Technische Universiteit
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AUTOMOTIVE/MECHATRONIC SYSTEMS DESIGN

PDEng projects 2017

The PDEng Automotive Systems Design is an accredited and challenging two-year doctorate-level engineering degree program. Since 2015 the subtrack Mechatronic Systems Design is part of this program. During these programs trainees focus on strengthening their technical and non-technical competencies related to the effective and efficient design and development of technologies and applications for modern high-tech automotive and mechatronic systems. In particular, there is a focus on the multidisciplinary design aspects of project-based research and engineering in high-tech automotive and mechatronic systems, reflected in the key contributions by four TU/e departments. For more information please visit www.tue.nl/asd.

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AUTOMOTIVE/MECHATRONIC SYSTEMS DESIGN - PDENG PROJECTS 2017

Prof.dr. H. Nijmeijer
Dr. P.S.C. Heuberger

The 2017 generation ASD/MSD trainees

The past year has been quite special as we extended the Automotive Systems Design (ASD) program with the track Mechatronic Systems Design (MSD) and the first 4 MSD trainees have graduated in 2017.

In this booklet we proudly present the results of the fourteen 2017 graduates of the PDEng programs ASD (10) and MSD (4). The ASD program has started in 2011, motivated by the urgent need of the automotive industry for system architects, people who are not afraid to go beyond the boundaries of disciplines and who are willing to work together in project teams to achieve results in a structural manner. The extension with MSD has been initiated and supported by the TU/e High Tech Systems Center, motivated by the rapid changes in the Dutch mechatronic ecosystem with huge challenges in terms of multidisciplinary product and process design and engineering.

These two-year post-master programs educate their trainees in-depth in various automotive and mechatronic related disciplines, as well as in personal and professional development. This variation in disciplines is reflected in the 14 projects that are described here. We see a wide range of applications and designs in the areas of Mechanical Engineering, Mechatronics, Fuel Economy, Software, 3-D printing, Vision, Transmission Systems, Control, Modelling and Advanced Driver Assistant Systems (ADAS). Two ADAS related projects are focusing on heavy duty trucks dealing with Blind Spot Detection and Predictive Cruise control. A third ADAS project discusses the real-time perception capabilities of a specific high-end embedded platform, used to sense the immediate surroundings of cars, showcasing a lane centering assist system.
Two other projects are aiming at improved fuel economy, again for trucks. One of these deals with improved, so-called multi-pulse, fuel injection, the second project investigates the possibilities of improved waste heat recovery, when preview information about the route is available. Heat has also been the subject of another project that considered thermal modeling and the development of a thermal management system for cars. Temperature is also an important element of transmission systems and one of the projects focused on the development of a simulation environment for a hybrid dual-clutch transmission system.

Much attention nowadays goes to big data and Internet-of-Things applications. Soon many cars will be connected through ‘the cloud’ and one project considers the new business opportunities that arise in this setting. Another emerging technology is Additive Manufacturing, or 3-D printing. One project is directed towards a flexible software architecture for the next generation of these machines. Two projects are focused on control applications. The first one is aiming at improving the performance of wafer dicing, where the second one is concerned with relaxing the mechanics of a weaving machine shedding system.
Another mechatronic application is to show the advantages of integration vision in company-specific positioning systems. Another vision related project aims at the architecture and implementation of a new computer vision platform for the guidance of robotic packaging machines. The last project deals with the challenge that the Netherlands will have to renew more than 50 ship locks in the near future. The aim of the project is to create a method capable of aiding decision-makers in lock design and lock maintenance.

These final PDEng projects, proposed and paid for by the high-tech industry are diverse, complex and challenging. They require our trainees to deliver products and designs that meet high requirements in a highly multidisciplinary setting. We are proud that that our trainees live up to the high expectations of the industry. We wish them all the best and a successful career.

Henk Nijmeijer
Scientific Director

Peter Heuberger
Program Manager

"The research conducted in this PDEng assignment offers excellent benchmark results. Moreover, the vehicle functions which have been tested on a prototype truck have received a clear position on the technology roadmap at DAF Trucks."

John Kessels
Sr. Control Engineer at DAF Trucks N.V.

Challenges

Collecting the knowledge of different Advanced Driver Assistance Systems (ADAS) and understanding how they work and interact with each other was challenging. Nevertheless, the main challenge was to pinpoint the possible areas for improvement and come up with a simple and pragmatic solution to improve the overall system performance with respect to fuel consumption.

Results

The proposed system consisting of four functionalities is the outcome of this project. The system was designed bearing in mind safety, driver comfort, and the truck's road acceptance. The system functionalities were tested in a simulation environment and one of the functionalities was tested on a DAF truck.

Benefits

Furthermore, the designed system is a step closer to the development of autonomous trucks. The system, if taken to production level, offers a reduction in fuel consumption while increasing the driver's comfort level.

Hazem M. Hany PDEng

Predictive ADAS functionalities to lower fuel consumption

Currently, the automotive sector is focused on increasing road safety and comfort levels for road users, while also decreasing fuel consumption and CO_2 emissions. OEMs alongside tier1 suppliers have realized that automated and semi-automated driving is the most pragmatic solution. On the road to an autonomous vehicle, DAF focuses on developing ADAS to tackle these goals. In this project, a proof of concept was realized consisting of 4 functionalities each aimed to tackle these goals in a direct or indirect manner.

Field data analysis, simulations, and real-world tests show promising results with respect to decreasing fuel consumption and reducing CO_2 emissions without jeopardizing the other goals.

Challenges

The main challenges were to align high-tech industry stakeholders' needs and prove, in reliability, accuracy and throughput terms, the advantage of integrating vision in the positioning systems used in the current workflows. Vision becomes a priority for the sake of future products and motion techniques; not only to verify the positioning but also, to detect other process and quality parameters and, ultimately, improve reliability by enabling smart error recovery mechanisms.

Results

A vision-based positioning proof of concept was implemented and validated according to customer's needs, exceeding expectations with regard to overall performance and flexibility.

Benefits

This proof of concept enables Thermo Fisher Scientific to strive for a competitive advantage in the market by developing more reliable and accurate solutions to further improve the intended workflows.

"Nestor had a great contribution in realizing and validating a proof of concept setup for a vision-based positioning system. Due to his work on image recognition and system integration, along with his focus on quality, we've managed to reach our goals in terms of accuracy and reliability. He showed to be a skilled and pleasant person, who fully blended in the mechatronics team. In fact, we welcome Nestor at Thermo Fisher Scientific as our new colleague."

Ron van den Boogaard
Senior Mechanical Design Engineer at Thermo Fisher Scientific Inc.
Martijn La Grange
Project Manager R&D at Thermo Fisher Scientific Inc.

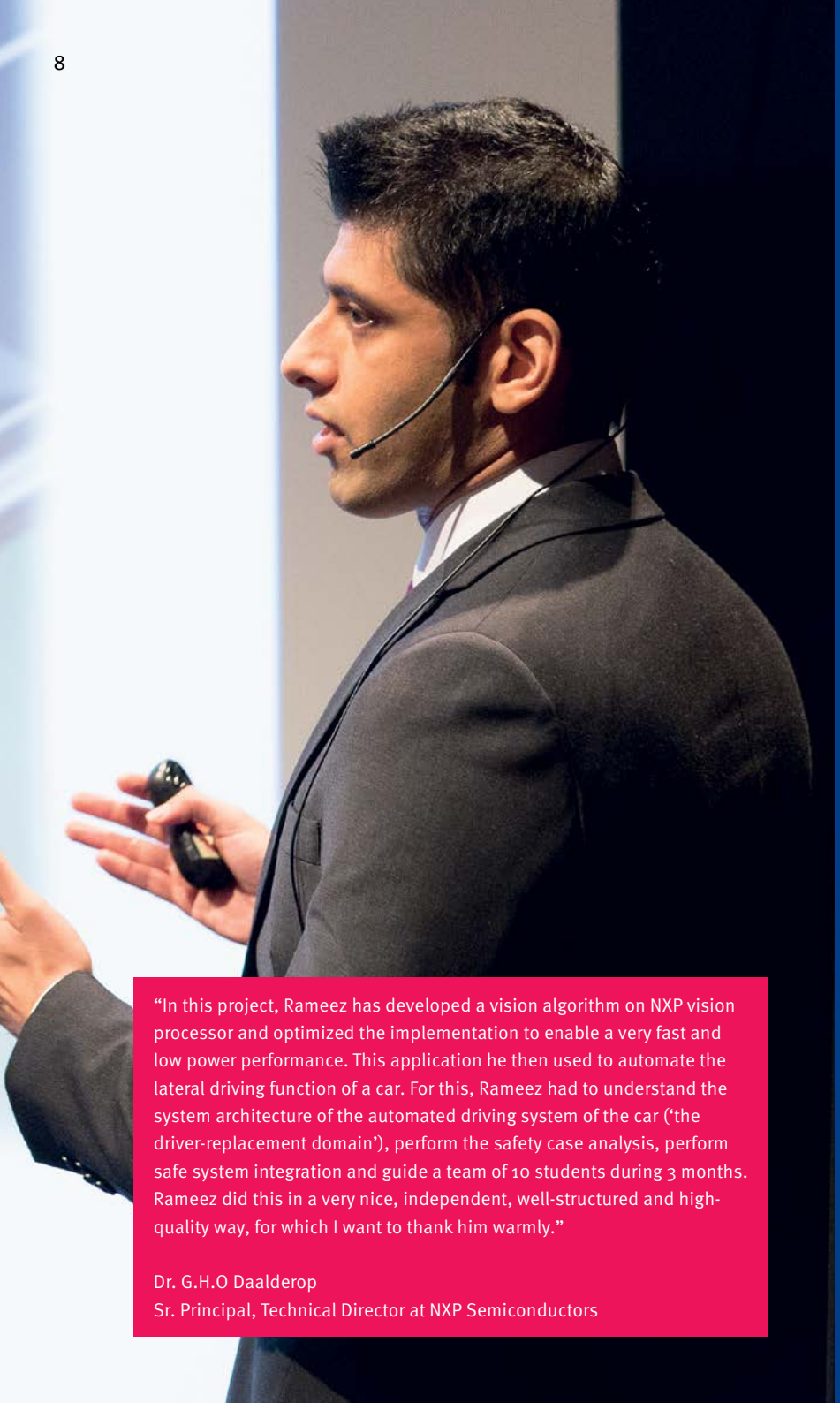
Nestor Hernandez Rodriguez PDEng

A system approach for a vision-based positioning mechanism

Thermo Fisher Scientific Analytical Instruments Group (AIG) division, formerly known as Field Electron and Ion Company (FEI), is a leading manufacturer of high-end electron microscopes present in a broad range of different areas, such as material science, semiconductor, oil and gas, minerals and mining, life science and industrial manufacturing. Mainly used to visualize objects at an atomic scale, the electron microscopes are able to provide resolutions of up to 50 pm helping science to advance further in its incessant knowledge research, providing the most innovative imaging and sample preparation tools to achieve this end.

Increasing demand in the high-tech industry asks for new ways of improving the current existing workflows. In this context, Thermo Fisher Scientific decided to comply with the current market growth by extending their current motion control and positioning systems with vision. Researching new mechatronic concepts will ultimately help them develop a solution that would match customer's expectations while providing a competitive advantage in the market.

This project yields the necessary input for the integration of vision into the existing positioning solutions. The developed proof of concept provides the expected robustness and complies with the current technology for which it was intended; achieving a performance that greatly surpasses the initial expectations and leaving enough room for future improvement.



"In this project, Rameez has developed a vision algorithm on NXP vision processor and optimized the implementation to enable a very fast and low power performance. This application he then used to automate the lateral driving function of a car. For this, Rameez had to understand the system architecture of the automated driving system of the car ('the driver-replacement domain'), perform the safety case analysis, perform safe system integration and guide a team of 10 students during 3 months. Rameez did this in a very nice, independent, well-structured and high-quality way, for which I want to thank him warmly."

Dr. G.H.O Daalderop
Sr. Principal, Technical Director at NXP Semiconductors

Challenges

A vision based lane centering system needed to be designed. The lane tracking algorithm must be robust against any kind of occlusions, lighting changes, road shadows as well as lane marking deteriorations. In addition to the design challenges, there are implementation challenges regarding realization of the LCAS on the NXP BlueBox, for example optimal utilization of heterogeneous computing units of the platform.

Results

The major tangible result of the project is a system that is deployed in the test vehicle to provide a reliable detection and tracking of the ego lane, in real-time. The results from the algorithm can be viewed on the open source repository for the project. Besides providing a real-time lane detection and tracking, the system is also capable of providing an active steering to keep the vehicle centered in the current lane.[1]

Benefits

This project served as a first milestone towards achieving a prototype for a self-driving car.
It establishes guidelines for designing and realizing an advanced automated system using a next-generation automotive platform. Furthermore, the results from this assignment are used to showcase the capabilities of BlueBox as well to derive recommendations.

[1] https://github.com/RameezI/TUeLaneTracker

Rameez Ismail PDEng

Next-Generation Lane Centering Assist System

Design and Implementation of a Lane Centering Assist System using NXP BlueBox

One severe consequence of driver's distraction is the drifting of the ego vehicle from the current lane. A brief diversion of the driver's attention from the road is enough to cause a fatal accident. Most new vehicles these days offer automated assist systems to prevent such accidents. Many of these systems, Lane Departure Warning Systems (LDWS), are passive systems which only alert the driver about a possible lane drift. Some more advanced systems, Lane Keeping Assist Systems (LKAS), also provide corrective actions, for example, corrective steering or braking the opposite wheel, to course correct the vehicle.

The distinguishing characteristic of a Lane Centering Assist System (LCAS) is that it continuously steers the vehicle to ensure that it stays centered in the driving lane. In case the LCAS is combined with an Adaptive Cruise Control System (ACCS), an SAE-level 2 automation system will be in place. This also allows the driver to disengage from physically operating the vehicle from time to time. The LCAS system uses a camera to track lane boundaries and is realized using an advanced embedded platform, NXP BlueBox, developed to enable self-driving cars.

Challenges

With in-cycle control, combustion data acquisition, computation, decision, injection commands communication and fuel injector actuation have to be performed within 1 ms. This imposes extremely challenging requirements on the hardware and software components.

Results

For TU/e's single cylinder engine set-up, an in-cycle control system is designed and implemented using a dedicated FPGA-based rapid control prototyping system. This includes the development of a combustion control strategy using new combustion control parameters. These parameters are estimated on-line based on in-cylinder pressure information. From hardware-in-the-loop tests, it is demonstrated that the realized system can enable real-time combustion control well within the challenging requirement of 1ms. This was not possible up to now.

Benefits

Experimental results from the test set-up illustrate that fuelling inaccuracies could increase variability of combustion conditions and corresponding engine performance indicators. In-cycle combustion control will compensate for these disturbances, such that engine performance can always be maintained at a desired level. With the realization of this in-cycle control system, the route is open for engine research on real-time control of advanced fuelling strategies.

"With the realization of this in-cycle control system, Lazaros made a crucial contribution to our advanced combustion research. It is amazing that he finally succeeded in realizing a system with a reaction time that is 200 times faster than humans. We believe that this is on the edge of what is currently feasible in combustion control."

Prof. Frank Willems (TNO Automotive/TUE)

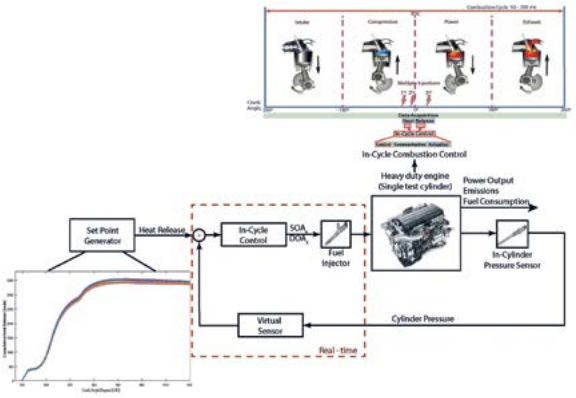
Lazaros Kefalidis PDEng

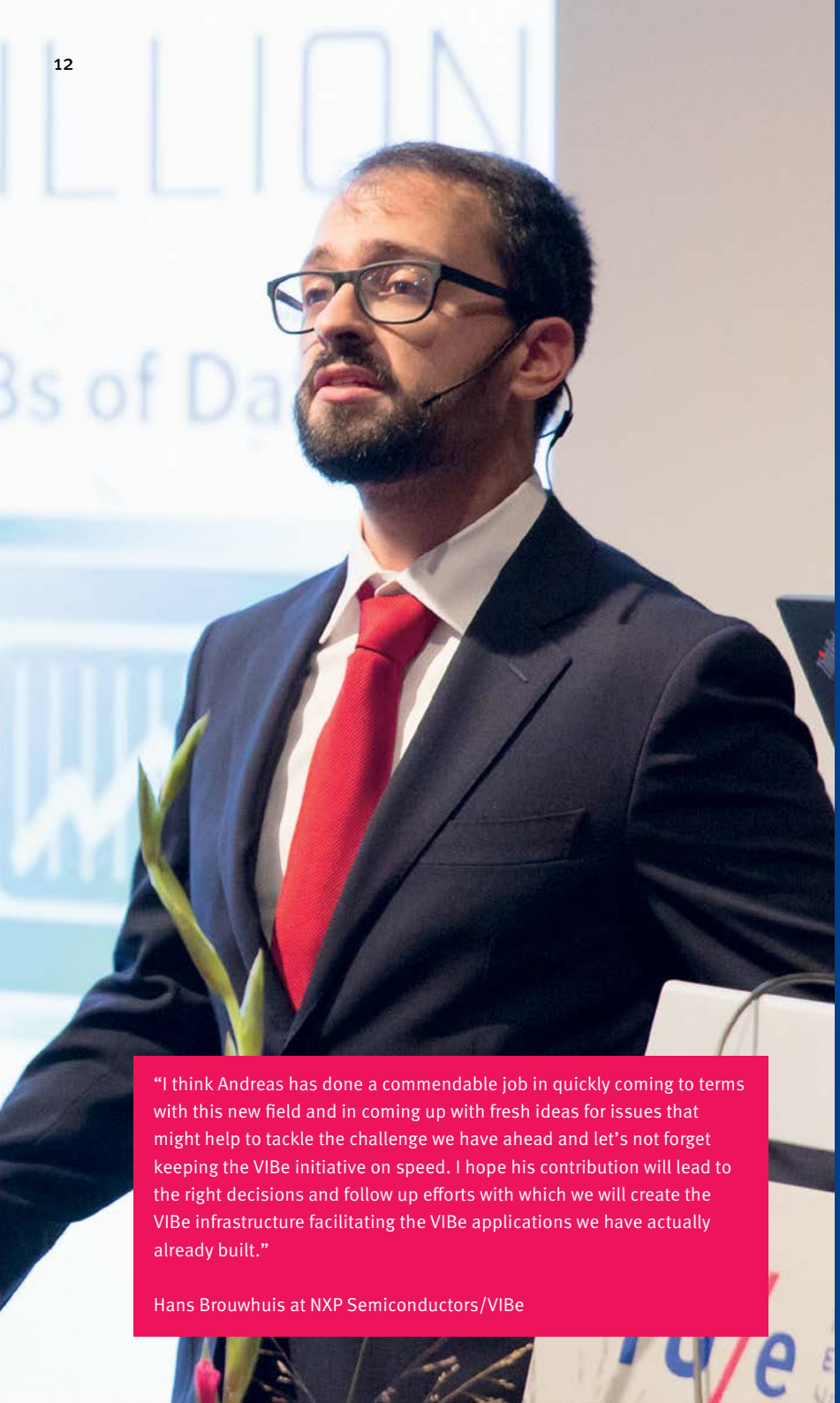
Systematic Design of an In-Cycle Fuelling Control System for Advanced Diesel Combustion Concepts

In today's modern world, strict regulations for admissible diesel engine pollutants and greenhouse gas emissions as well as the demand for high engine output torque with minimal fuel consumption, require advanced strategies of diesel engine control. In combination with requirements for enhanced safety and low calibration and maintenance cost of the engines, significant effort is required for the advancement of the current control systems.

New generation combustion concepts are investigated in the Heat2Control research project at the Eindhoven University of Technology (TU/e). It studies the potential of closed-loop combustion control of these combustion concepts on a diesel engine setup. Next cycle combustion control has already been successfully implemented, where fuel injection for the next cycle is adapted based on the combustion behaviour of the current cycle. The next step towards new generation advanced combustion control strategies is real-time, in-cycle combustion control for multi-pulse fuelling concepts. In such control strategies, fuelling decisions are made for the current cycle based on observations of the combustion process and disturbances in the air and fuel path can be compensated automatically and instantly. This aims a further improvement of the trade-off between fuel consumption and emissions as well as enhanced stability of the engine performance.

In this project, a systematic approach was followed in order to realize the in-cycle control of the fuelling system for a single cylinder heavy duty engine. The focus of the work lies on the design and the development of the in-cycle system architecture with regard to hardware and software design. The implemented system is an enabler for real time combustion control and potential of enhanced engine performance could be exploited with such control concepts due to the fast control response. The main benefits of in-cycle control are better compensation for cycle to cycle variations and improved transient response for conventional and advanced combustion concepts.





"I think Andreas has done a commendable job in quickly coming to terms with this new field and in coming up with fresh ideas for issues that might help to tackle the challenge we have ahead and let's not forget keeping the VIBe initiative on speed. I hope his contribution will lead to the right decisions and follow up efforts with which we will create the VIBe infrastructure facilitating the VIBe applications we have actually already built."

Hans Brouwhuis at NXP Semiconductors/VIBe

Challenges

The main challenge was to design a concept that connects effectively business objectives with technical implementation and proposes an alternative solution that challenges the status quo. It was required to perform at different levels of abstraction, ranging from high level strategic approaches to low level technical implementations. Finally, an agile mentality was needed with respect to acquiring the resources for realizing a prototype of the smart mobility platform.

Results

The recommendation to the VIBe initiative was successfully conducted, suggesting an alternative vision and specific strategic steps on how can VIBe and the region exploit new opportunities that arise from leveraging smart technologies. In addition to proposing design choices regarding an initial setup of the platform, a prototype along with a simple application was implemented, focusing on ease of application development/deployment and independence from vendor-specific infrastructure and cloud providers.

Benefits

The effort to understand the impact of the smart transformation starts by creating an open and multi-vendor environment, facilitating the creation of showcases that are able to demonstrate the added value of the smart applications. It is possible to create a common infrastructure that can ultimately help the region develop a shared vision on how can Eindhoven create a smart ecosystem.

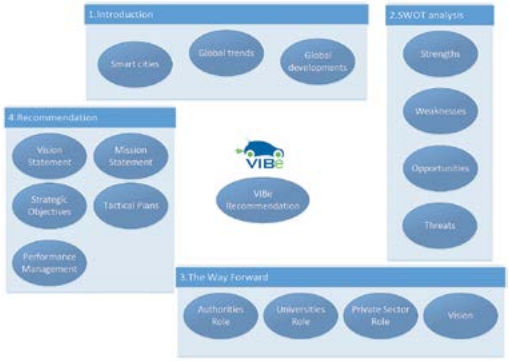
Andreas Krivas PDEng

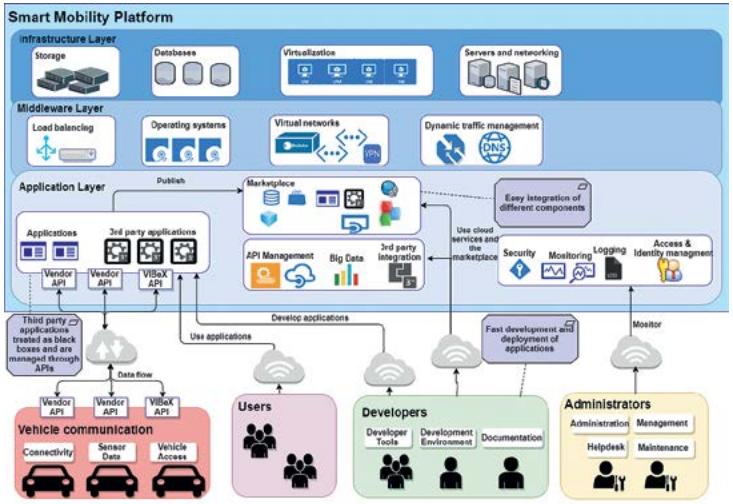
Cloud connected vehicles

Towards new business opportunities

The impact of the Internet of Things, smart technologies and cloud computing is evident already in modern societies. Sectors such as mobility, healthcare or energy are being transformed and new business opportunities are created every day. While IoT devices can generate a massive amount of data to be used by smart devices, cloud computing provides a pathway for that data to reach its destination.

The VIBe initiative (Vehicle for Innovation Brabant electric) has been active since 2013 in enabling business development in the region of Eindhoven, especially with respect to smart mobility and cloud connected vehicles. VIBe has recognized that effort is needed to understand what the implications of the smart transformation in our society are.





Therefore, a recommendation to the VIBe initiative is conducted containing the necessary next steps for VIBe and the region regarding exploiting new business opportunities with respect to smart technologies and especially smart mobility.
A cloud platform for smart mobility applications is proposed focusing on ease of application development, support of open standards and APIs, multi-vendor functionality and prevention of vendor lock-ins regarding the infrastructure.
In this way, a collaborative spirit and an open mentality are highlighted towards creating innovative smart mobility applications and numerous showcases that can provide an answer to the question of what the smart transition means.

Challenges

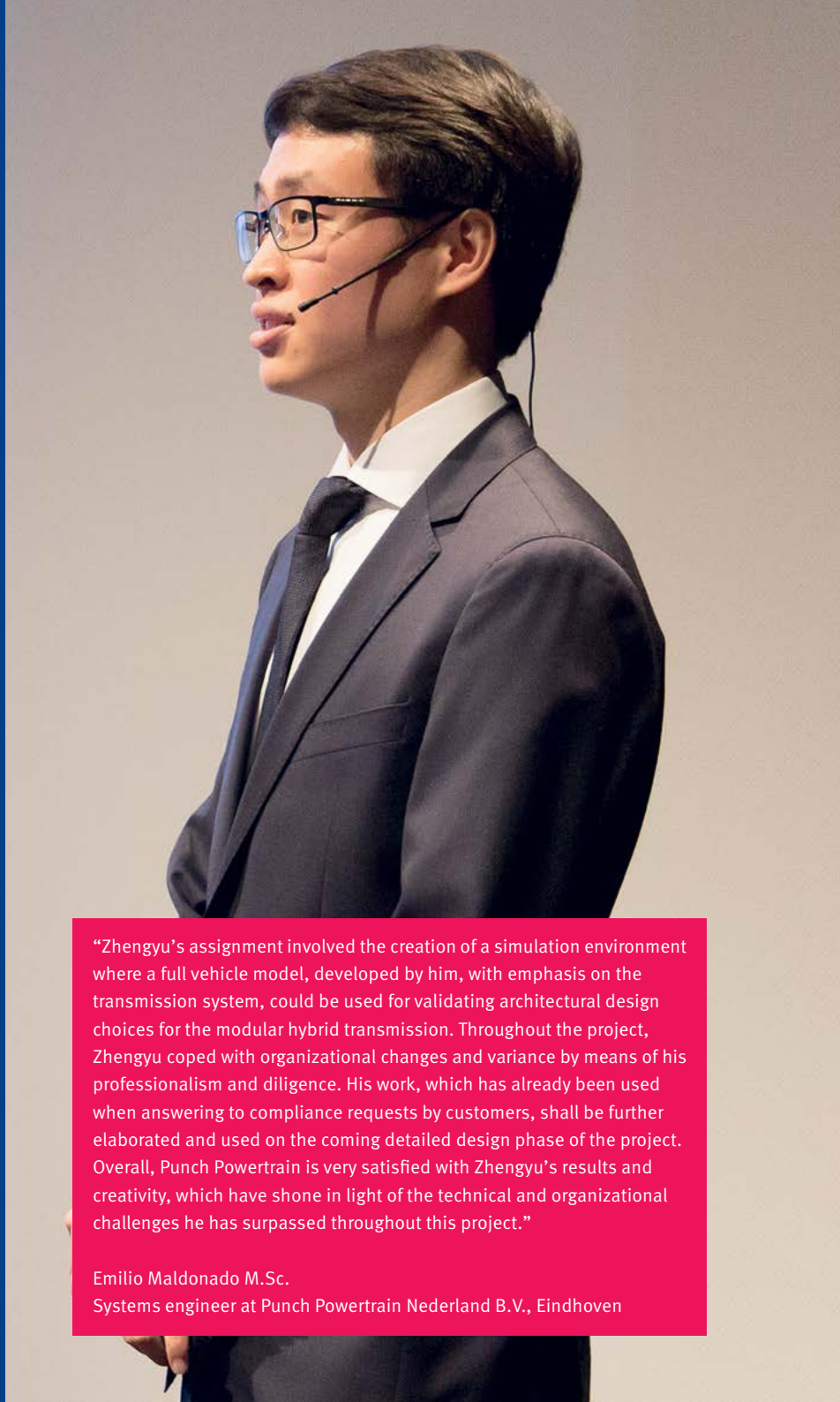
A major challenge of this project was the high complexity of the development process. In addition, as the simulation environment should be compatible with an existing simulation platform, a significant number of technical challenges and constraints were experienced in the design and the implementation process.

Results

A simulation environment of the hybrid dual-clutch transmission system, which includes MATLAB/ Simulink based models, corresponding control mechanisms and related hybrid driving strategies, has been designed and implemented for Punch Powertrain.

Benefits

The developed simulation environment has been used in evaluating the product architecture choices, generating functional performance requirements for subsystems, modules and components in the hybrid transmission system, as well as providing answers to the customers of Punch Powertrain on specific functional and performance requirements.



"Zhengyu's assignment involved the creation of a simulation environment where a full vehicle model, developed by him, with emphasis on the transmission system, could be used for validating architectural design choices for the modular hybrid transmission. Throughout the project, Zhengyu coped with organizational changes and variance by means of his professionalism and diligence. His work, which has already been used when answering to compliance requests by customers, shall be further elaborated and used on the coming detailed design phase of the project. Overall, Punch Powertrain is very satisfied with Zhengyu's results and creativity, which have shone in light of the technical and organizational challenges he has surpassed throughout this project."

Emilio Maldonado M.Sc.
Systems engineer at Punch Powertrain Nederland B.V., Eindhoven

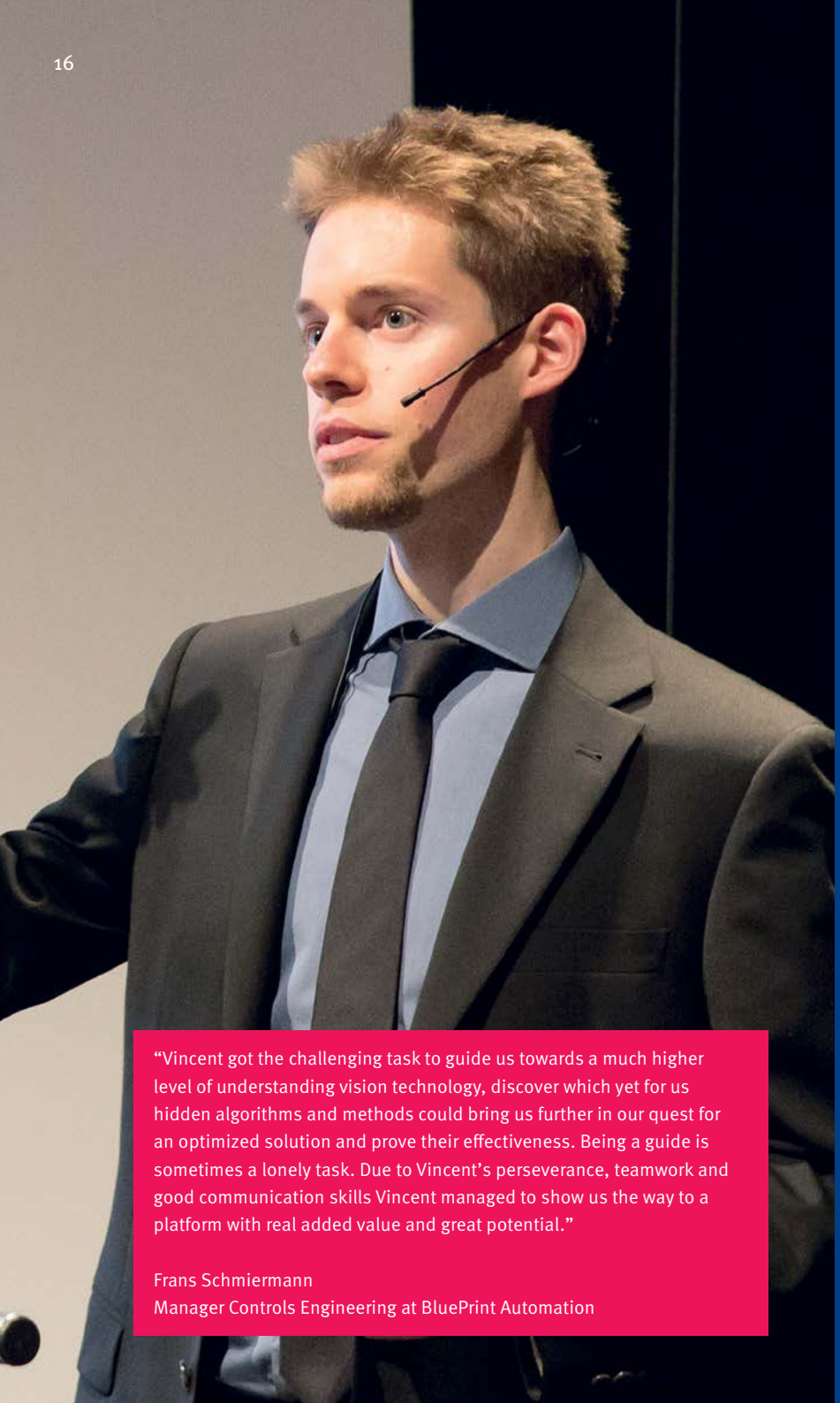
Zhengyu Li PDEng

Development of a Simulation Environment for a Hybrid Dual-Clutch Transmission System

Punch Powertrain Nederland B.V. is an international company that designs and manufactures vehicle transmission systems. Its product line ranges from continuous variable transmissions (CVT) to dual-clutch transmissions (DCT). To keep pace with the increasing trend of electrification in the automotive industry as well as respond to the growing market and customer interests, Punch Powertrain is working towards a whole line of hybrid powertrain solutions along with its conventional DCTs. A Hybrid DT1 transmission is one of the newest products that is currently under development.

This project is performed for the System Engineering (SE) department inside Punch Powertrain. The SE department is responsible for the product design, requirements definition at the system level and performing simulations for system integrations and validations. Currently the SE department is at the design phase of the new hybrid DT1 transmission development. In this phase, in order to test concepts and architectural decisions in a fast and timely manner, an efficient simulation tool that can be used in system-level simulations is essential.

Therefore, the main goal of this project is to create a MATLAB/Simulink based simulation environment, which can be used by the SE department, to aid the hybrid Punch DT1 dual-clutch transmission design.



"Vincent got the challenging task to guide us towards a much higher level of understanding vision technology, discover which yet for us hidden algorithms and methods could bring us further in our quest for an optimized solution and prove their effectiveness. Being a guide is sometimes a lonely task. Due to Vincent's perseverance, teamwork and good communication skills Vincent managed to show us the way to a platform with real added value and great potential."

Frans Schmiermann
Manager Controls Engineering at BluePrint Automation

Challenges

By definition, the shape and dimensions of deformable packages are not fixed. This is a major difference to common machine vision applications. To enable the handling of overlapping products, a novel approach had to be developed to reliably detect the products and to determine which ones can be picked safely by the robot.

Results

The modular and extendable framework is a solid and reusable foundation for the development of custom computer vision application. The pile-picking functionality is a major improvement as previous systems were limited to the detection of separated products. This function demonstrates how deformable packages can be detected in complex situations with partial occlusions.

Benefits

The company gained complete control over the computer vision system and is now able to implement vision applications independently. The hardware and software used are not proprietary anymore and can thus be freely sourced from several suppliers.
The pile-picking functionality reduces the mechanical complexity of the machines and the overall footprint of the packaging lines. Those elements combined lead to a significant reduction of the total system's cost.

Vincent Mazoyer PDEng

Computer vision platform for the localization and grading of deformable packaging

BluePrint Automation is a worldwide leader in secondary packaging machines. Their application range focuses on deformable packages, mainly for the snack and candy industry. Vision-guided robotic case packers represent an important part of the company's product portfolio.

The company faces increasing demands for complex packaging tasks and the grading of individual products. Additionally, the total cost of ownership as well as the footprint of the machines must be reduced. Flexibility and the ability to quickly develop tailor-made vision application are key success factors. The company needed a new vision system specially adapted to the particularities of deformable packages, and open for customization to meet specific customer demands.

This assignment completed two major aims. First, a modular and extendable vision platform has been designed and implemented. This resulted in a framework that can be used to support any existing or future vision application. Second, a novel functionality has been developed: the detection of overlapping bags. This new feature greatly simplifies the mechanical feeding of products stored in bulk. It was implemented using the vision platform, thus validating the framework at the same time. The new system exclusively uses commonly available hardware and software components. This reduces the dependency towards suppliers and their proprietary systems. This project opened new perspectives towards smaller and more economic robotic packaging lines.

Challenges

The main challenge of this project was designing a software architecture which is generic, extendible and supports multiple AM platforms for multi-material printing. Another challenge was designing and implementing the Recipe Maker in compliance with the software architecture and verifying it to the quality attributes.

Results

The project resulted in a software architecture which supports three different machines. The Recipe Maker, which is a software module in the software architecture, was designed, implemented and tested against the quality attribute.

Benefits

AMSYSTEMS gained a software architecture for the next generation multi-material AM platforms built in-house. By further developing all involved software modules according to the software architecture, AMSYSTEMS will have a full workflow for multi-material printing.

"For the software and architecture part, Gelila was amazing. Knowing that when she started she knew no C#, limited OOP and no software patterns at all the results she has achieved are impressive. During all the discussions about software and patterns I have seen a shift from information mostly going one way to a bi-lateral communication about how to structure the software. I have really enjoyed our discussions and have really seen her develop the attitude to think about software in certain patterns and how that will relate to coupling and extendibility."

Dolf Klomp
TNO Science and Industry/AMSYSTEMS

Gelila Negash Seifu PDEng

An Extendible Software Architecture for Next Generation Multi-material AM Platforms

Design and implementation of a Recipe Maker as test case of the software architecture

Additive Manufacturing (AM) is the process of building up components layer by layer. One of the basic principle of AM is producing an end product from a Three-Dimensional Computer Aided Design (3D CAD) with less process planning when compared with traditional manufacturing.

The main purpose of this project is to develop a software architecture for the next generation 3D printers at AMSYSTEMS which is maintainable, extendible and usable. A software architecture which supports three different machines at TNO is designed. Following the design of the software architecture, the first software module from the software architecture is designed and implemented.

"Arash has identified several possibilities in order to improve system performance. The potential of these improvements is assessed using methods ranging from 'back-of-the-envelope' calculations to FEM models to 'multi-body' simulations. Arash has learned that teamwork in a multi-disciplinary environment with internal- and external parties is key for progress. It was a pleasure to work with an independent, positive and hard-working trainee as Arash."

Ralf Noijen
System Engineer at ASM ALSI

Challenges

One of the main challenges of this project was the identification of different root sources of inaccuracy in the wafer separation process. The correct identification of these root causes was essential in the improvement design. Another challenge of the project was to improve the accuracy, without any effect on the machine throughput.

Results

The implementation of the proposed design, resulted in the reduction of the planar motor system control error. Tests indicated considerable improvements on the planar motor system accuracy. These improvements in the performance were achieved without any need for hardware change to the machine. From this, it can be concluded that it is fairly easy to increase the accuracy of the already sold machines by a simple software update.

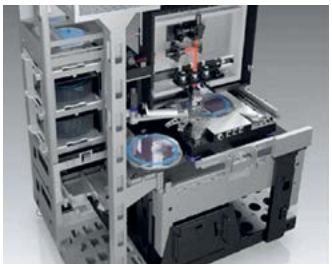
Benefits

ASM-ALSI has decided to implement the proposed design on their new releases of wafer separation machine software. This design benefits the customers by increasing the machine accuracy and reducing the machine down time, and by preventing the over-heating of the planar motor system of the wafer separation machine.

Arash Roomi Zadeh PDEng

Performance Improvement in Wafer Separation Machines

ASM-ALSI is a leading company in the production of wafer dicing and grooving machines. Wafer dicing is the process by which dies are separated from a silicon wafer. The wafer separation machine designed by ALSI is categorized in the back-end production industry, in which after the production of the circuits on the wafers, the wafer dicing machine cuts and divides the wafer to single chips. ASM-ALSI employs laser beams to cut and separate the silicon wafers. Accuracy in the wafer separation process is one of the lead advantages of ASM-ALSI compared to other competitors.



The aim of this project was to improve the performance of the accuracy with which the wafers are separated, specifically by improving the performance of the planar motor system of the wafer dicing machine. In this project different improvement designs were proposed and evaluated using a system engineering approach. The selected designs were implemented and tested.

Challenges

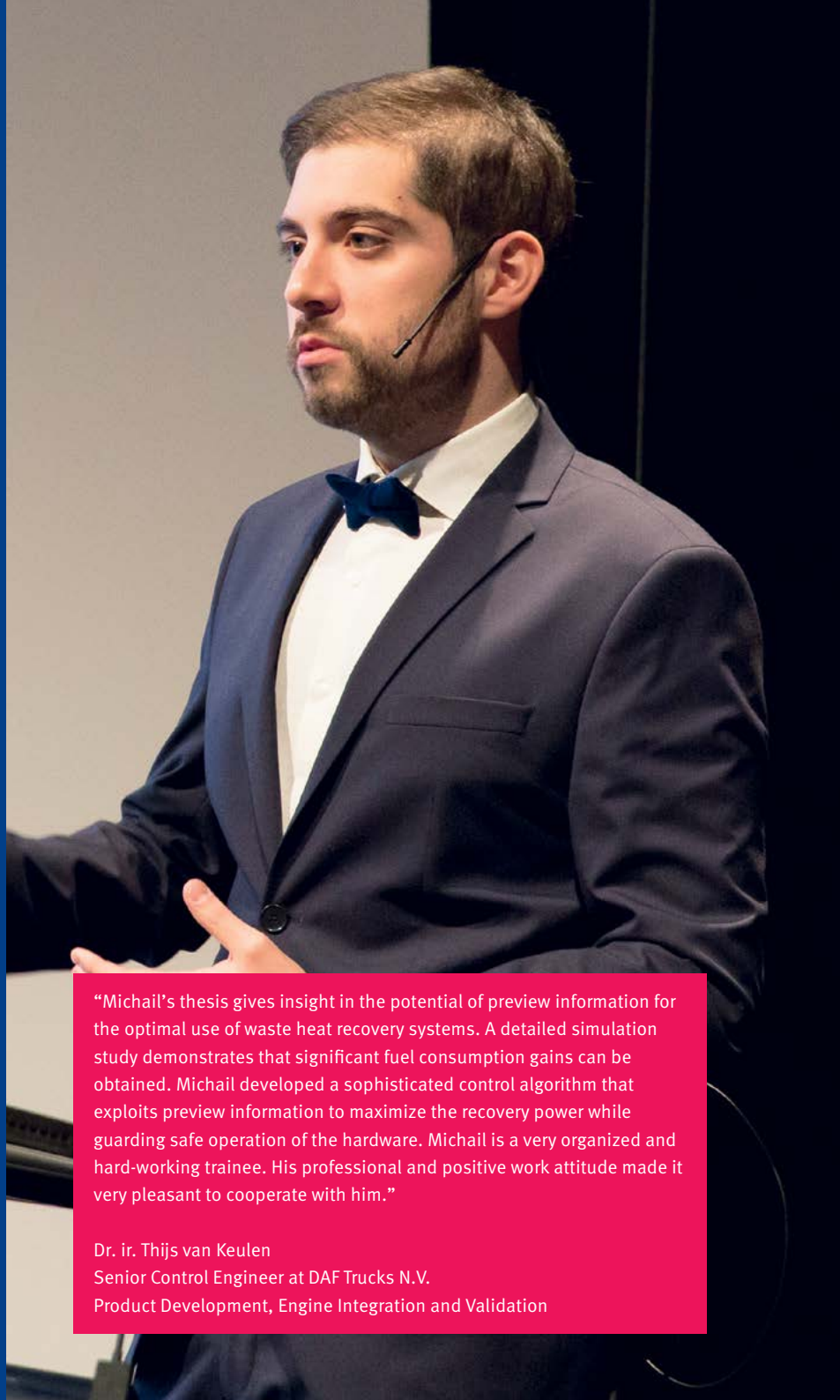
The Waste Heat Recovery System is a complex, non-linear system strongly coupled with the engine and exhaust gas aftertreatment system. The prime challenge of this project was to identify how preview information can be utilized such that the recovered energy by the Waste Heat Recovery System is maximized, while meeting the requirements for safe operation of the hardware. The additional major challenge was to develop a control algorithm capable of exploiting preview information.

Results

A control strategy, which uses preview information, in terms of the expected heat input to the Waste Heat Recovery System, was proposed and successfully implemented. A detailed simulation study demonstrated that significant fuel consumption gains can be obtained when preview information is utilized by the Waste Heat Recovery System's control architecture.

Benefits

The project gave insight in the potential of preview information for the optimal use of waste heat recovery systems. As information about the future power demand of the vehicle becomes available, the Waste Heat Recovery Systems' performance and efficiency can be increased by exploiting preview information. The demonstration of the benefit of preview information for energy recovery optimization promotes the further development of advanced control algorithms in the future.



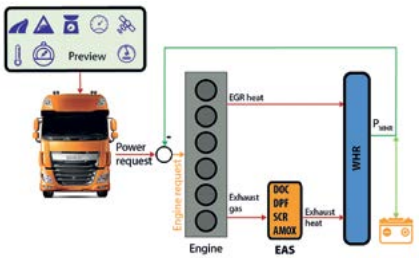
"Michail's thesis gives insight in the potential of preview information for the optimal use of waste heat recovery systems. A detailed simulation study demonstrates that significant fuel consumption gains can be obtained. Michail developed a sophisticated control algorithm that exploits preview information to maximize the recovery power while guarding safe operation of the hardware. Michail is a very organized and hard-working trainee. His professional and positive work attitude made it very pleasant to cooperate with him."

Dr. ir. Thijs van Keulen
Senior Control Engineer at DAF Trucks N.V.
Product Development, Engine Integration and Validation

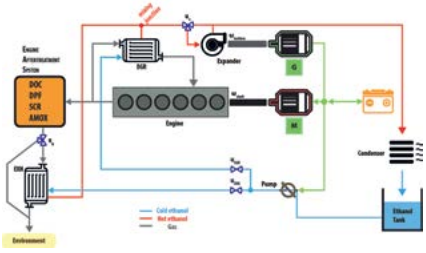
Michail Seretis PDEng

Design of a Predictive Control Strategy for an Automotive Electrically-assisted Waste Heat Recovery System with Preview

Lowering the emissions and decreasing the fuel consumption of heavy duty long haul vehicles constitute two of the main societal challenges in the transport sector. While low emission level targets have been adopted with the introduction of Euro-VI legislation, improving the fuel efficiency remains a major challenge that manufacturers of heavy-duty vehicles are confronted by.



For increasing the powertrain efficiency, augmenting the engine configuration with an Organic Rankine Cycle based electrically-assisted Waste Heat Recovery system (eWHR) is a promising solution for the near future. This is linked to decoupling the energy recovery from the energy supply to the engine. Furthermore, in the era of smart mobility and cloud technology, future route information, defined as preview information will become accessible that could be beneficial for dynamical systems with energy buffers. DAF Trucks N.V. in collaboration with the Eindhoven University of Technology, in the wider framework of the IMPERIUM project, focuses on the investigation of the potential of eWHR technology in truck applications, utilizing information about future power demands of the vehicle, in order to fully exploit the system capabilities.



In this project, a predictive control strategy for an automotive eWHR system was designed, capable of exploiting preview information, in terms of the expected future heat input to eWHR system. A realistic model of the system is evaluated using experimental data from a test-bench setup and used for control purposes. The proposed receding horizon strategy utilizes preview information to maximize the eWHR system's power output regardless of the variations in heat production.

"Sapfo defined the project plan during her first weeks, refined the overwhelming project scope into feasible and measurable building blocks, and eagerly dived deep into the subject. She leveraged various internal and external information sources and quickly started building valuable new insights. Thanks to this, she made a significant contribution to our understanding of the challenges and development opportunities related to blind spot detection and similar functionalities."

Dino Sepac
Vehicle Function Architect and Team Lead at DAF Trucks N.V.

Challenges

One main challenge of this project was managing the different stakeholders involved. Another challenge was the implementation of the BSD system on the truck, where different software and hardware were interfacing.

Results

The project resulted in a functional proof of concept for a Blind Spot Detection system, optimized and tested for the most relevant use case in a city environment. The design of the system was created, based on a system engineering approach, keeping in consideration the key drivers, use cases and requirements.

Benefits

DAF Trucks N.V. gained insight into collision avoidance algorithms, which can be used to further steer the development of a BSD system. Moreover, this knowledge can be used to refine the system requirements and so improve the development process.

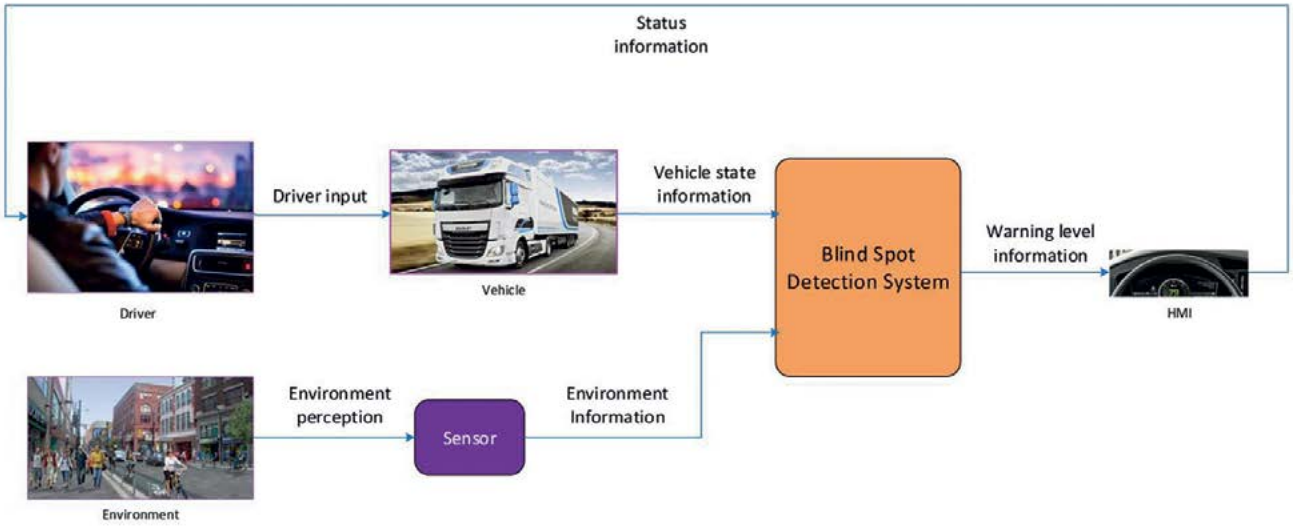
Sapfo Tsoutsou PDEng

Blind Spot Detection system for Trucks

Design and Implementation of a warning system

Currently, the automotive industry is concerned with road traffic safety. The reason for that is the high number of fatalities on the world's roads that reaches more than 1 million, according to the World Health Organization. To minimize the problem, DAF Trucks N.V. is working on the development of multiple Advanced Driving Assistance Systems (ADAS).

Among the ADAS applications, this project focused on making a functional proof of concept for a Blind Spot Detection (BSD) system that aims at the prevention of accidents with vulnerable road users by warning the driver for an upcoming collision. By following a system engineering approach, key use cases and requirements dictated the architecture of the system, which was implemented and successfully tested on a current DAF XF vehicle.



Challenges

This study is concerned with relaxing the mechanics of the weaving machine shedding sub-system, i.e. reducing shaft stiffness and increasing gearbox backlash gap, and compensating for the undesired side effects using non-linear feedforward control: i.e. torsional vibration- and backlash compensation. As preliminary research, initial implementation is done on a small modular driveline setup.

Results

Both tracking error and torque demand are used as performance indicators for the proposed non-linear feedforward control strategies. After relaxing mechanics, the proposed control strategies do satisfactory recover performance.

Benefits

This study illustrates the possibility for making a trade-off between relaxed mechanics and good performance of the shedding system, in order to achieve reduced cost and improved overall equipment effectiveness of the weaving machine.

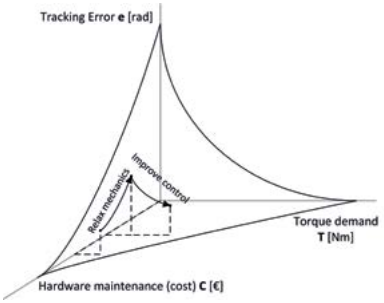
"Thanks to his successful results, we are now able to start an implementation on production machines. We really appreciate all this effort he has done at Flanders Make, and above all his professional and friendly attitude."

Albert Rosich
Senior Research Engineer at Flanders Make, Leuven
Maarten Witters
Project Manager at Flanders Make, Leuven

Cyrano Vaseur PDEng

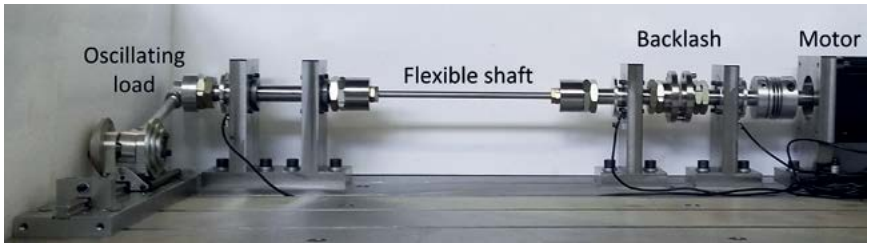
Torsional vibration- and backlash compensation using non-linear feedforward control

Model based control design for a high performant weaving machine



Flanders Make is the strategic research center for the manufacturing industry to which leading weaving machine manufacturers belong to. For these manufacturers, Flanders Make is concerned with improving the weaving machines in terms of cost, versatility and effectiveness. This is pursued through the improvement of the weaving machine shedding sub-system. Therefore, this project is concerned with relaxing the mechanics and simultaneously improving the control of this sub-system.

The weaving machine shedding sub-system with tight mechanics, i.e. a stiff drive shaft and a minimum backlash gearbox, does not intercept alignment errors with neighboring components. This causes component damage and machine downtime, which degrades machine cost and effectiveness. Relaxing mechanics, i.e. reducing stiffness and increasing gap size, can remedy this, but degrades tracking performance due to the resulting side effects: torsional vibration and backlash. Torsional vibration and backlash compensation using non-linear feedforward control, is therefore applied to recover performance.



"Powertrain electrification, in all its forms, is the logical answer to achieve upcoming CO_2 emission targets. To come to optimally integrated powertrain solutions, electrical, mechanical and thermal domains need to be jointly investigated in a holistic approach. Until now, thermal aspects were not intensively incorporated. Caiyang embraced the challenge to pioneer within Bosch Transmission Technology. With impressive personal drive and enthusiasm, he achieved the defined goals. He successfully created a tool that calculates the ultimate potential of fuel economy improvement for integrated energy and advanced thermal powertrain management for CVT-based hybrid electric vehicles."

Rokus van Iperen
Group Leader, GS-CT/ETR3 at Bosch Transmission Technology

Challenges

In addition to traditional energy forms, consisting of chemical energy, mechanical energy and electrical energy, thermal energy is incorporated in a hybrid electric vehicle context. The multi-domain nature adds complexities to the integrated system design and optimization to identify fuel saving potential.

Results

An integrated energy and advanced thermal management system for a CVT-based hybrid electric vehicle was developed, which is made up of various mechanical and thermal models of the powertrain components and an optimization strategy to optimize the energy flow. Results demonstrated the effectiveness of the proposed system to improve fuel economy, which achieved the desired target.

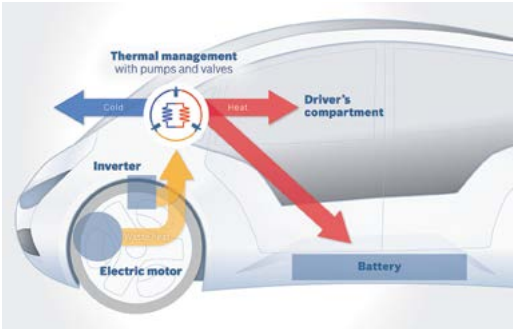
Benefits

This study provides insights into optimal control of hybrid powertrains in a complete form to quantify fuel consumption. More importantly, the developed tool enables Bosch Transmission Technology to identify opportunities and future research topics, especially in thermal domain.

Caiyang Wei PDEng

Integrated energy and advanced thermal management system for hybrid electric vehicles

During the past decades, an enormous amount of progress has been made to improve fuel economy of conventional internal combustion engine (ICE) vehicles, ranging from advanced fuel injection technologies to engine downsizing techniques. Continuous variable transmissions (CVTs) further contribute to powertrain efficiency improvement. Nevertheless, liquid fuels will still be dominant in the near future and the transportation sector accounts for these to a large extent, leading to CO_2 emission and energy depletion. Therefore, it is imperative to find alternatives to meet stringent emission regulations and energy shortages.



Since conventional powertrains with ICE as the sole power source cannot satisfy the unprecedented challenges, hybrid electric vehicles (HEVs) which probe opportunities of reducing fuel consumption are emerging to tackle energy and environment issues. As powertrain electrification is growing rapidly, apart from producing high-quality pushbelts and building high-tech CVT prototypes, Bosch Transmission Technology wishes to make a contribution to fuel efficiency improvement in a CVT-based HEV context.

When it comes to HEVs, most existing studies are concerned with energy management systems (EMSs) to minimize fuel usage, taking into consideration of chemical energy, mechanical energy and electrical energy. However, thermal energy which is also an indispensable part of an HEV has not been fully explored. More importantly, it influences the decision-making of an EMS, which eventually affects fuel saving potential. Therefore, this research focuses on developing an integrated energy and advanced thermal management system for HEVs.

Challenges

The main challenge of this project was to clearly define the complex role of maintenance during the lock life cycle, and get a good grasp on all the stakeholders. In Rijkswaterstaat, a clear separation exists between those responsible for the long term lock condition and those carrying out the maintenance actions. This creates significant difficulty to come to solutions Rijkswaterstaat can act on.

Results

The result of the project is a methodology Rijkswaterstaat can apply to the analysis of ship lock architectures and maintenance strategies. This method supports the clustering of lock components based on maintenance needs, and the comparison of lock components, interfaces and modules on the basis of key performance indicators.

Benefits

Presentations of the early work at the local districts confirmed the suspicion that the measurement and storage of data on locks should be optimized in order to analyze the contribution to LCC (cost drivers) and reliability (bad actors). The results of this project will help where improvement on data gathering is needed most.

"Tom's work is based on two aspects: research on similarity in maintenance of lock components and on the failure mode of components, or so called 'bad actors'. His research shows which components can be put forward for standardization. In this way lock maintenance costs can be decreased and system reliability and availability will be increased substantially."

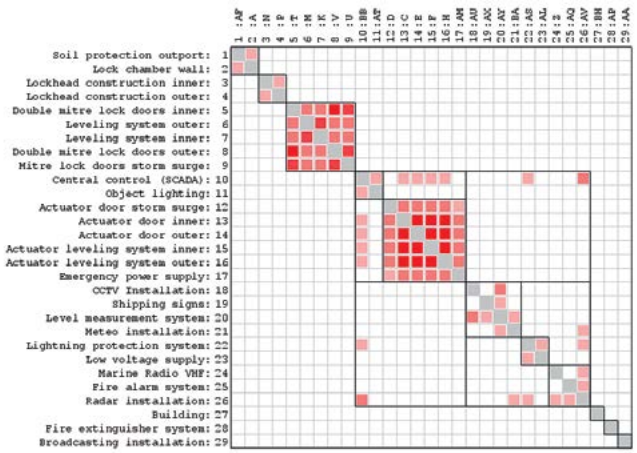
Eric-Jan Houwing
Sr. Advisor Hydraulic Engineering at Rijkswaterstaat
Han Vogel
Sr. Procurement and Contract Manager at Rijkswaterstaat

Tom Zwijgers PDEng

Maintenance and Services in a DSM-based Product Family Platform for Ship Locks

Rijkswaterstaat is the national authority responsible for administrating and assuring the quality and performance of the Dutch national infrastructure and water management systems, including 137 ship locks. By the year 2050, 52 of the 137 locks have to be renovated or even renewed. At the same time, lock managers indicate that they are working inefficiently with different solutions for the same functions, requiring a lot of specialist and local knowledge for the maintenance of the locks. As a result, Rijkswaterstaat is carrying out the Multi-Water-Werk (MWW) project, which is dedicated to develop a modularization and standardization strategy to increase the uniformity among lock designs. In this context, the PDEng assignment was formulated.

The focus of the assignment was to research the role of maintenance aspects on standardization decisions. Maintenance is a special subject within Rijkswaterstaat, with many stakeholders.



While the responsibility during the design and realization phases of a lock is with the central organization, during the operational phase responsibility shifts towards the local district. The main project goal was to develop a method and accompanying tooling that allows for the incorporation of the key maintenance and services aspects in the DSM-based representation of the lock family platform.

Credits

Edited by: P.S.C. Heuberger and P.J.M. van Hoof-Rompen, Automotive Systems Design program, Eindhoven University of Technology

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Hazem M. Hany PDEng; Predictive ADAS functionalities to lower fuel consumption **// Nestor Hernandez Rodriguez PDEng;** A system approach for a vision-based positioning mechanism **// Rameez Ismail PDEng;** Next-Generation Lane Centering Assist System - Design and Implementation of a Lane Centering Assist System using NXP BlueBox **// Lazaros Kefalidis PDEng;** Systematic Design of an In-Cycle Fuelling Control System for Advanced Diesel Combustion Concepts **// Andreas Krivas PDEng;** Cloud connected vehicles - Towards new business opportunities **// Zhengyu Li PDEng;** Development of a Simulation Environment for a Hybrid Dual-Clutch Transmission System **// Vincent Mazoyer PDEng;** Computer vision platform for the localization and grading of deformable packaging **// Gelila Negash Seifu PDEng;** An Extendible Software Architecture for Next Generation Multi-material AM Platforms - Design and implementation of a Recipe Maker as test case of the software architecture **// Arash Roomi Zadeh PDEng;** Performance Improvement in Wafer Separation Machines **// Michail Seretis PDEng;** Design of a Predictive Control Strategy for an Automotive Electrically-assisted Waste Heat Recovery System with Preview **// Sapfo Tsoutsou PDEng;** Blind Spot Detection system for Trucks - Design and Implementation of a warning system **// Cyrano Vaseur PDEng;** Torsional vibration- and backlash compensation using non-linear feedforward control - Model based control design for a high performant weaving machine **// Caiyang Wei PDEng;** Integrated energy and advanced thermal management system for hybrid electric vehicles **// Tom Zwijgers PDEng;** Maintenance and Services in a DSM-based Product Family Platformfor Ship Locks