EIT-EMS exit point (2013-2014) Final Degree Projects

Océ (Venlo)

1. Visualization of a virtual printer

The products Océ develops are large and complex. The functionality and the required control software continuously increase. In order to be able to develop the Embedded control software for such complex machine we use a virtual environment.
Part of this environment is our Software in the loop application (SIL) that simulates the electronics and the mechanics of a printer. With this SIL application it's possible to develop and test embedded software without having real hardware available. The SIL application is also part of our automatic test environment.
In order to improve the usability of the SIL application a 3d visualization of the 'real' machine is wanted. It's easier to diagnose problems when you see what went wrong!
The goal of your assignment is to improve an existing 3d visualization application and to visualize various moving parts in the machine.
You will work with a development environment using QT and C++.

2. Visualization of sheet timing design

Océ develops high productive printer systems. In order to get the most out of a printer, smart scheduling of sheets is required. For this purpose we have a sheet scheduling algorithm which determines the most productive sheet flow through the system.
To verify the sheet scheduler and sheet timing design in an early phase it's important to visualize the sheet flow through the printer to get visual feedback of the design.
The goal of your assignment is to read the scheduling algorithm and to calculate the sheet timing using this algorithm for a specific print job. The resulting sheet timing should directly be sent to a paper path visualization tool.
You will work with a development environment using QT and C++.

3. Dynamic Protocol behavior specification and verification using statemachines.

In FAIC (and other middleware) we typically only specify the static part of a protocol, i.e. the in- and out messages. The dynamic behavior is not specified in a formal way, only in documentation with sequence diagrams. Specifying the behavior between 2 peers using UML statemachines allows for offline and online verification. A tool like RSARTE can help.

4. Use FIQ Handlers in the ARM Linux Kernel for Motor Control Loops

Within Océ we use Real-Time Linux running on a ARM processor in at least ten different products for embedded control. Using a full blown OS for motor control loops of several kHz is problematic with respect to latency, jitter and CPU load. The Linux community sees Fast Interrupt reQuest (FIQ) handlers as a possible solution. FIQ is basically a higher priority interrupt available in the ARM architecture. This means that it will always have precedence over regular interrupts, but also that regular interrupts won't mask or interrupt an FIQ, while an FIQ will mask or interrupt any IRQ. FIQ's are usually not used by the Linux Kernel, but some infrastructure is available to use FIQ's in a driver. In this way it is possible to achieve some hard real time constraints. Your

assignments consists of prototyping and giving answers on the following type of questions:

- Prototype a FIQ handler on our own ARM Cortex-A9 processor module. This prototype should show the hard real time possibilities.
- FIQ's are executed in TrustZone on Cortex-A9. What are the limitations of this secure mode? How to execute you our own code in this secure mode? How do you communicate between non-secure (Linux kernel) and secure mode (FIQ handler)? Does this secure mode result in extra jitter (e.g. entry checks)?
- Which interrupts sources (e.g. timer interrupt) can be used to create FIQ handlers?
- What is the impact of cache flushes? How predictable is the timing of the code execution from on-chip RAM (e.g. the Linux Kernel is busy with DMA transfers in parallel)?
- Create a small FIQ Control Loop Framework. Think of printk-like functionality, timestamping and scheduling multiple controls loops with different frequencies. Describe the interface between Linux kernel and this FIQ Framework.

5. Implementing the Next Gen FPGA interconnection method for IP cores

Introduction

In Océ print systems, FPGA's are used for high speed signal generation. These signals are, for example, used in high precision motor control, capturing sensor inputs, interfacing with high speed memory and external interfaces like SPI, USB and CAN. Within Océ R&D we have a library of commonly used blocks (IP cores) which are used in multiple projects (15+) and on different types of FPGA's (both high-end as low-end). These IP cores are controlled by a processor, which can communicate with each core via an internal FPGA interconnect. This interconnect is based on an industry standard and can be deployed on different ranges of FPGA types and vendors. From business point of view it is wise to compare FPGA devices and choose the most cost-effective device for the problem.

Assignment description

The current interconnection between the different IP cores has a limited future outlook. Your assignment is to choose and implement a next generation of interconnection between IP cores in an FPGA. With this interconnect IP cores need to be addressed. The outcome of your assignment are 'proto-types' of the new implemented interconnect, running on FPGA's of different types and vendors. You will advise us in how we can move effortless to the next generation of FPGA interconnection and how it performs on different FPGAs. You will get the opportunity to learn a lot, about FPGA working methods, complex FPGA designs, FPGA tool flows . You are supported in your assignment by FPGA experts within Océ.

Possible questions:

- Compare some existing reusable IP cores with your new converted IP cores using the new interconnect. What is for example the impact on resources and timing? How to test that the new IP cores have the same functional behavior (e.g. it should be avoided that the current software using this HDL must be changed)?
- What are the advantages and disadvantages of this new interconnect?
- Is a hybrid FPGA design possible or does a current design needs to be converted in one big bang? Prototype a hybrid solution when possible? Some reusable IP cores with the legacy interconnect and some reusable IP cores with the new interconnect.

- When the previous steps are successful do the conversion on an actual project. Your result will then run on a real printer or finisher. Present the results to our HDL engineers. Give advice and howto's.
- Advise us which reusable IP cores of external parties are using the new interconnect and could be good candidates for Océ.

6. Behavioral/scenario-based programming

Explore the potential of scenario-based programming in the context of the software development for our printers. Focus is on **inter-**object communication (scenario's) instead of **intra-**object (state charts). Based upon (but not restricted to) the ideas of David Harel.

7. Generic machine dashboard

Currently the user interfaces on the printer offer limited functionality to observe the dynamic behavior of the engines. The feedback of the engine behavior is mainly based on text and static images. We want to explore the added value of enhanced user feedback giving better information of the activities in the engine (e.g. location of error sheets; calibrations going on; cleaning of print heads; etc.). Main stakeholders are R&D, Service and Production because they are very interested in the whitebox behavior of the engine, while the end-user is mainly interested in the blackbox behavior (getting the prints out of the printer).

8. Context aware print shop environment

A print shop often is an environment with multiple rooms, different departments, a bunch of people and a lot of phases through which a document needs to go to become a shippable product. In such an environment it is difficult to keep an overview of all that is happening within the print shop and put all your resources to their best possible use. We believe that a good and actionable overview of particularly people and/or products could drastically increase the efficiency of a print shop. To get to this overview, we envision a mapping method that keeps track of a person's or an object's location within the print shop in real-time. The mapping could for example result in (1) a heat map of people within a certain shop to track efficiency, (2) a real-time overview of who is where (doing what) and subsequent task division in the most efficient way possible or (3) a track and trace system of individual/batch jobs throughout the print shop to monitor the status of the product and provide the right kind of information at the right time at the right place.
We start from blank. First step: think of different user scenarios and value propositions in which the mapping system can deliver most value for the end-user. Second step: the mapping method itself should be created out of existing technologies such as camera detection or indoor mapping technologies. Third step: when the technology is in place, the data should be gathered and analyzed to make sense. Step four: the gathered information is presented on such a way that it becomes actionable and add value to the customer according to the proposition from step 1.
References:

- http://en.wikipedia.org/wiki/Indoor_positioning_system
- Indoor positioning solution NAO campus: http://www.polestar.eu/en/nao-campus/indoor-positioning.html
- Indoor GPS solution Blinksight: http://www.startuptip.com/2013/04/19/blinksight-chip-delivers-realtime-3-d-information/

Philips Research (Eindhoven)

Wireless outdoor Lighting Systems

Contact: prof.dr. Lukkien

Background

Many street lighting systems of the future will incorporate local/distributed lighting controls to ensure that the amount of light delivered corresponds to the precise needs. This can be achieved by various sensors (e.g. traffic, motion, presence sensors, etc.) that control the illumination levels of surrounding light poles, combined with networking capabilities.

9. System modeling and design

Project description

The challenge in the design of adaptive street lighting systems lies in the trade-off between sensing accuracy (e.g. sensor coverage, detection accuracy, and sensor density), networking performance (e.g. bandwidth, latency, scale, protocol overhead), and final system performance (e.g. perceived system behaviour, level of energy saving). In the student project we aim at increasing the insights in these trade-offs, by modelling the different aspects in the system and coming up with design strategies.
To this end, the student will create a system model, develop simulation modules to emulate system component behaviour, and finally simulate overall system behaviour. The designed models created will be verified with data from an actual deployed system.

10. Simulator architecture and design

Project description

To thoroughly understand the behavior of adaptive street lighting systems, under the wide variety of outdoor scenarios (e.g. street layouts, required behavior, and weather parameters) that can occur, it is necessary to create a virtual testing environment. Also, it allows tradeoffs between the different system components (e.g. sensors, networking technology, protocol parameters, etc). This allows the testing of design tradeoffs and decisions in an early phase of the development.
To this end, the student will design and create a modular simulator, which can be used to simulate these adaptive outdoor lighting systems. The solution will be based on a commercial simulator environment, in which an architecture for the simulator needs to be designed. We want to explore the use of publicly available data and models (e.g. traffic, weather) in this simulator. The simulator will be verified and calibrated with data from an actual deployed system.

Personal Health Solutions (Dept. Joerg Habetha)

11. Visualization of Sleep and Circadian Alignment Data

Supervisor: Hennig Maas

A significant part of the world population has problems related to a misalignment of their internal circadian rhythm to the external night-day rhythm. Such a circadian misalignment can lead to circadian rhythm sleep disorders, and in particular to a

delayed sleep-phase disorder (DSPD). The circadian rhythm is controlled by a biological clock in the brain, which has an autonomous rhythm. There exist mathematical models that can be used to estimate the current state of the human circadian pacemaker from activity and light data. Furthermore, activity data can be used to determine sleep/wake patterns. By combining information about activity, light, sleep, and circadian phase over extended periods, it is possible to reveal circadian misalignment and to suggest lifestyle interventions that are able to re-synchronize the circadian pacemaker.

The aim of this project is to develop and prototype concepts for intuitive visualization of real-time data as well as longitudinal data on activity, light, sleep, and circadian phase. The visualization shall initially be developed and prototyped in Matlab for iteration of alternative graphical concepts. The designed concepts shall be evaluated on existing data sets. Ideally (if matching with the student's programming capabilities and interests) the project finishes with a demonstrator of the visualization system implemented as an app on a smart phone.

12. Visualization and modeling for Sleep Apnea diagnostics

Supervisor : *Pepijn Wortelboer, Frits de Bruijn*

Endoscopic diagnosis of the human upper airway is critical in selecting the right therapy for OSA (obstructive sleep apnea) patients. To identify sites in the airway that tend to collapse, ENT (ear, nose, throat) physicians increasingly perform a daytime examination in which the patient is brought into sedated sleep. Based on direct endoscopic observations the ENT qualifies the patient and determines the best treatment. Because of the subjective nature of this examination there is a clear wish to obtain more quantified measurement results.

This assignment entails an inventory of imaging algorithms that can be used to reconstruct the upper airway geometry based on endoscopic images and data on the endoscope location. Implementation of found algorithms, and application to a series of provided endoscopic videos is part of the work. Verification of the algorithms will be performed with help reference models of the upper airway.

Lighting Control Systems (Dept. Martin Elixmann)

13. UAV

Supervisors: Alan Pestrin and Oscar Garcia

Intro:

A widespread interest is growing on the civil usage of small Unmanned Aerial Vehicles (e.g. multirotor systems) as fully autonomous devices for many different types of applications such as cartography or provisioning of different kind of services.

Technical description:

The student will have to improve the current UAV framework by designing, implementing and evaluating hardware and software extensions to enable new applications..

In particular, the student will be involved in these activities:

- Study of existing solutions and state of the art in UAV.

- Development of digital control systems (UAV autonomous navigation).
- Software development (low-level: UAV firmware; high-level: communication and integration with other systems).
- Hardware development: UAV extensions for landing and energy/data exchange.

Business case:
The student will have to do a detailed evaluation on the impact and the implications of introducing these systems in real contexts.
An additional business analysis of the possible processes for integrating these autonomous systems to the market and how to manage the interactions between the different stakeholders involved (Philips, service provider, consumer, etc.) can be also evaluated.

14. SW security in embedded devices

Supervisors: Santos Merino del Pozo and Oscar Garcia

Intro:
Advances in electronics and smart things are going to allow for the so-called Internet of Things comprising thousands of smart objects able to interact with each other. Connecting everyday devices to the Internet brings new functionality and capabilities to the end user, but it also makes of these devices a potential target for attackers.

Technical stuff
The research conducted during the internship will be focused on embedded systems security, and more specifically on wireless lighting systems. The main task will be to perform security testing of lighting devices in order to analyze existing vulnerabilities and discover new attack vectors. The evaluation will be carried out at different levels, from very high-level, i.e., security requirements and design, to low-level, i.e., implementation issues. After implementing and analyzing the impact of the security issues, the student will propose recommendations on how to address the security weakness and how to improve.

Business case
Wireless lighting systems will be incorporated in new infrastructure, such as hospitals or public venues. In such an environment, the consequences of a successful attack, such as the ability to cause a perpetual blackout, could be fatal since the life of lot of people would be threatened. For this reason, the student will elaborate a report with the impact of attacks on lighting systems.

15. New methods for public-key cryptography

Supervisors: Santos Merino del Pozo and Oscar Garcia

Intro
Advances in electronics and smart things are going to allow for the so-called Internet of Things comprising thousands of smart objects able to interact with each other. Connecting everyday devices to the Internet brings new functionality and capabilities to the end user, but it also makes of communications between these devices a potential target for attackers.

Technical stuff
The research conducted during the internship will be focused on lightweight cryptography, and more specifically on public-key cryptography. The main task will be

to analyze and later implement a new public-key encryption algorithm especially crafted for resource-constrained devices such as those of the IoT. For this reason, the algorithm will be carefully implemented in the AVR Atmega128L, one of the most popular 8-bit MCUs in embedded systems. In order to achieve a low-latency and lightweight encryption method, the student will design optimizations to reduce the cycle count and storage requirements. The final step will be the evaluation and comparison with other similar schemes proposed in the literature.

Business case

The development of secure, lightweight and low-latency algorithms is one of the hot research topics in cryptography. Recent developments in cryptanalysis are endangering most widely deployed public-key schemes and, for this reason at Philips we are developing the next-generation of cryptographic algorithms which will protect our day to day communications, e.g., Internet traffic. The novel features of our public-key encryption method will allow the efficient deployment of the Public-Key Infrastructure even in networks comprised by resource-constrained devices."

16. Security for Lighting systems

Supervisors: Sahil Sharma and Oscar Garcia

Intro:

The proliferation of wireless connectivity and advances in small, embedded microcontrollers has allowed for the Internet of Things, which comprises objects as diverse as sensors and lighting devices. Connecting devices to the internet offers new capabilities, but also brings with it issues related to security as these are easy targets for attackers to exploit.

Technical stuff:

The research conducted during the internship will be focused on embedded systems security, and more specifically on wireless lighting systems. The work will be focused on secure storage of cryptographic keys (secrets) in small embedded platforms that are deployed in the open. The work will comprise of analyzing the potential attacks (threat modeling), detailing the security requirements, research on the existing body of work that exists in the field. Finally, the student is expected to propose a technique /improve on an existing technique that addresses the issue, implement and evaluate/analyze the proposed solution. The technical challenge lies in securely storing secrets in resource constrained devices that are deployed in the open and are, thus, also open to physical attacks.

Business case:

Wireless lighting systems will be deployed in public spaces such as buildings, streets, etc. Since these systems will be installed in public areas, they are greatly exposed and attacks on such devices can compromise the proper functioning of these devices. This can seriously impact our brand value and, thus, security in such devices is crucial. The student will elaborate the impact of such attacks in the report.

17. Securely running 3rd party applications on embedded platforms

Supervisors: Sahil Sharma and Oscar Garcia

Intro:

The proliferation of wireless connectivity and advances in small, embedded microcontrollers has allowed for the Internet of Things, which comprises objects as diverse as sensors and lighting devices. Connecting devices to the internet offers new capabilities, but also brings with it issues related to security as these are easy targets for attackers to exploit.

Technical stuff:

The research conducted during the internship will be focused on securely running applications on an embedded platform, used within a lighting system. The work will comprise of analyzing the threats of running third party apps, detailing the security requirements, research on the existing body of work that exists in the field, such as managing security of third party apps is systems like Android, sandboxing techniques, etc. Finally, the student is expected to propose a technique /improve on an existing technique that addresses the issue and implement and evaluate/analyze the proposed solution.
Also, since the apps would be from third parties, the student is also expected to analyze trust relationships and how they are enforced (certificates, the role of PKI, etc.).

Business case:

Wireless lighting systems will be deployed in public spaces such as streets, shopping areas, etc. This opens up the possibility of running third party applications on the lighting system since it offers computing resources that can be utilized. The student will also analyze the value that can be generated by offering such resources to third parties and the benefits that can be derived from this value proposition.

Brain, Body & Behavior (Dept. Marieke van der Hoeven)

18. physiological signal processing for dementia

Supervisor: Erik Schuijers

Introduction

Dementia is a progressive disorder that is characterized by deficits in memory, language, motor ability, perception and executive functions, and that affects the ability to perform everyday activities. Alzheimer's disease is the most common type of dementia.
According to the Alzheimer's Disease International organization[1], the number of people living with dementia worldwide is estimated to increase from 35.6 million in 2010 to 115.4 million in 2050. Current associated costs are estimated to be around 600 billion US dollars. A major part of these costs are related to the informal care of people with dementia.
Also at a European level, dementia is a recognized societal problem. There are a number of projects subsidized by the European Union, foremost under the FP7 programme, which aim to address prevention, treatment and management strategies for dementia. One of these projects is the Dem@Care project (www.demcare.eu), which runs from November 2012 to October 2015. The aim of the Dem@Care project is to develop a closed-loop management solution for people with mild or mid-stage dementia through multi-parametric remote monitoring and individual-tailored analysis of physiological, behavioural and lifestyle measurements.

[1] Alzheimer's Disease International, World Alzheimer Report 2010, The Global Economic Impact of Dementia

Philips Research is one of the technical partners of the Dem@Care consortium. The primary focus of Philips Research inside this consortium is the provision of unobtrusive sensor devices, and the realisation of algorithms providing insight into the lifestyle of people with dementia.
Within the Dem@Care project a number of pilots will run, providing the technical partners with data relevant to develop algorithms. These algorithms are to provide insight into relevant physiological and lifestyle parameters of the person with dementia.

Student assignment goal

The student internship/graduation project aims at the analysis of measurement data obtained within the different pilots in the context of the Dem@Care project. Key in the analysis is the relation of the objective sensor data to subjective assessments for dementia as carried out by our project partners.

In the course of the project following points will need to be addressed:

- Get acquainted with available sensors through creation of own data sets based on available physiological sensors,
- Analyse available sensor data obtained through pilots within Dem@Care consortium,
- Defining features that are potentially of interest towards dementia,
- Development of algorithms for extracting features that are relevant for dementia using Matlab,
- Verify relation of extracted features to subjective measures for dementia,
- Report results.

Recruitment

We are looking for a student Electrical Engineering/Mathemathics/Biomedical Technology, with affinity with (biomedical) signal processing, who is currently studying towards his/her University Master's degree. The internship (or graduation) project will take place at Philips Research Europe in Eindhoven, the Netherlands. We expect the candidate to be available fulltime for the duration of the project.
The candidate should be enthousiastic, pragmatic, able to work independently. Affinity with technology and the target group as well as good communication skills are a plus. Creativity, commitment and a proactive attitude are expected and will be valuable in order to successfully carry out this project.
Students will be supervised and assisted by Philips Research staff involved in the research project.

Philips Lighting/Philips Research

19. Embedded SW Engineering

Supervisors: Pierre Peeters (Lighting), Eliav Haskal (Research)

Project:

Off-Grid Solar Powered DC Street Lighting System with Battery based Energy Storage

Background:

Philips has an installed base in PV powered Street Lighting Systems with Battery Storage.
Future developments in this technology consist of two main roadmaps;

Phase 1:

- Shift to higher quality and higher reliability battery systems like Li-Ion

Phase 2:

- Connecting individual poles into an intelligent, communicating system to enhance performance and reliability

Assignment Scope:

Phase 1 (battery):

- Define charge regime and safety settings for charging of selected Li-Ion technology
- Include safety settings for temperature and deep discharge
- Model the optimal settings for maximum reliability and lifetime
- Define the state machine for the Li-Ion charge cycle
- Implement above results in the appropriate embedded SW stack (either Gen2CC or BatManCC)
- Measure and model charge efficiency, battery State-of-Charge cycle and lifetime prediction
- Test and validate in High Tech Campus test poles (The Strip)
- Examine Business Case based on Li-Ion versus Lead-Acid technology

Phase 2 (communication, if time permits)

- Define scope of linking communication stack RS485 with remote management
- Build SW Stack and implement in demo setup
- Prepare demo with link to City Management System (CityTouch) for the test poles at HTC.
- Define Backbone structure to implement for:
- Intelligent System SW for group management of stand alone systems
- Failure and status reporting based on group performance

NXP Semiconductors (Eindhoven)

20. Network of low cost light sensors for people presence detection

Host institution: NXP Semiconductors, Eindhoven
Contact: prof.dr.ir. Basten

Project description

Modern buildings have complex light and climate control systems. Detecting people would bring many new options: better energy saving (e.g. better light control in unoccupied places), personal climate regulation, safety (e.g. locating people are during emergency situations) etc. NXP have newly developed building automation sensors that have only 5 light sensors that can measure infra read, ultraviolet and visible light. This gives a very low resolution image, 5 pixels. The question to be investigated is how a set of such small sensors can form a “distributed camera” system for person detection. The sensor will be part of a sensor network also designed by NXP providing a realistic test environment. The following two topics should be considered:

- Sensor fusion algorithms, i.e. “How to combine the sensors?”: probabilistic models are used for the sensor fusion. Distributed inference plays important role in sensor network settings.
- Distributed system architecture and requirements: Study the influence of the various detection schemes on the network traffic and power consumption. Study the trade-off between distributed or centrally performed processing. What influence does this have on the sensor nodes architecture?

21. Simulative analysis of automotive traffic shapers in Ethernet in-vehicular networks

Contact: prof.dr. Lukkien

Project description

Ethernet will soon be used as the main backbone for in-vehicular networking. This requires (1) the development of automotive-specific protocols that regulate the flow of data accessing the interconnect and (2) their subsequent implementation in the components of these networks. The goal of this project is the classification and characterization of the traffic shapers currently being proposed in industry forums for automotive applications (e.g. IEEE and AVnu). These analyses will include a characterization of the hardware implementation of each traffic shaper as well as the impact that these will have on the end-to-end communications between ECUs.

22. Distributed stream reservation for automotive Ethernet applications.

Contact: prof.dr. Lukkien

Project description

Ethernet will soon be used as in-vehicular network backbone connecting the main subsystems of a car. In such a scenario, critical and non-critical traffic streams will be sharing a single interconnect. The dynamic-stream reservation protocol defined by the IEEE 802.1AVB standard is a powerful technique that offers extreme flexibility in the configuration of the network at a price of a complex and error-prone approach. The goal of this project is the analysis of the reservation protocol via system-level simulation. Further the project considers the simulative analysis of possible automotive-specific optimizations targeted at the simplification and optimization of this protocol.

23. Transient errors resilient architecture exploration for Automotive safety critical applications

Contact: prof.dr. Lukkien

Project description

Transient errors can cause single bits to flip in an electronic circuit. When this circuit is deployed in safety critical domains such as automotive, aeronautics, and industrial automation, transient errors can have a severe impact. In the design phase of a circuit implementation, it is therefore essential to evaluate, and where necessary improve, the resilience of a circuit to all possible transient errors. The goal of this project is to study and evaluate: (1) the effect of transient errors on the system performance using analytical models, (2) possible, efficient mitigation techniques, and (3) different resilient circuit architectures.

24. Energy Aware Routing study

Contact: prof.dr. Lukkien

Project description

From a clean slate, find real world use cases that would only be feasible with battery (or energy harvested) powered end nodes and routers, e.g. humidity and temperature sensors in open field precision agriculture. Characterize the use case in terms of the network parameters (size, number of nodes, packet size etc.). Study literature for candidate energy aware routing algorithms targeted at embedded systems with limited CPU + memory. Simulate the network behavior in ns2 or ns3, identifying problems such as hot spots in the routing and, if possible, propose solutions.

25. Large ZigBee Networks

Contact: prof.dr. Lukkien

Project description

Typically ZigBee networks are built using embedded systems with limited (RAM) memory. In practice this means that the number of nodes in a network is limited by the sizes of the routing tables in memory. The assignment is to (1) investigate the trade-offs in ZigBee networks where the routing tables are used as a "cache" and dynamic route discovery is used on a "cache miss" and (2) to characterize the network behavior (e.g. latency, additional radio traffic, node energy usage, end-2-end reliability) using simulations in ns2 or ns3.

26. Network Planning

Contact: prof.dr. Lukkien

Project description

For WSNs in commercial buildings optimal node placement is a difficult and time consuming task, often leading to slow uptake of wireless networks in building automation despite their advantages. Assume an executable model is available that for a given floor plan calculates the signal loss from a transmitter at point <x,y> to any point on that floor plan. The assignment is to develop a tool that will calculate the viability of a ZigBee network where the node positions are assigned by a human. A possible, ambitious, second step is to investigate an algorithm for (near) optimal automatic placement of the coordinator and router nodes so that transmissions from the given sensor nodes are guaranteed to succeed.

imec/Holst

27. BTLE software power optimization

Host institution: imec/Holst, BTLE radio
Contact: prof.dr.ir. Basten

Project description

Holst Centre has designed a Bluetooth Low Energy (BTLE / BT Smart) radio transceiver, which can operate for a reasonable long period on a small battery. This project is part of a radio development and demonstration together with industrial partners. The project consists of power breakdown of the system w.r.t. software interaction with the

hardware (microcontroller and radio chips), implementation of low power features in the existing software, and demonstration of the power usage in different stages of the BTLE communication.

28. Sensor network for water quality

Host institution: imec/Holst, Integration team
Contact: prof.dr.ir. Basten

Project description

Dutch surface water is regularly checked; one of the parameters verified is the acidity level, pH. Ideally, the pH of surface waters is in the range 6.5-8.5. For instance, if the pH increases above 8.5, ammonium is converted to ammonia, which is extremely toxic for fish and plants. The acidity level is usually determined locally with a hand-held analyzer, or a sample is collected and subsequently analyzed in a lab. The goal of this project is to connect multiple sensors in a wireless network and to continuously monitor surface water or pool water quality at multiple places. Focus will be on the software and network protocol. A miniaturized pH sensor chip has already been developed.

29. Air quality gossip network

Host institution: imec/Holst, Integration team
Contact: prof.dr.ir. Basten

Project description

Holst Centre is developing a microsensor using a novel technology that allows the monitoring of NO_2 with a limit of detection lower than 20 µg/m3. In contrast, state-of-the-art microsensors are limited to concentrations above 100 µg/m3. The goal is to demonstrate reliable NO_2 monitoring using a network of sensor nodes in which the nodes can exchange relevant data (i.e. temperature, humidity, location, and NO_2 concentration) allowing increased accuracy by self-calibration and drift correction. This project assignment is part of a sensor system development. The assignment consists of theoretical study of ad hoc networking and proposing a proper mechanism for this application scenario. The sensor nodes are required to be added and removed dynamically. Developing a simulation framework or real implementation of software of the proposed solution is also included in the project.

30. Exploration of dynamic communication networks for neuromorphic computing

Host institution: imec/Holst, Integration team
Contact: prof.dr.ir. Basten

Project description

Holst Centre/imec-nl in collaboration with imec-be in Leuven are exploring future technologies like spintronic implementations of neuromorphic algorithms. Applications will have to run on several interconnected neuromorphic IC's. New communication strategies between these neuromorphic IC's are of interest. In this project we want to explore different options for implementing this communication network, starting from the requirements of the application and matching the properties of the silicon technology, especially in terms of the available interconnect options. We want to focus on highly dynamic and flexible communication networks that approaches as much as possible the communication flexibility that is available in the human brain, which makes our reasoning capability so powerful. Mathematics or Software Engineering students with an interest in network routing and/or neuromorphic applications are invited.

31. Multi-hop link demonstration in smart office

Host institution: imec/Holst
Contact: prof.dr.ir. Basten

Project description:
The newly developed long range ultra-low power 900 MHz radio is an ideal choice for the smart home/ office type of application. Operating at 900 MHz, the radio shows big link budget advantage over the 2.4GHz counterparts, besides the good sensitivity performance offered by the superior design from Holst. However, to combat with the multipath fading in the indoor environment, it is still very important to have the multi-hop option via the network layer. In this project, you will build up a routing algorithm interfaced with the ultra-low power in-house 900MHz radio. The main goal is to achieve stable and flexible link connection with low power consumption and less deployment of relaying nodes.

Chess (www.chess.nl, Haarlem)

32. Realistic radio model for MyriaNed wireless sensor nodes

Host institution: Chess, www.chess.nl, Haarlem
Contact: prof.dr.ir. Basten

Project description
In order to simulate the MyriaNed WSN network, we use the MiXiM OMNET++ framework. For MyriaNed there is a plugin available. The used radio model (uni-disc) is not realistic. The first step of this project is to investigate the availability of more realistic radio models (in the OMNET and MiXiM academic communities and elsewhere). Then adapt and/or implement the model in OMNET. It is also possible to use a radio model that is based on real-world measurements. In other words: record the real-world behaviour of the WSN and "re-play" this record in the simulator.

33. Developing simulation framework for WSN applications using MyriaNed

Host institution: Chess, www.chess.nl, Haarlem
Contact: prof.dr.ir. Basten

Project description
We have various real WSN applications based on MyriaNed in the field. We want to simulate these using the MiXiM OMNET++ framework, for which a MyriaNed plugin is available. The assignment is: Implement the WSN application in the simulator. This is a fairly simple task. Then simulate the application in various settings and conditions. Evaluate the result and compare these with the real world WSN. Things that will be investigated are: the behaviour of the flooding, gossiping and routing protocols.

34. Internet-Of-Things for MyriaNed

Host institution: Chess, www.chess.nl, Haarlem
Contact: prof.dr.ir. Basten

Project description
At Chess and in the field we have various real WSN applications based on MyriaNed. We have a lot of tools for the ongoing development of MyriaNed, but also for the development and analysis of WSN applications. These tools are: Eclipse based IDE,

simulator, sniffer (non-intrusive network observation), over-the-air programming and configuration, etc. On the host side of the WSN architecture we plan to use an "Internet-Of-Things" protocol, such as MQTT. (See: mqtt.org). The assignment is to investigate the use of MQTT for MyriaNed. If possible practical implementations and experiments of MQTT for MyriaNed can be carried-out and evaluated with physical WSN nodes at Chess.

35. Analysis and test of behaviour of real-world WSNs

Host institution: Chess, www.chess.nl, Haarlem
Contact: prof.dr.ir. Basten

Project description

At Chess and in the field we have various real WSN applications based on MyriaNed. We have a lot of tools for the ongoing development of MyriaNed, but also for the development and analysis of WSN applications. One of these tools is a tester. This device is able to generate real world radio traffic to stimulate the WSN. It can also observe responding messages from the WSN. The assignment is to carry-out various tests and analyse the results. Such tests can be: Analysis of timing and synchronisation behaviour of the nodes. Analysis of message integrity and experiment with various false and or spam messages. One of the ideas is to couple the real world WSN with the simulator, using the tester and sniffer devices.

36. Node counting in a distributed wireless system

Host institution: Chess, www.chess.nl, Haarlem
Contact: prof.dr.ir. Basten

Project description

Our wireless sensor and actuation network MyriaNed is a distributed system with mesh topology where it is important to have information about the neighbouring nodes. This assignement will analyse node counting algorithms by means of implementation and running experiments with many nodes.

TNO

37. Ad Hoc Network Architecture For Public Safety

Host institution: TNO, The Hague, or TNO - ESI, Eindhoven
Contact: prof.dr.ir. Basten

Project description

The world is brimming with cell phones, static and mobile sensors, and vehicles with sensing and computing resources. Most of these devices have Wi-Fi, Blue-tooth, Wi-MAX, cellular, RFID, and/or NFC available as access technologies. We see the potential of combining these devices in cooperative networks that allow us to sense and understand the environment around us. In this project, you will investigate how ad-hoc networks can be designed and implemented to increase the safety of crowded events, such as parades and festivals. The network will be composed of heterogeneous devices, such as smart phones, microcontrolled vehicles, and PCs; and communication interfaces, such as WiFi and Bluetooth. We want to tackle this problem by using an opportunistic communication approach. Your goal will be to conceive and implement/assemble a cross-platform software framework (middleware) that allows devices in the network to discover each other, negotiate resources, and forward data streams.

38. Simulation Techniques for Distributed Adaptive Systems

Host institution: TNO, The Hague, or TNO - ESI, Eindhoven
Contact: prof.dr.ir. Basten

Project description

Embedded and distributed systems are becoming ubiquitous : everywhere electronic systems are connected in an ever growing "network of things". At TNO, we investigate the design of such networked systems for application domains characterized by large scale, distributed, adaptive and high complex nature. For the design, we use a model based approach : a model expresses particular properties and behaviour of a (sub)system or process we are interested in while neglect others, which are considered irrelevant for a purpose. Models lend themselves for easy, cost-effective building and manipulation in computerised design environments, such as our in-house simulation tool DynAA. In this MsC project, you will investigate and develop techniques for the simulation of large, distributed systems. You will constantly be asking yourself how to translate the ideas of a system designer into an efficient and correct computation modules. Such modules are the basic blocks used in our simulation tool DynAA to analyse the behavior of large sensor networks, and to design the coming generation of embedded systems.

39. Presence Sensing for adaptive, robust, and cooperative buildings

Host institution: TNO - ESI, Eindhoven
Contact: prof.dr.ir. Basten

Project description

Buildings account for 42% of European energy consumption. In the FP7 project SCUBA, a consortium with among others ESI-TNO, Philips and Schneider Electric is investigating adaptive, robust, and cooperative building. Since presence detection is important for the energy efficient operation of a building, this project aims to investigate how a failed presence detection sensor (typically a passive infrared sensor) can be masked by a combination of other sensor readings (e.g., sound, CO2, humidity), historical presence patterns, and machine learning algorithms. A prototype experimental setup, i.e., instrumentation of a certain room with a set of sensors, and the setup of the data collection system is available. As a follow-up, there are various interesting directions that can be investigated. Comparison of various approaches for presence sensing that use multiple sensors and machine learning, investigation of new ways to combine live sensor data with historical presence patterns, evaluation of the accuracy of presence classifiers under incomplete information (e.g., one of the sensors failed) are examples.

40. Semantic Interoperability in Remote Patient Monitoring

Host institution: TNO, Delft
Contact: prof.dr.ir. Basten

Project description

A body sensor delivers the same bits of data independent of the application domain, but this data can have distinct purposes in different domains: heartbeat can carry an indication of health in the care domain or an indication of performance potential in domains of sports or entertainment. Semantic interoperability, therefore, requires not only sharing of data and concepts, but also positioning them in the specific purpose of the application for their appropriate use. This project can include requirements analysis (methods and techniques), and use of modeling languages such as UML, application development (design, programming and testing), and use of IDE's, knowledge- and

information modeling, and use of appropriate languages such as OWL, RDF, and service oriented paradigms such as web services, REST or others.

Internal projects

41. Wireless ad hoc sensor networks

Host institution: Electronic Systems group, Electrical Engineering Departments, TU/e
Contact: prof.dr.ir. Basten

Project description

Wireless Sensor Networks (WSNs) are networks composed of numerous wireless sensor devices, which communicate and cooperate with each other to acquire sensor data and process it aiming to perform some desired tasks. Health care, structural and environmental monitoring, urban supervision and automation, and precision agriculture are some applications of WSNs. These networks have specific characteristics that require scalable, power efficient, and secure architectures, and mechanisms. Potential topics for master projects or NES course projects include:

- ✓ Integrated WSNs and ad hoc network of android-based smart phones
- ✓ Techniques for designing dependable WSNs
- ✓ Real-time operation of WSNs for monitoring and control applications
- ✓ Reliable and secure architectures for very large scale automatic meter reading (AMR)
- ✓ Characterization of radio channel dynamics in public events
- ✓ Remote health and wellness monitoring using wireless body area networks

42. Ball handling mechanisms and strategies in mid-size RoboCup soccer

Host institution: TU Eindhoven, www.techunited.nl
Contact: prof.dr.ir. Basten

Project description

RoboCup is an international research and education initiative. It fosters artificial intelligence (AI) and intelligent robotics research by providing a standard problem where a wide range of technologies can be integrated and examined. For this purpose, RoboCup chose to use soccer as a primary domain. In a highly dynamic environment such as soccer, cooperation between multiple fast-moving robots requires a lot of new technologies. This leads to major innovations that society can benefit from. RoboCup consists of several different competitions, ranging from simulation leagues to humanoid robot leagues. The project is part of the Tech United Eindhoven Middle-Size League program, in which a team of five robots (called TURTLEs) autonomously play soccer. Ball handling strategies, including the handling itself, shooting and passing techniques, and cooperative strategies, are crucial for performance of a Mid-Size team. The project aims at improving both the intelligence and the speed of current ball-handling strategies.

43. Simulation of Drift Control for an Electron Microscope Stage using Image Processing in the Loop

Host institution: Department of Mathematics and Computer Science, TU/e
Contact: prof.dr. Lukkien (?)

Project description

The main objective in this research project is to develop a primary model for simulating the impact of drift during image acquisition process within an electron microscope and to propose a real-time closed-control loop scheme for compensating the effect of drift. Currently, a model exists that assumes perfect communication and zero delays. This project aims to adapt the model to make more realistic assumptions with respect to the distributed platform embedded in an electron microscope and possibly to create a prototype implementation.

Ericsson (Eindhoven)

44. Energy-aware buffer sizing for hard real-time streaming applications

Supervisor: prof.dr.ir. C.H. van Berkel
Coach: MSc. Hrishikesh Salunkhe

Project description

Dataflow (DF) is a well-known temporal analysis and programming model which is well suited to model concurrent real-time streaming applications. In dataflow, an application is modeled as a directed graph (DFG), where nodes (actors) represent processing elements and edges (queues with First-In-First-Out (FIFO) behavior) represent data dependencies. In Static Dataflow (StDF), actors have fixed execution times and they consume/produce fixed number of data items (tokens) from/on input/output edges. Moreover, StDF is equipped with techniques to verify real-time requirements such as deadlock-freedom and execution in bounded memory. In Dynamic Dataflow (DDF), actors may not have fixed execution times and fixed number of token consumptions/productions on edges. As a result, verifying real-time requirements for DDF may not be possible.

The computation of the minimum amount of memory needed by an application modeled as a data flow graph, to run without any deadlocks, is called buffer sizing. The problem of buffer sizing for real-time streaming applications, modeled as data-flow graphs, has been widely studied for various StDF flavors. One of the goals of the project is to extend the buffer sizing for Mode-Controlled Dataflow ([1], a restricted form of a DDF) which allows the same form of analysis as StDF.

Hard real-time streaming applications such as wireless transceivers, apart from having the real-time requirements, also have extremely low-energy processing requirements, as they typically run on battery-operated devices. Voltage and Frequency Scaling ([2], VFS) has been shown to be effective in reducing energy at system level by adjusting voltage and frequency, while meeting strict timing requirements.
The master thesis work is focused on studying the energy-aware buffer sizing for applications modeled as dataflow graphs i.e. to find a schedule that makes use of VFS to save energy, minimizes memory consumption through buffer sizing, while meeting strict timing requirements. The goals of your project are as follows:

- Extend the buffer sizing for Mode-Controlled Dataflow (MCDF).
- Investigate the effects of VFS on buffer sizing for MCDF.

References

[1]. O. Moreira, Temporal Analysis and Scheduling of Hard Real-Time Radios on a Multi-Processor. PhD thesis, TU/e, Eindhoven, NL, 2011.

[2]. P. Huang, et. al: Throughput-constrained voltage and frequency scaling for real-time heterogeneous multiprocessors. SAC 2013

The student is expected to have knowledge in:

- C, C++ and functional programming languages e.g. OCaml
- Embedded systems

45. Software defined radio, model transformation, data flow

Supervisor: prof.dr.ir. C.H. van Berkel
Coach: MSc. Alok Lele

Project description

The work on this project will be performed at Ericsson B.V. at the High Tech Campus in Eindhoven and involves modeling and analysis of state-of-the software architecture for a software defined radio (ex. 4G LTE) mapped onto a heterogeneous multi-processor hardware platform.

Data flow is a suitable approach for modeling and analyzing event based streaming application such as software defined radio that exhibit concurrent execution of asynchronous tasks conditioned by intra and inter-iteration task dependencies. On one hand data flow can be used as a programming paradigm for modeling the functional behavior of the application. Meanwhile, data flow is also used as a timed automaton to model the execution behavior of the application for analysis purpose.
Currently we use two distinct tools to support modeling and analysis of software defined radio applications. **CALtoopia** is a tool support for the data flow based functional modeling and code generation of an application while **Heracles** is used for the platform mapping and timing analysis.

CALtoopia is based on the synchronous data flow programming language CAL while Heracles uses a much more restrictive model and therefore enables predictive timing analysis.

The aim of this master's thesis is to develop a model transformation technique for extracting restrictive timed data flow models for Heracles from the functional models written in CAL. The project involves defining the model transformation rules as well as automating the transformation process. This also involves identifying the limitations and proposing novel abstraction techniques to enable conservative timing analysis.
The goals of your project are enumerated as follows:

- Define the transformation rules from functional CAL models to timed data flow model
- Identify the limitations in the model transformation and propose conservative abstractions
- Demonstrate the automation of the model transformation including the abstractions

References

[1]. Temporal analysis and scheduling of hard real-time radios running on a multi-processor (http://www.tue.nl/publicatie/ep/p/d/ep-uid/259742/)

The student is expected to have knowledge in:

- Any functional programming language
- Embedded systems

46. Image analysis, vision, smartphones, vector DSP, multi-core

Supervisor: prof.dr.ir. C.H. van Berkel

Problem Description

Image analysis (vision) is seen by many as the basis for the next wave of applications in smartphones. Amongst others it will enable augmented reality.
Image analysis algorithms are highly diverse and still rapidly evolving. Essentially there are no bounds to the computational resources that can be spent on these algorithms. Today's smartphones, even those with four ARM™ cores, can only support simple algorithms.

The goal of this thesis is to explore the possible off-loading of image analysis kernels from ARM cores to (multiple) embedded vector DSPs. It is expected that for many algorithms a speed-up can be achieved of one to two orders of magnitude.

Questions to be addressed include:

- Which image analysis algorithms map well to a vector DSP, and why (why not)?
- … and by how much?
- What are the major limitations of the vector DSP in this mapping?
- Which modifications to the vector DSP would improve this mapping?
- How should the ARM and vector DSP cooperate? Memory hierarchy?
- How does this scale with multiple vector DSPs?
- …

The student is expected to have knowledge in:

- Hardware architecture
- Embedded systems