifying *everything* we as humans hold dear (or should hold dear) and the tendency of goals taken literally to ignore everything that was not specifically specified. Next to that base problem, specifying what we mean by humanity itself is already an issue (do death or unborn people have the right to let their honour ot future rights to count in the value of the hypothetical artificial intelligence?) and we cannot make a mistake because of the instrumental goals a powerful artificial intelligence would have, one of them being the preservation of whatever initial goal we program it with, hence making it resist any hypothetical attempt form us to change it.

This topic falls between philosophy, lawmaking and engineering. Weirdly though, researchers in the respective faculties are generally discouraged from cooperating. The author of this piece of text is an engineer though, so let's roll that back a little and keep our conclusion at: engineers are generally discouraged from doing philosophy or creating proposals for new regulation and legislation.

This is not a new debate at all, Kierkegaard already talked about rather related sociotechnological power issues more than a century ago. Currently next to the academic Bostrom and very known and respected Al researcher Stuart Russel, a lot of public figures have entered the debate: Stephen Hawking, Bill gates and Elon Musk, all warning us for the dangers of powerful artificial intelligence. The last one, Musk, even started two organisations working on solutions: OpenAI and Neuralink, the last one to 'increase the bandwidth between AI and our brain'. His idea though, differs fundamentally from Bostrom's in that he argues for the democratisation of AJ, where as Bostrom focus on solving the value loading problem first.

Next to this 'it is a problem camp', there is also the 'it is *not* a problem camp' of course. Remarkably *Microsoft Research Cambridge* director, artificial intelligence researcher and professor at Cambridge Chris Bishop uses the *pull the plug* argument in one of his talks, thereby disagreeing with Bostrom and at the same time dividing the opinions here over Oxbridge, industry and academia and the string between Bill Gates and Microsoft. same time dividing the opinions here over Oxbridge, industry and academia and the string between Bill Gates and Microsoft.

Since the work of Bostrom and others like Eliezer Yudkowsky and Sam Harris a couple years ago sparked new attention for the AI safety issue, a lot has happened. Algorithms and new moral concepts have been developed. None leading to anything close to a complete solution though. Luckily getting into AI safety research is a lot easier these days though. One beautiful example is the ease with which we can now learn about the issues at hand through YouTube channels like that of Robert Miles, known also from the YouTube channel Computerphile.

Getting into AI safety research is possible by taking a sliver of the field and putting it into the margins of our research, by organising debate evenings, reading up books like *Superintelligence: Paths, Dangers, Strategies* from Bostrom and by founding and joining organisations like *Leuven AI Forum*.

These days tens of thousands of high school students protest every week in our capital, asking for climate change policy solutions. If we can make an AI safety equivalent of that happen a decade from now we might be increasing the gains AI developments will bring us substantially. That is not to say that there should be protests or that high school students should be involved, but a similar level of policy engagement in the matter could announce the beginning of our institutions coming together and solving this issue before neglecting it becomes relevant.

About the speaker

Raphaël Weuts is a PhD researcher in Engineering Science at KU Leuven, researching Advanced Automation Safety Paradigms, with ambitions in Al Safety policy solutions. He has a background in artificial intelligence, corporate strategy, patents, entrepreneurship, policy, university lecturing and managing interdisciplinary teams. Currently he is also preparing to start the *Belgian Al Safety Policy Lab* and is searching for partners, as well as co-authors in a related publication.



Ghent, Belgium

The 19th edition of FEA Research Symposium



PANEL

Prof. Patrick De Baets Dr. Hetty Helsmoortel Prof. An Verberckmoes Dr. Wim Audenaert Prof. Jeroen Dewulf Johan Bil Esther De Smet

WORKSHOPS

Greet Cardon Baryon Kurt Van Houtte Nerdlab Raphaël Weuts Margo Baele

KEYNOTE Marc Lambotte



Alexandra Bouriakova Andries Daem Kevin Dekemele Laurence De Meyst Brigitte Devocht Jasper Juchem Jeroen Lauwaert Maëli Lissens Gieljan Vantyghem Beau Van Vaerenbergh



DOCTORAL SCHOOLS



0

A



... arranged.

MARLINKS



GHENT UNIVERSITY





