3TU. School for Technological Design STAN ACKERMANS INSTITUTE

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Software Technology

Eindhoven University of Technology

PDEng projects 2009

Software Technology - PDEng projects 2009

Johan Lukkien

Healthcare

This booklet summarizes the final projects of the Software Technology PDEng-candidates during the period of January through September 2009. It is again a nice and impressive collection of high-tech challenges that were successfully brought to an end. We are glad and proud that the economic slowdown did not put any limitation on this work.
It is always hard to characterize the collection of final projects of a year's batch of Software Technology trainees. The title above does not cover all the projects; however, I want to emphasize the penetration of computer hard- and software into the health, care and home domains. Decision support in the form of advanced diagnostics and remote monitoring of patients are important developments that are needed to limit cost and human resources in the health care domain. Besides that we see projects in the high-tech industry aimed at controlling the ever increasing complexity of systems.
It is a pleasure to introduce the interesting results of all 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

The main challenge was to implement a true multi-user application that hides all the software complexity beneath a natural user interface and provides a seamless experience to clinicians. Another challenge was to do a proper feasibility and usability study to show the advantages of using such HCI devices in cancer care.

Results

A demonstrator has been successfully implemented that shows how such interaction devices help to improve the collaboration between the clinicians in a tumor board meeting. The usability study shows that the application is easy to use and that it provides all the necessary tools.

Benefits

With this project we have made a big first step towards a better understanding of how two clinical experts can combine their knowledge and patient information using this new human computer interaction paradigm. The demonstrator will serve as a base for future developments.

Zubair Afzal

Interaction And Visualization Hardware For Tumor Board Support

"With great enthusiasm, willingness to learn and an innovative mindset Zubair has created a very nice demonstrator that attracts attention and interest from multiple parties with-in Philips."

Roel Truyen,
Philips Healthcare

The treatment of cancer involves a collaborative effort of multiple disciplines. The Cancer Care Companion project is an initiative of Philips Healthcare that is aimed at facilitating clinicians from different disciplines to collaborate with each other in order to find an optimal treatment plan for a cancer patient.

Interaction and collaboration challenges

Cancer is a complex disease that requires a multitude of medical specialists to diagnose and treat. Good collaboration between the members of this multidisciplinary team is essential to reach the consensus that is generally accepted to lead to better patient care. The team members not only have to interact with each other and their patients; they are also faced with an increasing amount of clinical information about the patient. Since this information is more and more kept in electronic databases, there is also an increased need for better human-computer interaction. The goal of this project is to investigate what role new human-computer interaction devices can play in the complex world of multi-disciplinary, multi-information cancer care.

Microsoft Surface as a tool to enhance collaboration

The project focuses on the interaction between the two key participants of the Tumor Board meeting: the radiologist, and the pathologist. A Microsoft Surface specific prototype application has been implemented as a proof-of-concept that enables both clinicians to more efficiently interact and collaborate with each other. Techniques from HCI have been used to analyze possible behavior of clinicians and provide ways for better collaboration.

The application takes advantage of many of the new features in Microsoft Surface such as using physical objects to interact with the application. The application also implements discipline-specific data viewing for clinicians. Several viewing and interaction models have been implemented. One of the unique features of the prototype application is the ability to link radiology and pathology findings. This linkage of information was not available in software before.

Challenges

From the beginning, the main challenge of the project was to design and implement an application that fits in the Cardiac Explorer platform using as much as possible software functionality already available in platform. Developing a good design and implementation required a good understanding of the platform, which is huge and complex for someone who is not familiar with it.

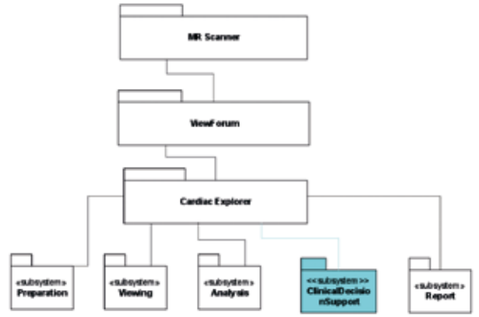
Results

The main result of the project is an efficiently designed decision support application that incorporates valuable clinical knowledge by displaying the measurements in Cardiac Explorer in the right order, at the right time. This application helps the clinicians to do their work in a more efficient and productive manner. As proof of the concept two workflows (Chronic Infarction and Ischemia) for user guidance, based on decision trees, have been implemented.

Benefits

The Cardiac Decision Support application is one of the pioneering projects at Philips Healthcare. It helps Philips Healthcare to get valuable feedback from clinical users.

Zebide Akkus



Clinical Decision Support Application

"Zebide's prototype software is a valuable step towards clinical decision support for the care of coronary-artery disease patients. It will help us to collect initial clinical feedback."

Marcel Breeuwer, Principal Scientist, Philips Healthcare

In recent years, Philips Healthcare has turned its attention to decision support applications for patient care providers. This activity focuses mainly on improving the quality of care for patients by providing applications to clinicians that help them make decisions regarding patient care in a more efficient way.

Cardiac Explorer

Coronary-artery disease (CAD) is one of the leading causes of death in the western world. More information at the right time may enable early recognition, which in turn may improve treatment of this disease and save many lives. In this context, the continuous improvement in cardiac magnetic resonance (CMR) imaging and analysis technology may facilitate accurate diagnoses. To support this, Philips Healthcare offers an effective clinical application for the analysis of CMR images (called Cardiac Explorer) that provides task guidance and automation to perform a quantitative analysis. As such, Cardiac Explorer can be used efficiently to generate vast amounts of measurement data. Cardiac Explorer however does not yet provide guidance for analyzing these measurements in relation to specific clinical questions.

'Sense & Simplicity' in the Clinical Decision Support Application

This project was aimed at the design and development of an interactive decision support application for the analysis of CMR images based on the Cardiac Explorer platform. This decision support application should guide the user in diagnosing the most frequently occurring forms of coronary artery disease (Chronic Infarction and Ischemia) using the measurements available in Cardiac Explorer. The application displays in each step of the guidance the corresponding CMR images, analysis results and patient data. The clinical knowledge for the various types of CAD has been captured in decision trees. Each node in these trees corresponds to one step in the guidance. The trees in fact describe a hierarchy of question dialogues.

Challenges

The main challenges are integration of A/V communication with a browser based IPTV platform and the variety of standards, domains (e.g. PC, mobile) and technologies (e.g. SIP, XMPP, Skype), which requires careful investigation in order to make an accurate trade-off and the implementation of prototypes.

Results

Two alternative solutions were investigated and prototyped – One was based on open standard (e.g. H.264, SIP) and another on Skype. In addition, I carried out several feasibility studies on the interoperability between TV and other devices, SIP integration, Webcam API and a comparative study on different alternatives (e.g. Flash P2P and Google Gmail A/V chat).

Benefits

The Social TV framework that supports A/V communication for IPTV, allows end users to meet their friends and families in a lean-back experience and enables easy access to online communities and social services from the comfort of their couch.

Tseesuren Batsuuri

Audio/video communication architecture for browser based IPTV

"Tseesuren has combined strong technical skills in developing software from driver-level in C/C++, multi-media frameworks, browser-plug-ins to application level programming in JavaScript."

Dietwig Lowet,
Philips Research

Over the past decade, Internet technology and broadband access have grown rapidly. This provides new paths for innovative internet use and enables new ways of social interactions and connectedness to people, as well as business opportunities to companies. A few well-known examples are YouTube, Facebook, Flickr, and Yahoo messenger. In Philips, the Social TV research project is intended to offer multiple ways of connecting people via a browser based IPTV platform, and thereby extend the business opportunities for Philips. The goal of the Social TV project is to create a framework that enables many interesting applications such as sharing pictures, watching movies together, playing online games together, and Audio/Video (A/V) chat. A crucial part of this framework is an integrated A/V communication solution.

Some key questions that need to be addressed by this A/V communication solution are:

- How to develop an A/V chat in a browser based platform that integrates well with Social TV applications such as sharing pictures and playing online games together?
- What solutions are available and which is the most suitable one for a browser based IPTV platform?
- How to achieve good interoperability with third-party solutions in different domains (e.g. PC and POTS/mobile)?

In my final project, I tried to give concrete answers to these questions. I studied technical and business aspects in two basic directions including open standard based and proprietary technologies and a number of different solutions, respectively. I prototyped two solutions as a proof of concept:

- Open standard based solution, using the GStreamer multimedia framework (H.263+ for video and, G.729 for audio, RTP/UDP for streaming, and XMPP for session management)
- Proprietary technology based solution, using Skype

From a business point of view, the study suggests that a Skype based solution can guarantee faster time to market whereas the open standard based approach could be more beneficial in the long term. From a technical point of view, both solutions proved to be feasible in a browser environment. However, certain aspects regarding the performance, interoperability and stability need further research. For instance, the performance of rendering a video in a browser needs improvement and this performance optimization would bring better quality and scalability.

Challenges

One of the challenges of this project was to provide insight into the coverage of the generic description language that is the basis to support a generic DSE process by implementing a prototype for the data path design of printers. Furthermore, an architecture that would connect the different tools in a loosely coupled way is very important for future extensibility.

Results

To support the DSE of high-tech embedded systems, a DSE toolset was designed and developed. This toolset integrates a variety of tools such as system analysis tools, performance metrics visualization tools, and interactive configuration editing tools in a loosely coupled manner. The toolset prototype demonstrates the basic support for the complete chain of the printer data path design. Apart from the primary achievement of easing the DSE, the toolset also provides some insight into the generic descriptions of system configurations and improves the early design of the generic data model. Moreover, recommendations have been made for further enrichment of functionalities of the prototype to allow a better support for the DSE process.

Benefits

The integrated environment for a DSE process provided by the toolset allows the system architects and designers to evaluate the system performance with less effort. It reduces the learning-curve of a DSE process because there is no need to perform the time-consuming calculation by hand or to understand the complex analysis models. The DSE toolset can be enriched and adapted to serve for other high-tech embedded systems.

Xiaochen Chen

Design-Space Exploration Toolset

"Consider the process of equipping a newly built house. Xiaochen developed the core of a tool for organizing and supporting this process, but then for printers instead of houses."

Twan Basten, Embedded Systems Institute and TU/e

The Embedded Systems Institute (ESI) participates, together with Océ, in the Octopus project aimed at improving system adaptability of high-tech embedded systems. One of the important issues is the Design-Space Exploration (DSE) problem as is encountered during the design of the data path of Océ digital document printers. The aim of my project was to design and build a DSE toolset that can help to ease the design process and is sufficiently generic to be useable for other types of high-tech embedded systems.

Design of high-tech embedded systems

The design of high-tech embedded systems such as the printer data path needs to consider multiple metrics of interest. The number of design and configuration parameters is typically very large, and the relation between parameters and metrics of interest is often unknown. DSE plays a crucial role in this system-level design. The goal of DSE is to find an optimal configuration in a typically multi-dimensional space of performance metrics (throughput, resource usage, etc.). For the printer data path design, different analysis models have been built to ease the DSE process carried out by system architects. Other tools are needed as well to support different steps during the DSE process. In this context, a flexible and extensible toolset is needed to offer an integrated environment for the design process of a printer data path.

Toolset to ease the process of design-space exploration

The architecture of the DSE toolset has been designed to allow different tools to work together in a loosely coupled way. The kernel of the DSE toolset provides a generic data model for describing system configurations. The generic data model promotes the flexibility of the toolset for other high-tech embedded systems. A prototype was developed for the case of data path design of printers.

Challenges

The biggest challenge was to make a vision-based person tracker that works with a lighting control system. Along with it, a second challenge was that this tracker could perform in real-time and also could be embedded in a solution of an affordable retail price.

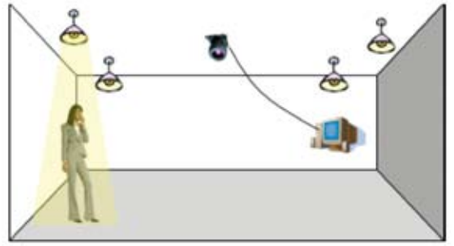
Results

We have created an approach that makes vision-based applications robust to sudden changes in the scene lighting. As a base for human motion analysis applications, we have developed also a people tracker that adjusts the lights according to the people's locations using our approach.

Benefits

Our approach can be used by vision-based human motion analysis algorithms. Together with the people tracker, it can be used as a framework for intelligent algorithms aimed at controlling the lighting of an environment according to the activity of a person.

Jorge Crespo Cedeño



Making Lighting Control Systems aware of Human Locations

"We are convinced that Jorge's prototype will convince several customers of our capability to develop comparable solutions for their problems."

Bastiaan de Groot, Philips Applied Technologies

Lighting where and when one or more persons need it is a desirable feature. Cameras are commonly used to detect the presence and location of a person. However, it is not trivial to combine lighting control with vision. To overcome this, we have developed an approach that allows vision applications to be used in lighting on demand solutions.

The challenge of presence detection

To add value to their home platforms, companies are very interested in creating smart environments capable of recognizing human activities. There is a considerable demand for solutions that can illuminate where and when it's needed. As a first step, companies face the big challenge of detecting and localizing a person with high accuracy using solutions that are easy to install and that can be introduced in the market at a low price. Systems employing cameras (vision-based systems) have become widely used for this purpose due to the affordable prices of cameras and computational power that target the consumer market.

Discriminating moving objects from illumination changes

Many vision-based people trackers detect moving objects from the differences in a sequence of images. This approach is fast and does not require many computational resources, but it makes it extremely hard to distinguish a sudden change in the scene illumination from the movement of an object. Hence changes in the lighting conditions of the environment are always avoided while using cameras. To solve this difficulty, we have developed an approach that makes vision-based applications robust to sudden changes in the lighting of the scene. Using our approach, vision-based applications can detect moving objects in the scene independently of light changes.

Challenges

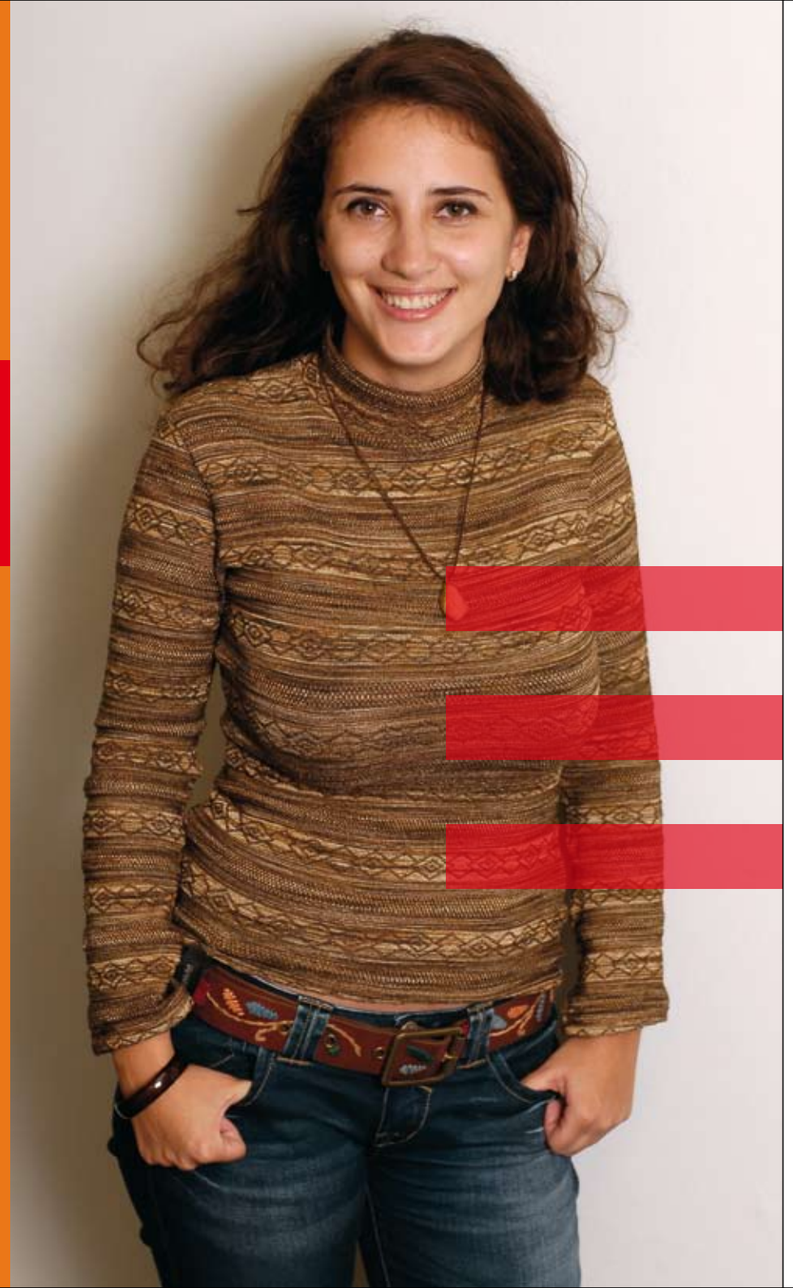
A major challenge in this project was to guarantee that the minimal haptic refresh rate is 1 kHz in order achieve acceptable tactile and force feedback perception during the simulation. It implies that at most one millisecond can pass between reading data from the device and outputting a new force feedback based on that data. This requirement was accomplished by using parallel computations and thoroughly optimised code.

Results

A prototype for a needle based simulator has been developed and implemented. A flexible architecture that allows for different haptic devices to be connected to the system and various force effects to be controlled was successfully designed and implemented.

Benefits

By implementing this prototype many haptic device limitations and design constrains have been discovered. This project is merely the first step in designing and implementing a medical simulator for procedures like biopsies, catheter insertion or other, ultrasound guided needle insertions.



Oana Dragomir

Augmented Reality to Train User Skills: Integration of a standard haptic device

"Oana rapidly became a specialist in haptic devices. Simple demonstrations evolved into a realistic environment by integrating into complex existing software."

Eddie Szulc,
Virtual Proteins BV

Virtual Proteins' future product is an innovative Desktop Augmented Reality System, which combines real patient data from MRI, CT and PET-scans in simulations of a wide range of medical interventions. The goal of "Augmented Reality to Train User Skills: Integration of a standard haptic device" project is to include haptic feedback in the already implemented MicroLab®, a software system designed to allow users to visualize and interact with 3D datasets from specific domains. In this way, better training effects and a better transfer of skills to the clinical setting can be ensured.

Health care is not as safe as it should be.

Medical students traditionally train on animals, cadavers, and patients. However, animals do not have the same anatomy as humans and their use can raise ethical issues, while cadavers cannot provide the correct physiological response. This training method creates an environment that threatens the safety of the patient while the students gain competence. Medical simulators address these issues by providing a safe and viable alternative. Virtual patient models can incorporate realistic human anatomy, while both normal and pathological physiology can be simulated. ARTUS (Augmented Reality to Train User Skills) is a virtual trainer in healthcare that is intended to be a tool used in medical schools and healthcare centres for certain medical interventions, such as minimally invasive surgery.

Integration of a haptic device

A simulation training procedure without haptic feedback is not realistic, as trainees are not able to practice their tactile skills. The outcome of this project brings Virtual Proteins closer to their goal of a good virtual trainer system by adding "true" interaction with 3D models. Several activities were carried out to accomplish this. First the capabilities of one specific haptic device (Phantom desktop) were investigated. Second, MicroLab® was extended with new functionality for haptic feedback during manipulation of 3D models (touch, press, insert) and control over a variable number of haptic devices. A prototype application that simulates a needle insertion procedure has been developed.

Challenges

The main challenge of the project was to augment the knowledge of Philips Applied Technologies with how the code footprint of a wireless network stack is compounded. For this purpose, we have developed a platform offering the functionality that is required in a home environment. The development of the platform included selecting the hardware and implementing methods for network formation, routing, reliable message delivery, and recovery from interference.

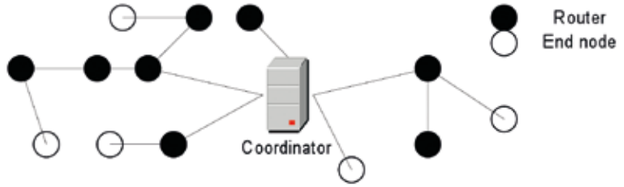
Results

From the Wireless Home Platform we have learned what the cost per functionality is. Using this cost per functionality we can create a customized solution that requires 24 - 32 KB of program memory to support a typical home control application. For the Wireless Home Platform, we also defined an API so that demonstrator developers at Philips Applied Technologies can reuse the developed platform.

Benefits

Philips Applied Technologies is able to make a trade-off between developing a solution based on ZigBee and creating a customized network stack. Based on this knowledge, they know it can be profitable to customize a network stack in projects that have a node take-off in the order of millions.

Eric Elsackers



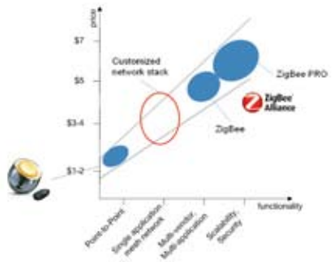
Design of a Wireless Home Platform with a small code footprint

"Eric managed to take our somewhat unusual requirements and translate them into a successful design of a wireless home networking platform with a small code footprint."

Koen Holtman, Philips Applied Technologies

In our project for Philips Applied Technologies, we have investigated the code footprint of a mesh network optimized specifically for a home environment. Because we have reduced the program memory requirements for our network software by including only those functions that are absolutely required by the application, we were able to use low-cost chips with less flash memory. Eventually, Philips Applied Technologies will be able to offer network software customization services to its customers, so that the customers can produce products at a lower cost.

Philips Applied Technologies is developing solutions for the home and building automation domain. In this domain we can find different applications, such as heating, ventilation and air conditioning (HVAC), energy monitoring, and ambient lighting. There is a trend in which the devices that form an application communicate wirelessly. For wireless communication there exist different solutions and standards. In the spectrum of wireless solutions, we see low cost point-to-point connections at the lower end. On the higher end of the spectrum, we have products based on the ZigBee standard in which a single wireless mesh network can support multiple applications simultaneously, mixing hardware from multiple vendors. Philips Applied Technologies sees a business opportunity in developing customized network stacks for single application mesh networks.



During the project, we created the Wireless Home Platform to determine the development costs, functionality trade-offs, and the code footprint of a customized network stack. The Wireless Home Platform offers functionality that is typically required in a home environment, such as auto-configuration, reliable message delivery, and self-healing from interference. Based on the figures of the Wireless Home Platform, we concluded that the development time of a customized network stack at production level is approximately one man year. Furthermore, we concluded that the code footprint can be reduced from 128 - 256 kilobyte (KB) for ZigBee solutions, to 24 - 32 KB for a solution optimized for a single application.

Challenges

The main challenge was to understand and to integrate some of the available tools into a toolbox that would reduce the design effort of the warehouse designer. Another challenge was to hide the technical details of the integrated tools and make them accessible for warehouse designers.

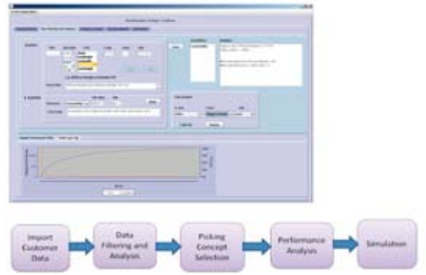
Results

A proof of concept prototype toolbox was designed and developed which integrates tools supporting the early phases of the warehouse design. This toolbox was subjected to a usability test with potential toolbox users at Vanderlande Industries. The users saw the potential benefits of using the toolbox. The tool that allows users to analyze the customer's business processes, was considered the one with the highest value.

Benefits

The Warehouse Design Toolbox is a pioneering application at Vanderlande Industries, in the sales engineering domain. The WDT application has a lot of potential to evolve into a fully supported product with automated intelligence, which would provide recommendations to sales engineers in the warehouse design steps. It may also form the base application for integration of future tools into the warehouse design process.

Lusine Hakobyan



Warehouse Design Toolbox

"This tool allows users to import customer information and analyze the customer's business processes. It forms the solid basis for the entire toolbox."

Roelof Hamberg and Jacques Verriet, Embedded Systems Institute

Warehouses are critical links in supply chains: they receive goods from many different suppliers, provide temporary storage of these goods, repack them, and distribute them to many different customers. Warehouse design is a complex process performed by sales or system engineers who are mainly guided by their experience.
The goal of the Warehouse Design Toolbox project is to facilitate the warehouse design process and thereby reduce the warehouse design effort.

Warehouse Design Process Steps

The main tool of the warehouse designer is his/her expertise. Still, there are steps common to most warehouse design processes. This has been identified by Vanderlande Industries and the Falcon project. Both have developed tools that support some of the common steps of the warehouse design process. Unfortunately, the available tools are just stand-alone tools and not all design steps are supported by a tool. Steps that are generally followed during the warehouse design are the following: gathering the customer requirements, filtering and analyzing the customer data, selecting the item picking concept, designing the process and material flow diagrams, designing the 3D AutoCAD layout, simulating the design and finally putting the building blocks inside the already available building provided by the customer.

Motivation for the Warehouse Design Toolbox

The warehouse design process is time consuming and there is little computational support. This implies that the sales engineers are not able to explore the full warehouse design space; their efforts are generally limited to a single warehouse design, which need not be the optimal solution. Automating and visualizing the warehouse design steps will increase the efficiency of the warehouse design process. Alternative solutions can be provided to the customer resulting in a higher customer satisfaction.

Challenges

The main goal was to develop a simulation environment for testing the control software of a class of complex mechanical systems. An important challenge was making the simulation work with existing control software that previously only ran on an embedded platform with physical components.

Results

A simulation environment has been developed that can simulate printing processes of different printers. Using it, a simulation was created for a printer that is currently being developed. It is currently used for automatic verification of that printer's embedded software. Additionally, the same simulation is also coupled with a specialized temperature model for use by system designers.

Benefits

The simulation offers advantages in different phases of the software development process. Testing can be performed more controlled, more repeatable, and more thorough. Software development can start earlier when hardware is not yet available. Finally, design exploration of behavior can be performed by coupling specialized models to the simulation. In total, this can lead to a reduction in development time and an improvement of reliability.

Amar Kalloe

Simulating a printing process for verifying control software

"Amar has extended our Software-In-the-Loop simulation environment with components to simulate the warm and cold process parts of a printer. He has taken on a lot of work of high technical quality, resulting in a tool that is usable in actual practice."

Lou Somers,
Océ Technologies BV

Testing embedded software that controls a printer is hard when there is no printer yet to test on. Even when a physical prototype is available, many tests are difficult to perform. Therefore, Océ is increasingly using software simulations. In this project, a simulation environment has been developed for testing a mechanically complex part of the printer, called the printing process.

Embedded control software development

Océ develops professional printers that require an interdisciplinary effort of mechanics, electronics, software, and more. Embedded software is responsible for controlling the printer's many components. In the past, testing this software had to be performed on hardware prototypes. This can be difficult, as hardware may not yet be available and many scenarios are hard to test. To improve testing capabilities, Océ previously developed a Software-in-the-Loop simulation that simulates paper movement by reading and writing IO signals from and to the embedded software. However, the part responsible for actual printing was not simulated yet. Compared to the paper transport path, it contains a much greater diversity of components and relationships.

Printing process simulation

The simulation environment developed in this project can be used to test the embedded software for the printing process. It contains a set of generalized components that can be reused in a different configuration for other printers. The embedded software's error handling can be tested, for example, by simulating a broken motor or a sudden loss of heat.

To test certain aspects more in-depth, the simulation can be extended with specialized models. For example, an advanced temperature model developed by mechanical designers can be connected. By connecting the embedded software with detailed physical models, errors over the entire development process can be discovered early.

Challenges

The HDS system, with its central controller is very efficient with remarkable throughput. This project was set up to investigate if the same throughput and efficiency could be achieved with the system, if its control was distributed. So the main challenge in this project has been to define the structure of a distributed control component for the HDS system. To define the structure of the distributed control, an architecture had to be developed that would clearly modularize the control in order to ensure that there would be less or no coupling of functionalities. To verify the defined structure of the distributed control, an implementation had to be made that would simulate the HDS system. The new distributed control was to have a holonic structure and should be realized as a multi-agent system control.

Results

Using the two concepts, holons and agents, the HDS system control has been defined as a modular, distributed control, consisting of simpler components that have well defined, specific functionalities and roles. The project has yielded a design for a distributed HDS system control that is robust, maintainable and comparable in performance with the current centralized implementation.

Benefits

The resulting architecture provides an insight into ways to go if the control is to be changed from centralized to distributed, especially with the use of holons and agents. A distributed approach provides an opportunity to decouple the functionalities of the HDS system control which will make analyzing, maintaining and updating it easier.

Martin Kavuma

Holonic Highly Dynamic Storage

"Martin managed to complete a fully functional holonic HDS prototype. This proved to be a challenging task because of the complex dynamics of the HDS and the background of the people involved."

Jacques Verriet, Embedded Systems Institute

The Holonic Highly Dynamic Storage project has contributed to the investigation into distributed system control. The project was done as part of the Falcon Project at the Embedded Systems Institute (ESI), and was aimed at defining the structure of the Highly Dynamic Storage (HDS) system control as a distributed control.

Distribution Centers

Distribution centers are warehouses used to store specific, frequently demanded products. The operations of a distribution center are constrained by factors like time, accuracy, efficiency, and safety. To ensure that all these constraints are met, today's distribution centers consist of several subsystems, which can be of varying complexity. A distribution center consists of six areas; receiving, storage, picking, consolidation, transport and shipping. In all the areas of the distribution center, Vanderlande Industries provides several products and solutions. At the storage area one of the solutions it provides to its clients is the Highly Dynamic Storage (HDS) system. The HDS system control has been the subject of this project.

The HDS System

The HDS solution is an automatic storage and retrieval (AS/RS) system. Indeed, the HDS system is highly automated, employing several mechanical systems for both the storage and retrieval of the products. Products are placed in plastic crates called totes, and it is these totes the HDS stores and retrieves depending on which products they contain.
Attached to the HDS system are the inbound and outbound conveyors that carry totes to and from the HDS respectively. It also consists of a lift system that transports totes from the inbound conveyor into the HDS and from within the HDS to the outbound conveyor.

Challenges

Partial software updates in Allura cardiovascular systems are required because the current update procedure is expensive, time consuming and therefore, represents a source of dissatisfaction both for Philips Healthcare and its clients.

Results

The partial software updates proposed have reduced the current installation time between 25% and 61%. Because the size of a partial installation set is significantly smaller than that of a full installation set, the distribution (via computer network) of this smaller set and hence its remote installation become feasible.

Benefits

The reliability of the partial installation process allows the Cardiovascular Business Unit of Philips to consider releasing automatically their software to the systems in the field, which will contribute to satisfaction of the customers.

Orlando Méndez Morales

Faster and managed remote partial installation and distribution of complex system software for state-of-the-art medical imaging devices with a large set of product variations.

"Our ultimate goal is to have a fully automated software distribution and installation process..... Orlando's work has been a major step towards this goal."

Peter Dingemans, Philips Healthcare

Have you ever wondered how soon your computer would be limited in functionality because it does not have its software updated? How would you feel if you cannot quickly update your high tech Cardio Vascular system to the latest technology and feature set? These questions popped into the author's mind while working on the project

Nowadays software is a critical factor for business success and more importantly for patient safety in many devices. Medical imaging devices rely on the safe and stable operation of the software that controls them, and their operation begins with the software installation process. Software installation is a supporting process to the production of Cardiovascular X-ray systems. In the case of this type of systems produced by Philips Healthcare, the magnitude of the installation process is extensive when compared to other types of embedded systems such as mobile devices. The main goal of the project was to make the software installation of cardiovascular systems faster, more managed, and remote.

The partial software updates proposed have reduced the current installation time between 25% and 61%. The reliability of this partial installation process allows the Cardiovascular Business Unit of Philips to consider releasing automatically their software to the systems in the field, which will contribute to satisfaction of the customers. Furthermore, because the size of a partial installation set is significantly smaller than that of a full installation set, the distribution (via computer network) of this smaller set and hence its remote installation become feasible.

Challenges

To find the right level of abstraction, where the timing designer can easily specify the timing behavior of paper and generate the control software in terms of underlying machine parts, is a big challenge in automation. Also, the code generator has to be as simple and transparent as possible so that the timing designer can clearly be certain about the generated code.

Results

A domain specific behavior specification language was designed, which contains a set of high level directives that can be used to identify specific patterns of paper movement in the paper path. The code generator maps these directives to IO control calls of the machine. Using these directives, a timing designer can model the required timing behavior, generate the control software and realize the behavior of a sheet of paper in a machine.

Benefits

The automation of the development of control software offers new possibilities for innovative product development, with quick feedback on design decisions and shorter development time. It is ideal for developing complex products like printers whose development involves lot of trade-offs between multiple disciplines.

Chitra Padmanabha Pillai

Model-Based Control Software Synthesis for Printer Paper Handling

"Chitra's work connects models in a consistent framework resulting in connected engineers from differing disciplines. The prototype for fully automated machine control synthesis based on a behaviour description, shows the way forward in model based product development."

Ronald Fabel,
Océ Technologies BV

At Océ, the vision is to efficiently design and develop printers using a model-based approach. This project is a step towards this vision by automating the control software development from multi-disciplinary models and behavior specifications. A high level specification of paper movement along with the machine design information model has been used to synthesize the control software for paper handling in printers.

Control Software

Productive printing systems have evolved to be innovative and complex multi-disciplinary products. The amount of software control has equally grown because of the many offered functionalities. As a result, a lot of effort has shifted towards development of control software. A model based approach helps to manage this complexity. Also, the ability to synthesize software from models helps ensure the consistency of the design information throughout the development cycle. This ensures that the design specification matches the implementation, thereby tremendously decreasing the development time as well as improving the quality of the products.

Domain-Specific Behavior Specification Language

The key to the automation of control software development is to specify the behavior at the right abstraction level. A domain specific approach is ideal because it fits the domain needs, closely relates to the required behavior and enables code generation. In the printer paper handling, the timing behavior of the paper can be specified using a high level language specific to the paper path. A domain-specific code generator can then automatically generate the control software from this behavior specification.

Challenges

At the start of the project, the requirements were mostly unclear. Also, there was very limited access to end users (clinicians), while knowledge of the clinical domain is essential for the application developed in this project. Usability testing in the clinical setting was scheduled after the end of the OOTI project.

Results

A successful implementation of the timeline view was created using state of the art user interface technologies. The solution has been designed with flexibility in mind, so that new insights that were generated during the project, and the clinical feedback that will be gathered after the project, can easily be incorporated in the timeline view.

Benefits

The timeline view provides clinicians at a tumor board meeting with the complete history of a patient at a glance. It is a solution that will significantly contribute to inter-disciplinary collaboration, knowledge transfer, and decision making, and will therefore help clinicians to provide cancer patients with optimal treatment.

Erik Sluiters

Timeline visualization of patient information for tumor board presentation

"The success of the project was ultimately rewarded by enthusiastic responses from clinicians to the initial prototype demonstration."

Xander Verbeek, Philips Healthcare

Cancer is the second leading cause of death in developed countries, following heart diseases. Treatment of cancer is a multidisciplinary effort. To promote interdisciplinary clinical decision making, in most hospitals, patient cases are discussed by clinicians at weekly tumor board meetings (TBMs), having a profound positive impact on the quality of patient care.

Challenges for Tumor Board Meetings

Various challenges exist for TBMs, one of which is the collection and presentation of patient data in a way that optimally supports the clinician's workflow and is compatible with their way of working. The current way of presenting patient information in TBMs does not optimally support clinical case presentation and team communication, and is not optimally supported by visual aids.

Timeline view

To confront this challenge, a timeline view for visualizing patient data has been created in this project. The timeline view allows clinicians to effectively present and discuss patient information at TBMs. The solution positively contributes to interdisciplinary collaboration, knowledge transfer, and decision making, which play an important role in providing cancer patients with optimal treatment.
The prototype has been implemented using state of the art user interface technologies. By separating timeline logic from data visualization logic, a solution has been created which is flexible for different types of data (i.e., not limited to patient data), and visualizations can be easily changed, extended, and added. Other projects at CS&AD have started to make use of the timeline component, thereby proving that applicability is not limited to the CCC project.

Challenges

A great deal of knowledge in multiple domains was required in this project, such as clinical tool features, three dimensional image processing and visualization, user interaction, and the new platform. It was indeed a challenge to acquire all the necessary knowledge in a short period.

Results

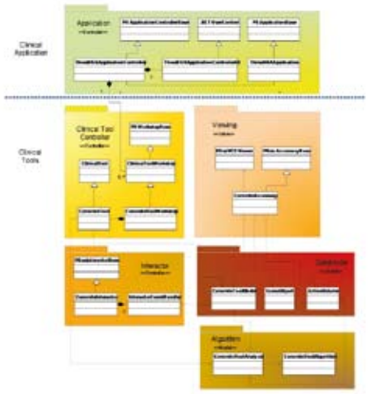
Compared to the current architecture, the new design eliminated the dependencies among the packages, which creates the flexibility for extending or reusing these packages. Furthermore, we took maintainability into consideration from the beginning of the design and implementation phases, which raises confidence in the quality of the design and implementation.

Benefits

The new architecture design makes it easier and faster to deploy new clinical features on XtraVision. These new features will provide the patient with a better experience while undergoing the medical procedures, and give the physician more capability for better and easier diagnosis and treatment.

Emma Song

A new architecture for a cardio-vascular medical image reconstruction application



"Emma defined the design of the clinical tool concept which is one of the most critical new architectural concepts. She also validated this concept through prototyping one of the sub-clinical tools."

Mahmoud Elbanna, Philips Healthcare

Philips Healthcare is a leading supplier of diagnostic imaging systems and related services. XtraVision is one of Philips Healthcare's software products. It is a rich set of clinical interventional tools, which represent a very important value for patients and physicians in hospitals. In recent years, hospitals increasingly have been asking for new clinical features that help them in diagnosis and treatment during the intervntional cardio/vascular procedures.
However, the current architecture of XtraVision has shortcomings with respect to product quality and the effort to extend the system. In addition, XtraVision is being migrated to a new platform. These circumstances translate into an unacceptable increase of time and effort to add new functionalities. Therefore, this re-architecting project has been put on the agenda.

A new extendable Architecture

We have proposed a new architecture design, which aims to decouple classes and minimize the dependencies between the packages in order to achieve an extendable, changeable, and testable application. The new design consists of a general architecture and extensions. The general architecture is applicable to all the clinical tools and provides basic functions, while extensions focus on tool-specific requirements.

A prototype to validate the architecture

In addition, we have implemented a prototype consisting of two clinical tools to validate the feasibility of the new design. Three extensions have been made to fulfill their tool-specific requirements. The result shows that the general design can be extended easily. With its extensions, the general design can fulfill all the functional requirements in these two clinical tools.

Challenges

The challenge in developing this new approach is maintaining an acceptable processing time. The penalty of extra processing time has to be in balance with the produced results, because size reduction has a large impact on the time-to-market of a digital navigation map.

Results

Our effort resulted in a design for the size reduction of polygons and polylines within context of one another. Multiple algorithms can be used and for performance enhancement, parallel processing is supported by the design. The implementation successfully reduces the size of digital maps while preventing visual artifacts from forming.

Benefits

The benefit for the company at which this project took place is that they now have a distinct competitive advantage given the fact that they can significantly reduce the size of their navigation maps while avoiding visual artifacts. For the consumer, the digital navigation map may contain more value through additional points-of–interest.

Arcilio Virginia

Figure 1: Exaggerated example of Amsterdam before (1) and after (2) applying our solution.

Context Based Size Reduction of Digital Navigation Maps

"Arcilio is a perfect team player who knows how to keep his stakeholders interested and contributing. This way he has laid the foundation for a successful project."

Ronald Maanders, Mapscape

Although a high level of detail in digital navigation maps is aesthetically pleasing it is not needed for navigation and it requires a lot of storage space. This space can be used for points of interest that add value to the map. In this project a system was developed that reduces the size of digital navigation maps.

Introduction

However, reducing the size of the maps leads to visual artifacts that negatively influence the perceived quality of the digital navigation map by consumers. These artifacts manifest themselves as gaps, for example holes in between areas in the map. Other examples are roads along a river that are shown on the map as being in the river. As the size of the maps decreases more visual artifacts appear.

New approach

To avoid these visual artifacts while reducing the size of the digital navigation maps involved a new approach in size reduction. A digital map is constructed from two-dimensional shapes called polygons and polylines. The former is used to represent areas (such as parks, lakes, land) and the latter represents the road network. Traditionally, an algorithm is used to reduce the size of a digital navigation map by processing polygons and polylines independently. This approach is what leads to the visual artifacts. In our approach each polygon and polyline is processed within context of one another. This new approach involves establishing the relationships between the shapes that make up the digital map and processing multiple shapes at a time.

Credits

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