Software Technology
Eindhoven University of Technology
PDEng projects 2008
3TU. School for Technological Design, Stan Ackermans Institute offers eleven two-year postgraduate technological designer programmes. This institute is a joint initiative of the three technological universities of the Netherlands: Delft University of Technology, Eindhoven University of Technology and University of Twente. For more information please visit: www.3tu.nl/sai.

Software Technology - PDEng projects 2008

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The last years have shown a rapid increase in the use and deployment of sensors and actuators in all kinds of applications. In this way, technology is increasingly interacting with the real world. The projects of the Software Technology PDEng candidates were a clear reflection of this trend. In the period from December 2007 until the end of August 2008 a number of candidates did their projects with leading industries or research organizations, many of which were around the theme of technology interacting with the environment. This booklet gives a brief description of these projects showing the wide range of design and development projects in which our candidates contributed. In this way they applied scientific research in practice. It is a sincere pleasure to introduce you to the interesting results of this work.
The Software Technology PDEng (Professional Doctorate in Engineering) degree programme is an accredited and challenging two-year doctorate-level engineering degree programme. During this programme trainees focus on strengthening their technical and non-technical competencies related to the effective and efficient design and development of software for resource-constrained software-intensive systems, such as real-time embedded systems, in an industrial setting. During the programme our PDEng trainees focus on systems architecting and designing software for software-intensive systems in multiple application domains for the High Tech Industry.

The programme is provided by the Department of Mathematics and Computer Science of Eindhoven University of Technology in the context of the 3TU.School for Technological Design, Stan Ackermans Institute.

For more information, visit the website at www.3tu.nl/sai/st.
Challenges
A major challenge of this feasibility project was the design of an automated test framework to test the behaviour of XtraVision against a model of its interface with the X-ray scanner (compliance testing). This test environment needed to incorporate statistical testing principles of ASD technology in order to output a statement on the software reliability of the system being tested. Another challenge was to find technical possibilities of increasing the business value of compliance testing.

Results
The technical feasibility of the compliance test framework has been partly proven by a prototype which automatically generates and executes tests covering a part of the interface model. A set of feasibility issues has been answered, including analyzing the possibility of increasing the business value of compliance testing by extending the compliance test framework to functional testing. The idea of creating an X-ray simulator to test the XtraVision system was also explored.

Benefits
The company has now estimated the costs and benefits of further developing and using the Compliance Test Framework for testing XtraVision. Compliance testing could be used as a pre-check on the interoperability between the XtraVision system and the expensive X-ray scanner before connecting the two systems. From a technical point of view, the technical risks that remain to be tackled are now known. The architecture and the prototype created during this project could be used to support the further development of an extended Compliance Test Framework. Part of the components could be re-used for creating the X-ray simulator.

Maria-Alexandra Contiu

"The feasibility must be proven business wise (cost effective) and technology wise ... she did an incredible difficult job to get this feasibility completed."
Paul Swarts
Project Mentor at Philips Healthcare

XtraVision Compliance Test Framework

The XtraVision Compliance Test Framework project at Philips Healthcare investigated the feasibility of applying statistical testing concepts to the testing of a medical 3D image reconstruction system against a model of its interface with an X-ray scanner. The aim of the project was to reduce testing costs and to increase the software reliability of the medical software system.

3D models of scanned heart
Two systems, the medical 3D image reconstruction system (called XtraVision) and the X-ray scanner, are deployed in hospitals. The XtraVision system supports surgeons in performing cardio-vascular operations by reconstructing 3D models of the scanned heart or vessels by using images taken by the X-ray scanner. Considering its impact on the patient, it is important that the XtraVision system is properly tested. A proper test approach for the XtraVision system requires testing it against the X-ray scanner. Knowing that X-ray scanners are a scarce and expensive resource, the goal is to use a model of the protocol (agreed between the two systems) instead of the real scanner.

Test execution engine
An automated test environment was designed to support model-based testing of XtraVision (against a model of its protocol with the X-ray scanner) and apply statistical testing principles. This framework integrated the ASD (Analytical Software Design) tool-chain, a technology and tooling which provides the automated generation of test cases from a high-level specification of the protocol model. Furthermore, tests were automatically executed by a test execution engine on the system being tested, XtraVision. The execution engine, an environment with complex multi-channel interfacing and decoupling, was designed during this project. Finally, the execution results were collected by another integrated component from the ASD tool-chain to automatically create an execution report which contains statistical figures.
Challenges

Normally, features must be selected together because of their interaction. However, we wanted to be flexible about the features set by the component supplier and those set by the customer. They had to able to be selected in any order. This flexibility required the development of a new approach that could combine models in unconstrained ways. Moreover, the solution had to be such that every feature selection step in the chain could be carried out automatically, and the selection made by people without a technical background.

Results

The ‘proof of concept’ that implements the model-weaving approach enables incremental staged configuration of behavioural models represented as state machines. The resulting model is tailored to each customer’s specific business requirements. Insights into the benefits and drawbacks of the various MDA approaches were gained by applying generic methods found in academic research to the concrete case study.

Benefits

The model-weaving approach untangles features to reduce the dependencies between the transformations that implement them. This generic method is independent from the model types (behavioural or structural) and can be applied irrespective of the modelling formulation (UML, DSLs or others). NXP Semiconductors can further use the expertise achieved during the project.

The aim of this project was to develop a range of embedded software that could meet a variety of customer demands. By combining Model Driven Architecture (MDA) with mass customisation, the benefits of quickly creating cost-effective, computation-efficient and high-quality software products could be achieved. This project developed a style of MDA that configures software to support a combination of features. It also built up in-depth knowledge of the opportunities provided by this technology.

Enabling fast creation of custom-made software

NXP Semiconductors supplies software with its ICs to a broad range of customers. These customers usually develop a range of products and must configure the software accordingly. However, the variation of requirements between its customers means that NXP must support a greater range of diversity and it wishes to isolate customers from each other’s choices. Therefore, it needed a way to programme features independently, even if they interact. This is comparable to the car industry, where the engine type can determine which type of gearbox is supported; software features constrain each other in a similar way. Moreover, adding a new feature for one customer should not alter the software delivered to another.

Incremental feature extension of behavioural models

By using MDA, the abstraction level is raised from code, so that the states that describe the behaviour of the system become explicit and can be used in transformations that add feature-specific extensions incrementally to an initial model. In this model-driven context, the use of behavioural models represented as state machines can eliminate the overhead caused by unused features. In this project, an investigation of the most sophisticated MDA methods represented by model-to-model transformations of state machines is performed. The approach supports the optimal generation of source-code for all their customers’ specific requirements and hardware platform.

Octavian Cota

Octavian has ... given great insight into the potential for this technology. His work has highlighted the relative merits of purely additive and subtractive transformations and has illuminated the benefits and challenges of weaving features as aspects in UML models.

Tim Trew
Research Fellow
NXP Semiconductors

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Challenges
The main challenge was to design a communication infrastructure capable of sharing data between distributed software components with low latency and high throughput. Individually deployed software components had to discover and connect to each other’s plug ’n’ play style. But, most importantly, developers had to compose a custom software component partition rapidly to keep the development effort to a minimum.

Results
A system was designed and implemented based on an international middleware standard, Data Distribution Service (DDS), and time synchronization, NTP. The middleware provides a software bus that connects distributed software components to each other at runtime based on their data specification. Tooling developed during the project reduced the development effort and learning curve in using the previously mentioned technologies. This makes it possible to integrate these technologies rapidly into domain specific systems. To prove and validate these concepts, an object-tracking demonstrator has been developed with the designed system.

Benefits
The designed system helps developers to create and test different software component compositions rapidly. This allows developers to focus on domain specific challenges and develop prototypes and distributed systems with minimal effort, making them more competitive. Rapidly assembled demonstrator systems can be used to attract new businesses and give more insight into the system’s behaviour in earlier development phases.

Smart Environments
Philips has an interest in developing smart environments. Systems in such an environment react to or interact with users in a more natural way. Users could, for instance, control devices in the environment with hand gestures, which makes a remote control unnecessary. Even more sophisticated environments could analyse the behaviour of objects and react to it. An example of such a smart environment could be the adjustment of lighting conditions in an office to assist humans in their activities. Sensors in the environment collect data on human activity, which is analysed to determine their activities. This behavioural information is then used to adjust the lighting conditions in the office. To give an example: if the system detects a person reading a book, it optimises the lighting conditions in that part of the office for reading or even to the personal reading preferences of the individual. This smart environment not only improves the user’s experience, but also reduces energy consumption.

Software Composition
The vision group of Philips Applied Technologies uses cameras as sensors to provide information for smart environments. Cameras can produce a lot of data; to reduce these data streams, embedded cameras are used to pre-process the raw sensor data into aggregated and more useful information. Developers have to partition the software tasks among the embedded cameras and other devices in the system to create a suitable system layout. These distributed software components have to discover each other and exchange data at runtime. Some applications, such as human computer interaction, need a low response time while other applications such as measurement systems produce information at a high frequency.

I In this project, a system was designed to connect software tasks running on smart sensors to tasks deployed elsewhere in the network. The developed architecture is based on commercially off-the-shelf, open-source middleware and time synchronisation software. This enables engineers to develop and test software partitions of devices in a network with minimal effort.

Stephan Damen
A DDS-based system for data-driven software components

“Stephan successfully managed to define an architecture and built a prototype to prove his concept … and provided a sound base for the development of visual sensing networks.”

Harry Broers, Philips Applied Technologies
Challenges
One of the key research challenges of the project is that the system requires the combination of different, previously unconnected domains: the TV domain, the PC domain and the mobile domain. Moreover, there is a strong need for social applications to have a common platform that is interoperable across multiple types of devices.

Results
We have successfully extended the Social TV platform by re-using the Google Talk service. This allows access to the user's contact list and re-uses the Google Talk server for instant messaging and presence information exchange. An open API (Application Programming Interface) enabling 3rd party service providers to develop their multi-user TV applications has also been proposed and a ‘proof of concept’ has been prototyped.

Benefits
The framework is important for providing an eco-system around social web applications. It allows consumers to access their on-line friends for content and to experience sharing across different services and different types of devices. The open interface also gives 3rd party application providers access to functionality they would otherwise have to develop themselves, but at the same time guards the privacy of the user.

Philips Research develops many advanced products in Healthcare, Lifestyle and Technology. The Connexted Consumer Solutions (CCS) department provides technologies that enable users to have easy access to communities and services by means of Philips Consumer Electronic (CE) devices. In the Social TV project, the possibilities of enhancing the television with social aspects are explored, making it a central device for communication and sharing in the living room.

Making the television a social device
Television is changing rapidly and so is its audience. Nowadays, people want to have much more than a traditional live broadcast on their television. The emergence and popularity of social services in the PC domain such as YouTube, Facebook and Flickr offer CE device manufacturers an opportunity to tap into this market. A browser-based social TV framework for sharing content and experience in real time by using CE devices has been developed to connect people in various ways. This framework allows content to be shared synchronously and asynchronously. Examples are: sharing pictures, video chat, remotely watching YouTube movies together and remotely playing (casual) games together.

Enabling an eco-system for social TV applications
This project aims to enable the Social TV framework to re-use 3rd party services inside and outside the TV domain. Firstly, there are 3rd party infrastructure services such as SIP or XMPP servers (e.g. Google Talk) that allow existing communication and session set-ups in the PC and mobile world to be re-used. These services already provide Internet users with the ability to interact with virtual communities, and they are interested in providing this interaction on devices other than the PC. Secondly, we aim to enable third parties to develop new social applications for television by providing them access to the functionality of the Social TV framework. This enables content services like YouTube or Flickr to add (real-time) sharing features to their services.

Eva Khmelinskaya

“Eva showed a strong drive and ability to come up with the best solutions, not just from a technical standpoint, but also taking into account how these solutions should fit in Philips products.”

Dietwig Lowet
Challenges
The main challenge of this project was the development of a demonstrator designed for an NXP CE platform capable of interacting with an existing web service but using only limited user input devices (no keyboard / mouse), and monitor the current status of a user's objects on eBay. Like most web services, the eBay trading web services have a very high level of user interaction; they rely on different types of input and give a lot of textual and graphical feedback to the user. The limited resources and means of user input of the platform proved to be challenging.

Results
We managed to prove the possibilities of interacting with existing web services using a fairly standard CE platform. The prototype is capable of interacting with the eBay trading web services and allows a user to browse and place bids on items added to his watch-list. In addition, a user can receive eBay related notifications while watching TV.

Benefits
Like most web services, the eBay trading web services have a very high level of user interaction; they rely on different types of input and give a lot of textual and graphical feedback to the user. We delivered a ‘proof of concept’ for interacting with web services by using a CE device and without using advanced input devices such as a keyboard or mouse.

Accessing web services – a new experience

“Mehmet ... investigated the challenges ... made successful and independent attempt to gather requirements, define software architecture, and implement an application accessing the service and providing a TV specific user interface.”

Piotr Polak,
NXP Semiconductors / CTO / System Technology & Architecture / ASL
Project Supervisor

During this project, which took place in the advanced systems labs of NXP, we developed a prototype capable of interacting with eBay web services by means of an NXP set top box platform. The results serve as a ‘proof of concept’, showing the possibilities of this interaction with existing web services by means of a Consumer Electronics (CE) device.

Web service access by means of CE devices
The PC platform is powerful compared to most CE devices. Moreover, it has the advantage of being the target platform for web services. Nevertheless, CE devices are becoming powerful and versatile enough to handle access and interaction with web services. For this reason, manufacturers are looking for ways to make existing web services available on their CE platforms, giving consumers the ability to access these services where they want and whenever they want. In the last few years especially, the shift in the way people access web services has become clearly visible - just think about the development of devices such as the iPhone, the Blackberry, Internet tablets or game consoles.

A ‘proof of concept’
We focused on a prototype that allows interaction with the well-known eBay web services by using a set top box and a Wii-mote (controller for the Wii console). Once set up, the prototype could be used to receive notifications from eBay on the television, browse through items placed in a watch-list by means of the Wii-mote and even place bids on specific items. We have successfully implemented this prototype and shown the feasibility of web service access by means of an embedded or CE platform.
Challenges
A fully decentralised system may not be industrially acceptable because it requires departing abruptly from the existing (centralised) warehouse control systems. A holonic approach has to prove its applicability in the material handling domain, allowing extreme flexibility for modelling user requirements, diverse tasks and equipment, but still providing the expected functionality, robustness and quality.

Results
An agent-based framework for the design and development of holonic control systems has been developed. It allows fast prototyping of warehouse control systems. The framework uses a library with pre-developed agents, their behaviours and a system layout to start a warehouse control system that interacts with simulation and visualisation. Due to the agent library, simply changing the layout leads to starting the control system of a new warehouse system. Agent behaviour can be changed at run-time as well as at the start up. This allows the agents to optimally adapt to changes in the environment.

Benefits
The framework allows fast experimenting with different control strategies. The experiments lead to a faster development process of warehouses. The design and development methodology helps Vanderlande Industries to migrate to holonic decentralised control for their material handling systems.

A holonic approach to decentralised warehouse control

A warehouse is a combination of a mechanical layout and a system-level control algorithm that fits the customer’s requirements. These requirements may involve costs, throughput, reliability, robustness and scalability. Traditionally, warehouse control systems are centralised systems that are responsible for planning, scheduling and executing all warehouse operations. The global trend towards more complex warehouses makes it practically impossible to control all (normal and exceptional) operations in an optimal manner using a centralised control system.

Decentralised holonic control
An alternative is a decentralised warehouse control system which consists of autonomous components (agents), each controlling the operations in a limited part of the warehouse. The Falcon project, which was set up by the Embedded Systems Institute and Vanderlande Industries, investigates the feasibility of holonic warehouse control systems. These can be viewed as a hybrid form of centralised and decentralised control systems. Holons are autonomous and co-operative building blocks for transforming, storing and/or validating information and physical objects. The developed framework considers three types of basic holons: resource holons representing equipment, order holons representing tasks, and logic holons mapping tasks onto equipment. These basic holons allow decoupling concerns such as variety of tasks and equipment.

Framework for design and development of holonic control systems
The framework has two purposes – to find a method for migrating to decentralised control and to provide a means for rapid experiments with control strategies. The resulting control systems are robust to exceptions providing graceful degradation. They are flexible, scalable and easily adaptable. The approach allows the re-use of components. Two prototypes were developed to test the framework. They demonstrate all these qualities and provide monitoring of control messages and system visualisation. The prototypes are used to control warehouse simulation, but the approach allows connection to the real equipment without any adjustments. The holonic approach and the framework are generic in the sense that they are applicable for other material handling systems as well.

Hristina Moneva

“Hristina’s results have motivated Vanderlande Industries to consider the more flexible holonic control systems as an alternative for their current centralized control systems.”
Jacques Verriet
Research Fellow
Embedded Systems Institute

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Challenges
A lot of technical obstacles were involved in determining a solution for the collection of patient data (current and historical) from multiple data sources, which is composed of textual reports and multiple modality (mammogram, ultrasound and MRI) images and then presenting it using web-based approach. The main challenge was to provide a generic architectural solution that can be extended to other workflows and care cycles.

Results
The prototype demonstrates the feasibility of having pertinent and timely patient data available with ‘anywhere access’ for optimal treatment decisions during MDT meetings. The prototype allows patient data to be added from within the system and to be exported from clinical applications outside of the system.

Benefits
The prototype demonstrates the efficient execution of MDT meetings, and at the same time minimising the labour-intensive and time-consuming tasks of the clinicians. The software architecture provides for functional and user scalability and clinical application interoperability.

The application of information technology in the medical domain is an interesting challenge for software developers and a beneficial solution for clinicians and patients. Cancer Care Companion is one such solution where the data warehousing concepts are applied to medical decision-making environments. It is aimed at facilitating the multidisciplinary team (MDT) meeting workflow in breast cancer care cycle, which is a prescribed and effective standard for patient treatment decision making.

In the breast cancer care cycle, the patient passes through different clinical disciplines such as radiology, pathology and oncology. The care providers in these disciplines form the MDT. The MDT meeting has three distinct phases – preparation, execution and follow-up. In the preparation phase, clinicians from different disciplines have to collect current and historical heterogeneous (text, image, audio) patient data. In the execution phase, this collected data is presented to the MDT using varied data sources (electronic database, paper archives) and a consensual treatment decision is made for the follow-up phase. Currently, the collection and presentation of patient data are labour-intensive and time-consuming tasks, which makes the MDT meeting workflow less efficient and productive.

Enabling efficiency and productivity in cancer team meetings
Based on the observed needs of the clinicians, the Cancer Care Companion MDT meeting management system has been proposed as a software solution. It is intended to support the collection of patient data from multiple disciplines and data sources and the consolidation and presentation of a comprehensive view to the MDT. The key functional challenges that such a system has to accommodate include the support of existing clinical applications, varied healthcare messaging protocols, various patient data views, web-based access and minimal hardware requirements. The resulting prototype demonstrates the feasibility of patient data collection and presentation in a non-laborious manner for the MDT meetings, enabling the clinicians to be more efficient and productive.

Cancer Care Companion: a team meeting management system

“The difficulty of multi-disciplinary clinical work was also reflected in this project ... finally the stakeholders’ expectations and the project’s deliverables met in the Cancer Care Companion demonstrator.”

Roel Truyen
Philips Healthcare
Challenges
One of the challenges we faced was that different system components had to be built using different developing environments, thus raising compatibility issues. In order to integrate the developed components, parts of the existing software had to be re-used. This increased the complexity of the system.

Results
The main result of the project is the Cardiologist Viewer software prototype. This can be used as a dynamic report by presenting the key analysis data in a comprehensive, efficient manner and updating it according to the modifications of the analysis performed by the cardiologist (e.g. update of the contours that delineate the heart muscle in the cardiac images).

Benefits
By investigating and implementing role-based user interfaces and data views which are meant to meet the needs of various types of clinical users, the project supports the cardiac image analysis workflow and increases its efficiency. It provides Philips Healthcare the chance to use the developed ‘proof-of-concept’ as a means of getting valuable feedback from clinical users.

The Bookmarked Cardiac Reporting (BCR) project was carried out in the Clinical Science & Advanced Development group of Philips Healthcare. It focused on making the existing cardiac MR analysis application more efficient and user friendly by adding a role-dependant user interface and task flow.

Cardiac analysis
Cardiovascular diseases are a significant cause of death throughout the western world. Early recognition and proper treatment of these diseases could save many lives. To support this, Philips Healthcare has developed clinical cardiac image analysis solutions which are meant to assist cardiac care providers. The cardiac diagnosis process is organised according to a workflow in which each clinical user has a unique set of tasks. The cardiologist usually receives the cardiac patients and decides which information is needed to diagnose and plan therapy; the radiologist is responsible for planning the proper imaging and analysis to supply the required information; well-trained technologists perform the imaging and analysis. The current cardiac analysis software uses the same user-interface and task flow for each of these clinical users.

Enabling role-dependant user interfaces and data views
The BCR project aimed to increase the efficiency of the described cardiac analysis by providing role-based user interfaces and views for each of the clinical users. The radiologist view was specified and documented, while the view adapted for the cardiologist was taken through all the phases, from requirements analysis and design to implementation in prototype software and testing. Moreover, the project helped to enhance the cardiac analysis application by providing a structured representation of the cardiac analysis results according to a well-known medical standard, DICOM SR.

“Mirela had to dive deep into many new areas ... cardiac disease, cardiac quantitative analysis and DICOM structured reporting ... get acquainted with our complex product software and our software prototyping environment. Mirela did a great job in a well-planned, efficient and effective way!”

Marcel Breeuwer
Principal Scientist
Philips Healthcare Best Practice

Mirela Popa

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Challenges
The challenge in this project was to define the architecture of a sensor-enabled smart nomadic device that can process the data from sensors, build ad-hoc networks, and announce and listen services from these networks. This imposes many design constraints, for example, limited memory and processing power, energy usage, and bandwidth requirements for short-range communication. The framework should also include a number of aspects such as data management, context awareness, resource management and power management.

Results
The functional, non-functional and technical requirements have been written down as the starting point for the system. A number of methodologies and technologies have been invested to test their performances to make right choices for our sensor-enabled nomadic infant seat. The nomadic infant seat framework is based on Service Oriented Architecture (SOA) techniques to build services of the system, expose services to the network and use services from the network. The SOA technique provides us the platform for seamless integration of newly-developed sensors in future. An additional IP stack has been introduced on top of Bluetooth stack to implement the IP-based Universal Plug and Play (UPnP) mechanism for service discoveries in ad-hoc networks. This mechanism allows the nomadic infant seat to use all the functionalities of the WIFI networks while taking the benefit of the better Bluetooth power management.

Benefits
The result of the project is a framework that supports the sensor-enabled wellness monitoring system that can invoke external services in emergency cases through building ad-hoc networks. We investigated new yet cheap sensors like buckle sensors for infant seats, smart textiles to measure ECG, and vision sensors for face detection. Such frameworks can be used in various contexts such as in our primary application smart infant seat as well as in elderly people’s health monitoring systems.

As a step towards creating the ambient experience in the car, Philips Applied Technologies is participating in a European collaborative research and development project called “Caring Cars”. A sensor-enabled nomadic infant seat is one of the applications in this project. It monitors the ‘wellness’ of an infant primarily in an automotive environment but also in a home environment.

Designing future industrial standards
As part of the Glastonbury Cluster at Philips Applied Technologies, this project aims to be a precursor to new concepts and technologies liable to be integrated in Philips products, as well as extending the Applied Technologies competencies. These new technologies are being developed in co-operation with other European companies by means of European collaborative research and development projects. The participation of Philips in this kind of multinational project is a great opportunity to design future industrial standards and to perform a technological survey of the next technologies likely to be present in the Philips markets.

Developing a sensor-enabled wireless ad-hoc network framework
To achieve this, the project made an open infrastructure based on a sensor network in the infant seat that co-operates with the car gateway. This sensor network consists of ready available sensors such as low-mass thin ECG sensors, and buckle sensors augmented with up-coming new smart vision sensors. Along with the sensor network, a middleware framework based on service oriented architecture (SOA) has been developed by using OSGi service platform. The framework uses the Universal Plug and Play (UPnP) protocols of the Bluetooth to build ad-hoc networks seamlessly and dynamically with zero configurations. Extensive Bluetooth experiments have been conducted in the special EMC centre to check performance and reliability in typical harsh environment where lots of other networks co-exist. By adding external communication to the infrastructure, it also becomes possible to re-use the infrastructure to support health care applications for elderly people at home.
Challenges
In a multidisciplinary design environment of continually increasing complexity, it is important for a high-tech company to develop products faster while maintaining quality. Although engineers and architects at Océ-Technologies BV are very good at doing complex projects (many concepts, design iterations and disciplines), there is a core of design information they want to use as a compass on the often foggy road of taking engineering decisions.

Results
A flexible foundation for capturing essential multidisciplinary design parameters has been developed: MoBasE. Several applications of MoBasE have been investigated, including simulation, design visualisation, testing, domain-specific modelling and software synthesis. In the case study of paper path development, all of these applications have been successful, taking the overall engineering process to a higher level.

Benefits
Using information models built on MoBasE in the engineering process allows the prevention of duplication and enables the availability of every piece of information to all tooling. Architects and managers can quickly get early feedback on design decisions they make without building a prototype and writing software. Software engineers can automatically transfer design decisions as parameters or templates in their code.

A model-based engineering framework for developing production printers

“Eugen Schindler has gone into lengths to guarantee the success of MoBasE ... most importantly, he has organized a pilot in a product development group with excellent results.”

Ronald Fabel
Océ Technologies
The industry’s growing interest in personal robotics led to a feasibility study of the applicability of vision-based Simultaneous Localization and Mapping (SLAM) techniques for robot navigation in consumer applications. Although good results were achieved in research environments, a commercial application of vision-based SLAM for 3D tracking and localization is not yet feasible.

Commercial applications of robot navigation

Robotics has been an active research area for many years now, but only in the past few years have commercial applications of robot navigation in consumer products been available on the market. Therefore, the industry is now interested in the applicability of robotics research results. Several research publications claim good tracking results with vision-based SLAM. However, existing open source implementations are not robust enough to be used in commercial applications. For that reason, it is important to investigate the applicability of SLAM before starting the development of new products.

Kidnapped robot problem

In this project, a demonstrator was built for a particular 3D SLAM implementation. It performed well with a high-precision camera system. However, the accuracy and robustness evaluation showed that a commercial (cheap) camera system cannot provide enough accuracy for reliable tracking. A good starting point for further research is to decrease the scope to 2D, allowing additional sensors on the robot’s wheels to make a good estimate of its movements. The global capabilities of vision help correct drift and solve the so-called ‘kidnapped robot’ problem. The demonstrator has been developed to serve as a research platform that allows developers to integrate easily additional sensors and different strategies for further research.
Challenges
The biggest challenge is to guarantee the real-time performance of the image-processing pipeline. In a medical imaging device, real-time image processing and background tasks are executed in parallel at the same time. These tasks have different priorities and use computer resources such as memory, processor load and internal system bandwidth. These resources must be properly distributed depending on the priority of the task.

Results
The results of this project showed us that virtualisation technology is still too immature to share and manage resources for combined real-time image processing and background tasks. The main reasons are the impossibility of sharing advanced graphics card features among multiple virtual machines, high I/O overheads, lack of I/O resource partitioning, and virtual CPU and virtual network performance limitations.

Benefits
The results of the feasibility analysis uncovered a number of shortcomings and challenges of using virtualisation technology for the combination of image processing and background tasks on the same PC. It provides enormous insight into how virtualisation technology needs to be improved to make it suitable to solve the problem.

Using virtualisation technology for high-performance medical image processing

Within interventional X-ray, there is a growing need for sophisticated real-time imaging which give the medical specialist direct feedback. However, image processing is a demanding process that requires a large amount of computing resources. The main drive for cost reduction does not allow for an increase in equipment expenses. This led to a feasibility study of the combination of image processing and background tasks on a single multi-core processor.

Mobile surgery system
Nowadays, in the X-ray division of Philips Healthcare, a multitude of high-performance imaging chains is required with advanced image analysis functions such as object recognition, motion detection and feature extraction which are realised in software on standard multi-core PCs. This leads to a continuous need for power consumption reduction, cost reduction and miniaturisation of X-ray systems, especially for the mobile surgery system. To satisfy this need, Philips Healthcare is considering combining low latency image processing with background processing on a single multi-core processor. One of the scheduling approaches to combine real-time image processing and background tasks on the same processor that is often suggested is virtualisation, an emerging technology that makes a single physical resource appear to function as multiple logical resources. Resource management is handled at a high level in the systems where different virtual systems receive a part of the system resources.

Virtualisation architectures
The goal of this project is to investigate the combination of real-time image processing and background tasks on the same processor using virtualisation technology. During this project, a comprehensive feasibility analysis was carried out. Appropriate virtualisation architectures were defined, and demonstrators were built for running an image-processing pipeline. The demonstrators serve as research platforms for analysing feasibility relevant aspects such as performance, device sharing and resource partitioning.
Challenges
The main goal of the project was to set up an object detection applications framework that provides developers with the ability to use existing components in feature extraction and supervised learning algorithms with minimum effort. The additional challenge was to enable developers to annotate images with multiple labels and adopt multiple features that could be developed in one application.

Results
The quality of an object detection application is highly dependent on a set of ‘ground truth’ images. In other words, a selected set of annotated images, a set of selected features and the type of supervised learning algorithms. A prototype was built to enable image annotation to support existing feature extraction components such as plug-ins, and to support multiple feature extraction in one application.

Benefits
The outcome of this project facilitates the development of the object detection application by offering a tool that annotates JPEG and BITMAP images and a system that enables the use of existing feature extraction components developed in MATLAB and C/C++. The lead time in developing the object detection application was significantly reduced by using the developed framework.

“A framework for developing object detection applications”

“Parts of the framework have already been used in a customer project. I am sure the framework will prove its value for new projects as well.”
Sander Maas, Philips Applied Technologies

Computer vision technology has proved its value in industrial applications such as robot control. Price reduction in camera sensors and processing power has created a trend in applying computer vision technology to consumer electronics and automotive and user-interfacing devices to detect objects in less constrained environments.

Supervised learning algorithms
Objects in less constrained environments are more varied in shape and appearance. However, traditional computer vision algorithms are not designed to cope with this increased complexity. New approaches employing supervised learning algorithms, which are example-based learning approaches, have made several major breakthroughs in recent history, and these have been used in many consumer applications.

Object detection application
There are three steps in developing object detection applications using supervised learning algorithms: image annotation, feature extraction and training. Image annotation specifies the region of interest (ROI) on images and assigns a label to the ROI. Feature extraction retrieves characteristics and property data from the ROIs, and training applies supervised learning algorithms to the feature data. In this project, a framework for an object detection application was built to provide facilities for image annotation, multiple heterogeneously feature extraction and the application of different supervised learning algorithms.
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