De Vonk

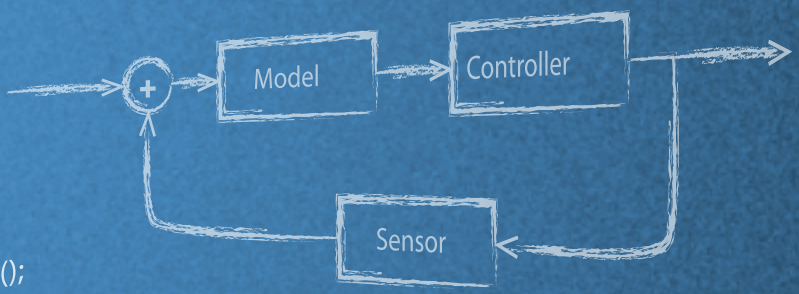
Periodical of E.T.S.V. Scintilla

Main Article

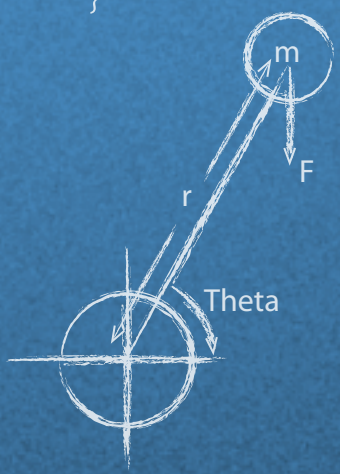
Model-driven development of robot software

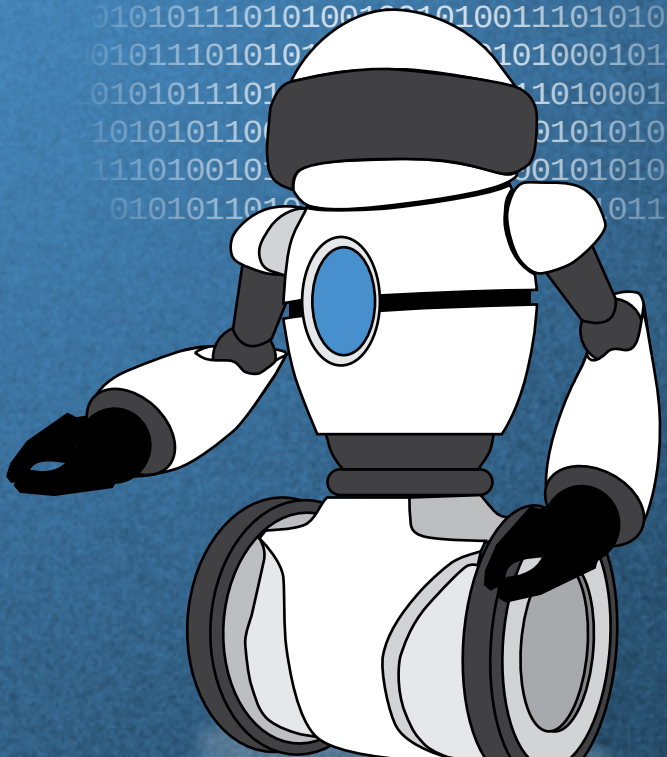
Promovendi

A bio-inspired hair-based acceleration sensor




```
int main(void) {
  int angle;
  while(1) {
    angle = readSensor();
    ...
  }
  return 0;
}
```





Year 32 | Edition 4 | September 2014

A new year

Author: Robert Fennis

Dear members, as of this moment, I am hopefully no longer the president of this beautiful association. After a full year of working hard together with my much respected companion, it is time to continue my study. If everything went right, Scintilla has now 6 new board members. Since they will be reading this as well, I wish them the best of luck!

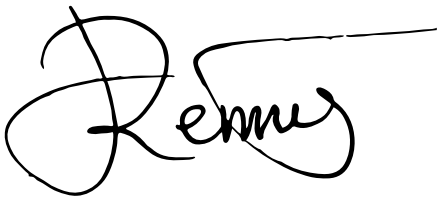
Let me start by thanking everyone who supported us during this heavy year by for example, cleaning their dishes and helping out with the routine tasks. A board member of another association once asked me if they could have our members because they actually clean the balcony. I am proud to have been the president of this specific association. First of all, we have a relatively large percentage of older active members who are experienced and have a sense of responsibility. This makes running an association a lot easier. Besides the older group, I also notice that our younger group of students is picking up on the responsible behavior. Again, thank you for being such an amazing group of students!

Besides a new board, there is a whole new group of first year students. To them, this story might not make a lot of sense. To summarize it for them: previous year we had to run this association with just two board members. In order to help us through this, the active members of this association helped us out by doing some of the choirs. Active members are members of Scintilla who do committee work. For example they help to organize events or maintain our servers. There is a lot to learn from being an active member and it doesn't necessarily have to consume a lot of your time. And besides the learning experience, it is also a lot of fun!

If I am right, there will be an activate lunch soon. During this free lunch, you will be able to learn about the committees while enjoying some free sandwiches. It is totally free of obligations.
Anyhow, since I am writing this in the midst of our exam period, most of you will have had a nice summer vacation and some even participated with the Kick-In. I hope you had a lot of fun.

For the international students: Welcome in Holland! I really hope you will have a great time here. It must be an incredible culture shock for you. To you I have to say only one thing: if you ever have any questions at all, feel free to come by the Scintilla Room and ask them to us. E.T.S.V. Scintilla is a group of volunteers who are here to help you with your problems. However, in contrast to a lot of other cultures, help doesn't come to you in Holland. That doesn't mean that nobody is willing to help you. You just have to ask for it yourself. This might be a little difficult at first but hopefully you will get used to it!
With that being said, I have to finish up this final message by saying this line one last time, planted into the future:

Dames en heren!
Op de koningin! Op Scintilla!



Robert Fennis
President

Start new academic year
Monday 1 September
08:45h, Twente University

General meeting Scintilla
Tuesday 2 September
20:00h, Citadel T300

Constitution drinks
Thursday 4 September
16:00h, Abscint

Scintilla dies
Tuesday 9 September
16:00h, Abscint

BSc. graduation ceremony
Friday 10 October
TBA, Waaier

Christmas dinner
Thursday 18 December
19:00h, Edu-café

Masthead

De Vonk

Periodical of E.T.S.V. Scintilla.
Published four times a year in the amount of 700 copies.

year 32, edition 4
August 2014

Editorial team

Tim Broenink, Erwin Bronkhorst, Arno Geurts, Fieke Hillerström, Maikel Huiskamp, Vera Nauta, Ewoud Vissers, Rowan de Vries.

Print

Gildeprint, Enschede

Editorial office

E.T.S.V. Scintilla, University of Twente,
Postbus 217, 7500 AE Enschede,
0031 53 489 2810
0031 53 489 1068
vonk@scintilla.utwente.nl

Material

vonkkopij@scintilla.utwente.nl

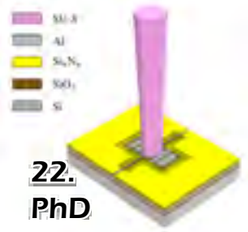
All members of Scintilla receive De Vonk free of charge by post.

ISSN 0925-5421

A promising way of developing software is a model-driven developement method. This is a new way of designing a software system by describing the model instead of the actual code in, for example, C or Java. At the RAM group, research is done on this model-driven design method in the application of robotics. In this article, you can read about the current state of the research. The article covers the way of working and the supporting tools.

A few months ago, the Shell Eco-marathon took place in Rotterdam. A team from the University of Twente was present and they tried to win the competition. Sander writes in this article how the day was filled and how the match went for the team.

A lot of things in technology are inspired on what nature has to offer. Harmen just got his PhD on this subject. He developed some sensors based on the 'sensors' that animals have. In this article, he describes an acceleration sensor which is based on the clavate hairs of crickets. These animals are able to sense very low variations in air acceleration to detect hostile predators. Can the technique of these animals used in artificial technology?



Like every year, in the last quarter of the year the B2 project takes place. In this project, second year students work in teams on a large design assignment. In this edition of the Vonk, 5 groups write about what they have done in the last weeks of the college year. From cycling to skimming and from wireless monitoring to 3D printing: very different applications are discussed in this article.

Editorial

Relief

The summer holiday is coming, or by the time you read this it has already begun. At this point in time I can barely image the relief that must come with it. The end of another academic year, the promise of the 85th board relieving the 84th and the end of the quartile of death in the second bachelor year. More that enough reasons to feel relief. So take a moment to feel the relief you deserve after a nice, long intensive academic year 2013/14 at the University of Twente. Feel free to allow yourself to feel the relief.

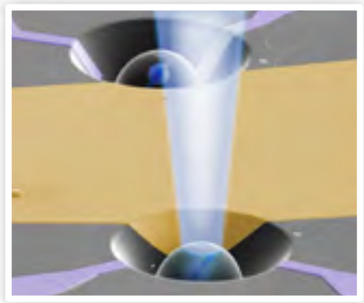
In my personal case I most definitely feel relief because I am being relieved from my functions in the Lecture & EXcursion committee, de Vonk, MEEKI, study tour and company contact committee. That is approximately ten hours of relief each week, forty weeks a year. I will miss the activity and 'gezelligheid' of those committees, but I leave them in the capable hands of those relieving me of the responsibilities. And what do you feel relieved about? No more BSA fear? Finished B2? Bachelor assignment completed? Arranged an internship abroad? Or maybe in the Netherlands? Never taking exams again? Just a couple of reasons to feel relief this summer!

And while you are feeling relieved, why not consider becoming a bit more active? After all, committees are awesome and do not take a lot of time. Or if they do, like the study tour, then I dare say, promise even, that it is more than worth it! The same applies for our Lustrum committee; did you know we will be 50 years old in September 2015?! I will most certainly participate, facilitate and provide relief!

News for the electrical engineer

Author: Maikel Huiskamp

Dutch scientists teleport data for the first time



Would it not be amazing to be teleported directly to another location? Unfortunately this seems to be impossible by the laws of physics, but for information this is a completely different matter. With the help of quantum mechanics, researchers from the TU Delft have succeeded in deterministically transferring information from a contained quantum bit to a different quantum bit three meters away.

To achieve the teleportation the scientists made use of entanglement. When two particles become entangled, their identities merge: their collective state is precisely determined but the individual identity of each particle disappears. Both particles are one, even when separated over a large distance.

To achieve the teleportation of information diamonds are used because in this material "mini prisons" for electrons are formed whenever a nitrogen atom is located in the position of one of the carbon atoms. The fact that the mini prisons can be observed individually allows the study and verification of individual electrons and even single atomic nuclei. The entire experiment is done in materials that can be made on chip, which allows integration in future technologies.

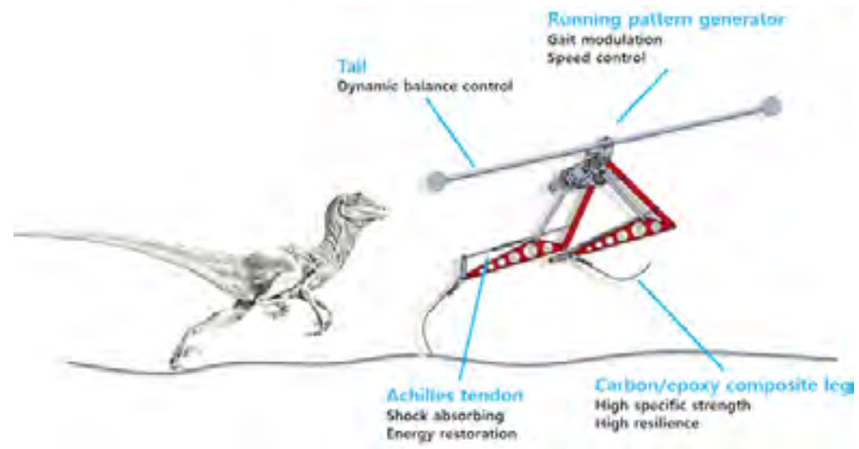
The group from Delft is the first to succeed in teleporting information between qubits in different computer chips. The unique thing about their technique is that it is guaranteed to work 100%. The technique is an important step toward quantum networks and future communication networks.

Source: http://tinyurl.com/vonk3241

FPGAs are filling data centers

After a test period of a bit more than a year, Microsoft has decided to use FPGA hardware instead of traditional CPUs in the hardware that services the Bing search engine. The new hardware setup will consist of 1.632 servers, each with an Intel Xeon CPU and an FPGA of Altera. Microsoft claims that the FPGA is able to use Bing's algorithm 40x faster than a CPU. With this network, Microsoft expects the search engine to become twice as fast as the engine is today.
Short after this news, Intel announced that they will start producing Xeon processors combined with an FPGA. Intel aims at the datacenter market and the chip has to compete with ARM processors. It is not confirmed that Microsoft will use this new chips of Intel for their Bing search engine, nor that an Altera FPGA will used. However, it certain that the industry moves to programmable hardware to keep up with the increasing demand of processing power.

Source: http://tinyurl.com/vonk3242



Velociraptor inspired robot developed

A lot of time and effort has been spent on researching fast running robots with powerful legs. Several of the already existing solutions are based on things we find in nature. Now scientists from the Korean Advanced Institute of Science and Technology have developed a new sprinting robot inspired by velociraptors.

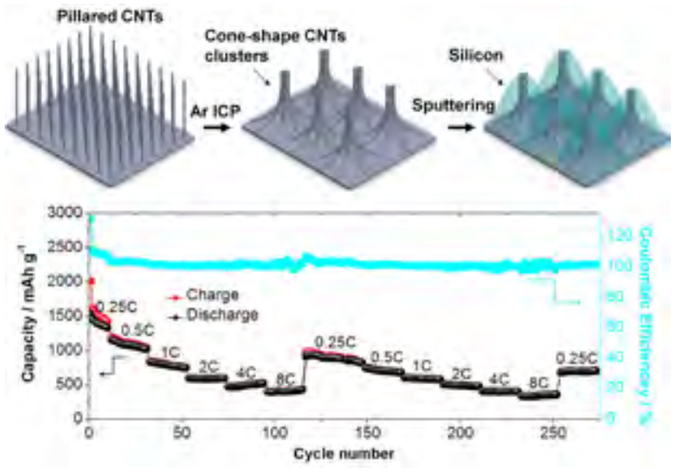
The robot called Raptor has two legs and a mechanism that mimics the tail movement of a velociraptor. The tail is needed to help the robot maintain its body stable while it is stepping over obstacles. A recent video shows that Raptor can progressively increase its speed until it reaches it mark speed of 46km/h.

Using a tail for stability is not a new idea in robotics since the cheetah inspired quadruped from MIT also has a mechanical tail. What makes Raptor unique is that It is a relative simple design. Unlike other legged robots Raptor only uses one motor per leg. To recover part of the energy used to make the robot move Achilles tendons were added to absorb and restore energy with every step.

The control system used is also quite simple. Raptor runs on a computer program known as a running pattern generator, which control gait and speed. At the moment the KAIST team is still working on improvements to control and stability.

Source: http://tinyurl.com/vonk3243

New fast charging technique for lithium-ion batteries



Researchers from the University of California have developed a new technique that could fast charge lithium ion batteries in 10 minutes instead of hours. They have created a tree-dimensional silicon decorated cone-shaped carbon nanotube cluster that could replace the commonly used graphite anode. The silicon anodes have a charge capacity that is 10 times higher than the graphite ones.
The new batteries show a high reversible capacity and excellent cycling stability compared to the graphite batteries. The new architecture also demonstrates excellent electrochemical stability and reversibility even at higher charge and discharge rates

Source: http://tinyurl.com/vonk3244

The educational committee

Author: Rowan de Vries

The past few years a lot of educational reforms have been made, and more are coming with the TOM going into the second year after the summer holiday. Despite some reservations students have about this TOM we are monitoring and influencing the changes. One of the committees with influence for both employees and students is the educational committee (OLC). Any and every change of the educational program of EE is discussed in their meetings, in the rest of this article you will find some of the issues considered.

What does the OLC do?

The Dutch law states that each educational program must have an advice organ in which an equal amount of students and teachers must participate. The most important task is reporting about the education and exam regulations. On top of this the OLC advices the OLD on the current execution of the education. Examples of stuff I have seen pass during these meetings the past few months are the proposed modules for the second year TOM, changes in master subjects, complaints about bachelor subjects, an evaluation by master students and the Teaching and Examination Regulations (OER) for the EE bachelor and master, including whether or not it should always be okay for students to take the exam paper home after making it.

Why should students NOT be allowed to keep an exam paper?

The OER passed trough the OLC for the academic year 2014/15 with only minor adjustments compared to 2013/14. A point of discussion however was whether or not students have the right to keep an exam paper after finishing the test. As a student I was personally in favour. Now some tests are publicly available, via the Scintilla website, and some are not. This leads to the situation were it is hypothetically possible that a student illegally makes a copy of a test, and distributes it to a few friends. Tests usually look a lot like previous tests, as the same material is given each year. In the above mentioned case the friends of the spy have an unfair advantage over those who have do not have access to the extra material. On top of this possible weakness in the current system it looks like a teacher has something to hide, otherwise why hand in the exams? The counter argument was illustrated by the following case, an international student who has no social connections yet wants to take a test but can not be physically present on the real test moment. The next day this student makes the same test as the others made yesterday, no problems, no need to make a new exam for one person. Additionally it gives serious restrictions in the freedom of re-using (very) old exam questions, making life more difficult for certain teachers. In the end it was decided that it should not be a given right that students may take their exam papers home. I hope the OLC will reconsider this question next year.

Year. Quartile		Module (+indication of what subjects it replaces)
2.1		Computer systems • Fundamentals of Digital Logic • Computer organization • Computer Systems
		Linear Difference and Differential equations
2.2		Systems and Control • Linear Systems • Control Engineering • Engineering System Dynamics • Mechatronics Project
2.3	choice 1	Device physics • Mechanics and Transducers Science • Introduction to Semiconductor Devices • Optical Basic Functions and Microsystems • Realization in materials
	choice 2	Computer Networks
2.4		Signal Processing and Communications • Introduction to Communication Systems • Probability • Random Signals and Noise • Embedded Signal Processing

Table 1: Indication of lecures per module in the second college year

> "I am a bit sceptical about EEers who know nothing about silicon"

What will the second year TOM look like?

Even though it starts in September not everything appears to be publicly known yet. A global indication of what sort of lectures to expect in what module can be seen in table 1. However, as every student who has (nearly) finished the bachelor will tell you, it would be impossible to complete all the subjects in Q2 and Q4 if no adaptions are made to the program. At the time of writing some hopeful signals have been received on merging parts of the old subjects into coherent modules. Another remarkable new development is the choice module in the third quartile. As a normal/conservative student I am a bit sceptical about EEers who know nothing about silicon , but I guess this does allow for more specialisation in the Bachelor. If you are now thinking what courses are left for in the third year, take a moment to think about it. That is right there are none left, in the third year TOM a minor like system will be implemented for Q1 and Q2. Students will (probably) be allowed to choose two different modules, which can be in the depth of EE or like the current minor system a module to broaden your horizon. Much is still in development, so who knows how it will all work out. One thing is for sure, all the committees for educational quality and complaints will definitely keep an extra watchful eye on the modules coming year.

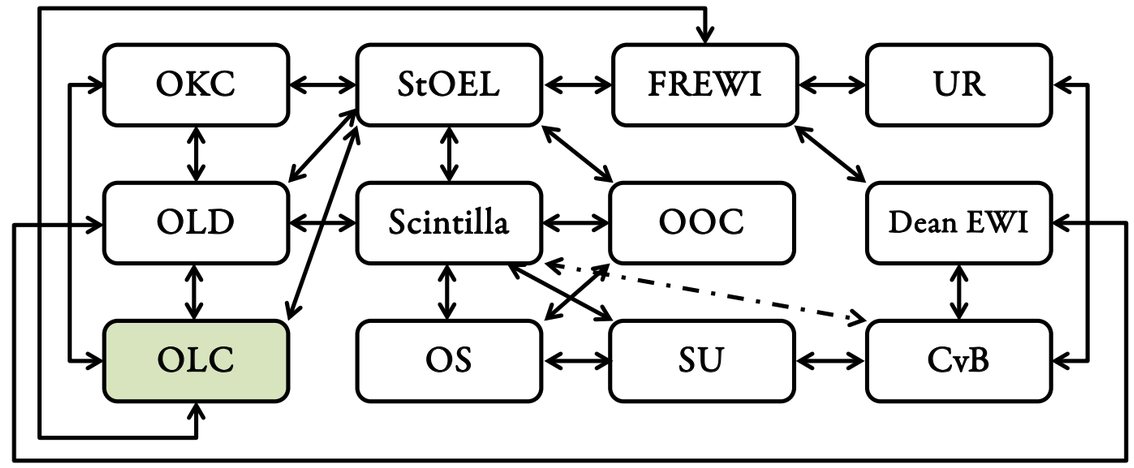


Figure 1: The position of the OLC in the educational picture

Model-driven development of robot software

Author: Jan F. Broenink

In this text, the current research on model-driven design of embedded control software for robotic applications is presented. A Model-driven way of design asks for a structured approach using models and models of models, or meta models. Model-driven design of robot software supports efficiency of the design work, which is really necessary as the high-tech industry is in need of faster development of higher quality products. We use an integral approach where both the discrete-event part and the continuous-time part of a computer-controlled robot is modeled. Both a way of working and supporting tools are being developed. The current state of this development is presented.

1. Introduction

Robots are mechatronic machines and are basically computer-controlled mechanical systems. As such, they are also a specific class of cyber-physical systems. The cyber part and the physical part clearly influence each other: the dynamics of the machine dictate how and how fast the computer has to respond, and in the software the steering values for the actuators are computed. Hence, for describing these systems, both parts need to be modelled integrally.

For the description of these two different parts, two main Models of Computation (MoC's) are used: a continuous-time MoC for the dynamics of the physical part, and a discrete-event MoC for the embedded control software. The synchronization between these two parts is time, the independent variable in both description forms.

In modern development of embedded control software (ECS) for robots, Model-Driven Development (MDD) [1] is used, which reduces the distance between a specification and a software realization [2]. This efficiency is really necessary, as industry demands for an effective way of working, allowing shorter time to market and better quality products. New products or versions of products need to be produced in a shorter time than before, and complexity, versatility and configurability of products increases. The latter group especially being realized through embedded software. Furthermore, in reaching a better quality and dealing with the safety-criticality of the embedded software, fault tolerance and error / exception handling must be taken into account.

The above calls for an iterative development, and an early integration of models of the different aspects of the total system. Such a way of working must, of course, be supported by a software tool chain, that supports a stepwise refinement from the global models towards detailed models, from which the embedded control software can be generated. Manual coding steps should be avoided, as those easily introduce errors.

In this paper, the current status of the work on method and tool development for model-driven development of embedded control software (ECS) for robots, as conducted at RaM is discussed. The method is on stepwise refinement of models of the total system such that the embedded software can be generated from the cyber part. The supporting tools are developed using a meta-modelling approach. Meta-models (i.e. models of models) specify the expressiveness of the models, and are also used to generate the software tools, using Eclipse-based tool generators / development workbenches, like EMF, GEF, Encore [3, 4].

The development method is discussed in Section 2, and the tools and meta models are discussed in Section 3. In this text, we use regularly material from relevant PhD theses from our group, especially Maarten Bezemer's thesis [5]. Also several drawings in this paper are used in the course Real-Time Software Development.

2. Development Method

2.1 System architecture and Models of Computation

The overall system architecture is presented in Figure 1, showing the physical domain at the right, consisting of the plant and the signals part of the I/O; and the cyber part at the left, as the computing part of the I/O and a layered structure of controllers, organized by its real-time demands. This figure has evolved over the years, showing ongoing insight [6, 7, 8, 9, 10]

For the continuous-time MoC we use bond graphs that are a domain-independent notion to describe dynamic systems behavior [12, 13, 14], based on energy exchange. For simulation, bond-graph models are made computationally explicit and represent ordinary differential equations. Numerically solving them is simulation. For this, good tools exists, like 20-sim.

For the discrete-time MoC we have worked the last few years with two different ones. The functional language VDM, a formal, object-oriented specification language with timing extensions [15, 16]. It is a textual language with the flavor of C++ and functional languages. We used this in the DESTECS project. The other discrete-time MoC is a graphical CSP (Communicating Sequential Process) [17], a dataflow diagram based on the process algebra CSP [18, 19]. Communication between Processes is waiting rendezvous: processes wait on each other when engaged in a communication. This allows for formal checking of absence of life lock and deadlock, giving some quality to the resulting network of processes. Currently, we use the gCSP MoC.

The synchronization between these two parts described in different MoCs is time, the independent variable in both description forms. This synchronization is used in, among others, co-operative simulation of the DE and CT model parts. Note that in hybrid systems research, a combined DE and CT system is described as one formulation. [20, 21]. This gives room for mathematical reasoning about combined systems.

As the topic of this paper is development of embedded control software, we focus on the DE part, although the other parts need to be kept in mind, due to the mutual influence of these parts.

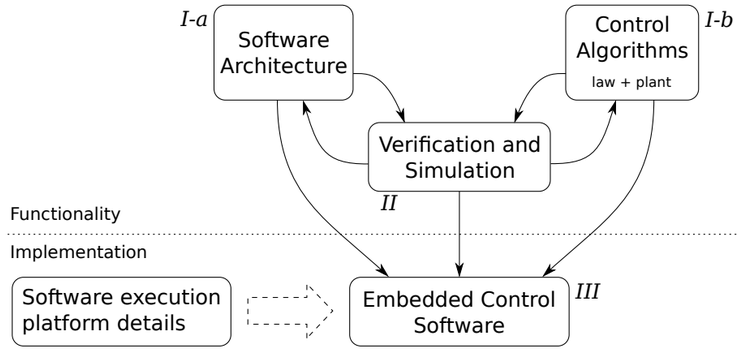


Figure 2. Overview of the embedded control software development approach [5, Figure 3.1]

2.2 Embedded Control Software Development Approach

Figure 2 presents an overview of the proposed Way of Working (WoW). It starts

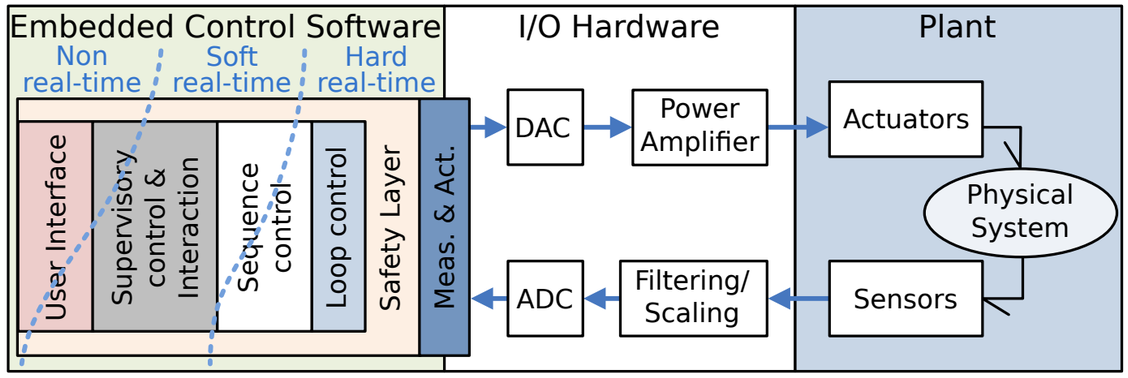


Figure 1: System architecture of a cyber-physical system [5, 11]

with designing the software architecture and the control algorithms using a plant model simultaneously. Using a model-driven approach, via verification and simulation techniques, models of the architecture and algorithms are developed. The embedded control software is constructed by combining the software architecture and algorithms with implementation details of the computing platform.

More detail of the WoW is given in Figure 3, where the involved physical domains are indicated. Each domain gives an entry point to the WoW. Electronics design and Mechanics design are dimmed in the Figure, because the focus is on the embedded control software design. However, some knowledge about the design in those domains is needed to design the software.

One can start with the software architecture (b in Figure 3) or modeling of the plant part (d in Figure 3), depending on the problem at hand (complex sequence / supervisory control logic versus complex loop controllers / plant dynamics) or the experience / background of the developers. When starting at one side, the other side may be worked on simultaneously, or added later, in step 2. In the DESTECS project, we called these approaches Contract-first, DE-first and CT-first respectively [23]

Step 1 and 2 are the functional design: via global architecture and modeling of the dynamic behavior of the plant, the embedded control software structure and algorithms are designed and tested against the dynamic model of the plant (called a virtual prototype). Step 3 and 4 deal with the implementation: details needed for code generation, like timing, signal converters, target-specific drivers, are added. Tests are still against the plant model, first in normal simulation, and later in real-time simulation (Step 3b). Finally, the plant model can be exchanged by the real plant, and the embedded control software can run first-time right.

Step 1, branch b is on designing the ECS software architecture: to produce the overall structure of the foster, and to build software placeholders to place control algorithms in. When in this stage the plant behavior is needed for testing, it is enough to mimic the plant by a stub that later will be replaced by a connection to the plant model. The DE MoC is not so suitable for describing the plant model.

Step 1, branch d is on designing the control algorithms using a competent model of the dynamic behavior of the plant. Different plant models can be made, with different levels of detail, as the plant models have different goals, namely design support, to check the feasibility of design choices; control law derivation; and testing the system, using the plant model as a virtual prototype of the plant mechanics. Clearly, these goals ask for different aspects and different levels of detail of the models, allowing for refinement of the plant model(s) throughout the whole design process.

Step 2, branch b deals with supervisory and sequence control logic and higher-level safety measures (like graceful degradation). This is filling in details in the software architecture from Step 1. When the stub-like plant model is not sufficiently competent anymore, one needs the model from branch d, so one has to move to Step 3.

Step 2, branch c is on designing the loop control algorithms and tuning them, using the plant model of branch d. These control algorithms can directly be formulated as discrete-time algorithms or first as continuous-time algorithms and later converted to discrete time. The latter is the more classical controller design approach. The result must be a (set of) discrete-time algorithm(s), as the implementation of it is on a digital computer. Verification of the control laws is done via simulation, using the plant model of Step 1. This step follows the exiting approaches in control law design.

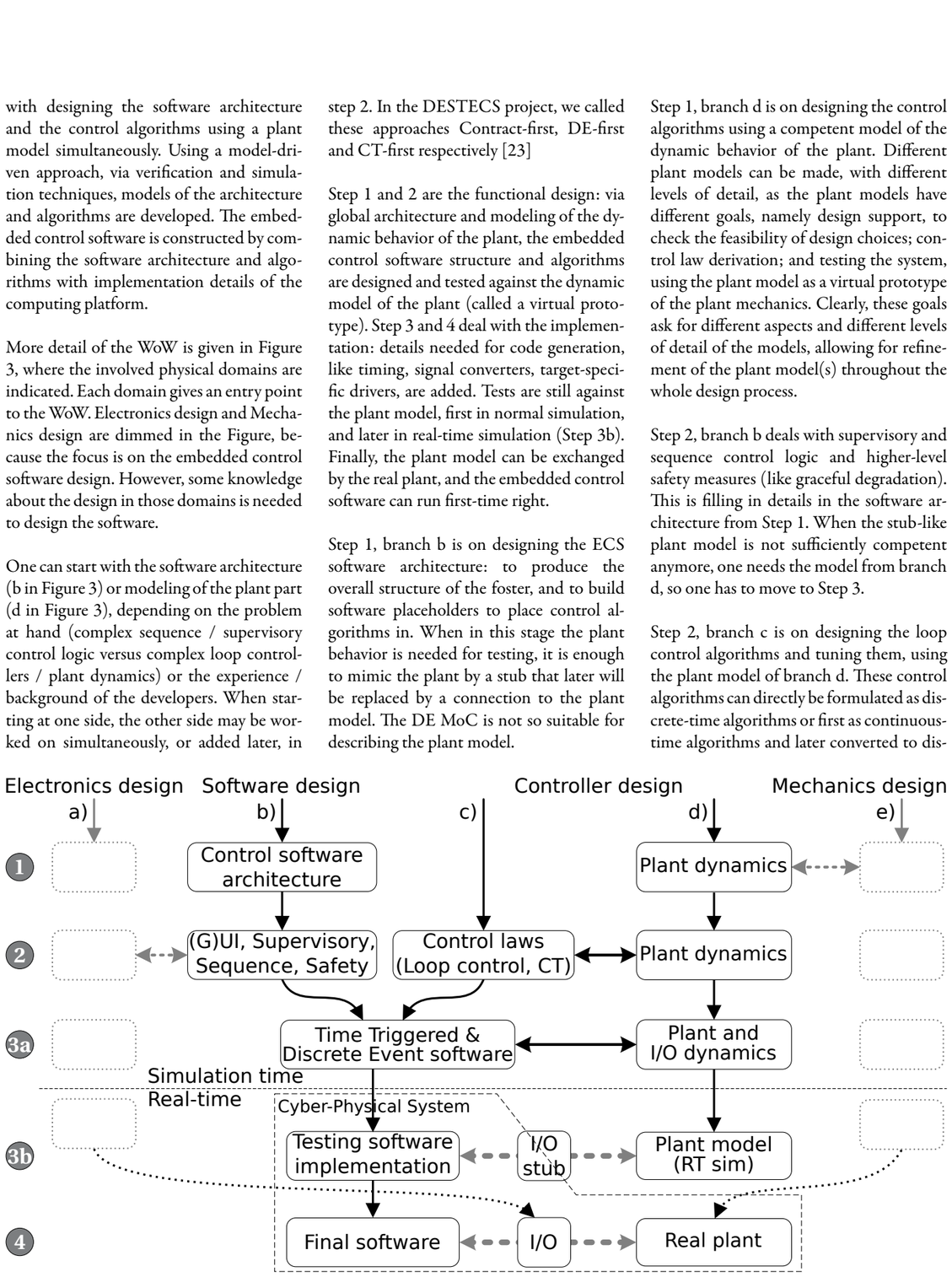


Figure 3. Way of Working to design embedded control software [5, 9, 10]

Step 3 deals with combining the two design branches, focusing on implementation of the control laws and software architecture resulting from Step 1 and 2. Step 3 is a refinement process towards realization as a first-time right activity. Spending more time in Step 3, saves on-target testing and debugging in Step 4, which is harder than testing the models in simulation or in a test environment. Furthermore, integration issues and problems in Step 4 are also prevented. The bottom line is that the overall design time in general is shorter.

In this refinement process, the following aspects are considered:
1. Integrating the control laws with the supervisory etc. control logic and other computations. Test especially hand over between logical situations, which should go smoothly at the plant side. Reactions to external commands can also be tested. In this phase, the implementation of all the algorithms is assumed ideal.
2. Add safety, error handling and maintenance facilities. Safety and exception handling are on all levels of the layered control structure: some aspects can best be handled locally (obstacle avoidance for a mobile robot) while other aspects need a system-wide treatment (graceful degradation, i.e. bringing functionality down in a controlled way).
3. Detail out non-idealness of components, to take the effect of not being ideal enough into account. Effects of these refinements can be tested in simulation, to avoid unnecessary issues in the realization phase in the end. Estimators for those signals that cannot be measured in the real plant can be added and tested.
4. Deal with effects due to the non-idealness of the target computer hardware, i.e. latency, jitter, accuracy. Algorithms might need to be optimized with respect to memory usage and computation time.
These 4 issues do not need to be treated in this order, although mostly issue 1 is done first and issue 4 last.

All parts that eventually are realized as software should be described in the discrete-event MoC and those parts that are realized in the physics domains should be described in the continuous-time MoC. This indicated how the I/O parts as shown in Figure 1 should be divided over the DE and CT parts of the model. Carefully doing this makes the transition to Step 4 easy.

Step 3b is the real-time implementation of the ECS. It is to test whether the planned target embedded computer can run the designed software. Timing constraints can be checked here. For testing and debugging purposes, one can first use a more powerful target computer, as the monitoring and test software also consume CPU cycles, memory and network bandwidth. After this testing, a final test can be using the final target computer(s).

Step 4 on realization, is actually only exchanging the plant model (virtual prototype, also called virtual machine) with the real plant. Obviously, this can only be done straightforwardly, when in Step 3, the I/O is correctly partitioned over the DE and CT parts. The interface between these DE and CT parts must be exactly the same as the final real hardware offers.
The dashed lines in Step 4, Figure 3 represent the results of the Electronics and Mechanics design, i.e. the I/O electronics and the plant. The embedded control computer mostly is a commercial off-the shelf component.

3. Tools and Tool Coverage

As the method is a Model-Driven Development method, tool support is inevitable. Several tools are available, but do not cover all aspects in the way we want. They either lack a meta-modeling support to structure models and thus the design of the tools, or lack proper modeling support to interact with the hardware, or do not provide software architecture modeling capabilities. Our own development does fill some gaps, but cover not all relevant aspects yet.

Eclipse EMF [3] is tool that supports meta-modelling extensively. It is suitable as a framework to support tools that are mea-model based, but it does not have facilities to interact with anything others than those (meta-)models. However, the tool building capability using meta-models is such that we use EMF, using its Ecore meta-model, to construct our design tool TERRA.

Matlab / Simulink, LabView and 20-sim are tools that do support interaction with I/O hardware, support MDD, but do not support proper software architecture modeling. Component-based Software Development is currently used in robot software development research [24, 25], and frameworks supporting reuse of large-grained robot software parts are available, like ROS, Orocos and SmartSoft [26]. Separation in to concerns, separating the algorithm from the connection and network is supported. However, these frameworks do not at all guarantee hard real-time performance, except for the Orocos RTT module.

3.1 ECS design tools at RaM

At RaM, next to using MDD for robot software, we also develop tools to support our MDD techniques, and thus further develop the techniques.

For the continuous-time MoC, we obviously use 20-sim, which started as a bond-graph simulation package only. Later controller design and code generation was added. Deploying the generated code on a single target embedded platform has been developed resulting in the tool 20-sim 4C, Note that for testing of controllers in a continuous-time MoC supporting-tool can be done using any continuous-time simulator with a proper tool interface to the discrete-event simulator being used.
For the discrete-time MoC, we have used three different types of tools, each supporting a different DE formalism.

In the EU project DESTECS (www.destecs.org), we have used the tool Overture, which supports VDM and provides co-si-

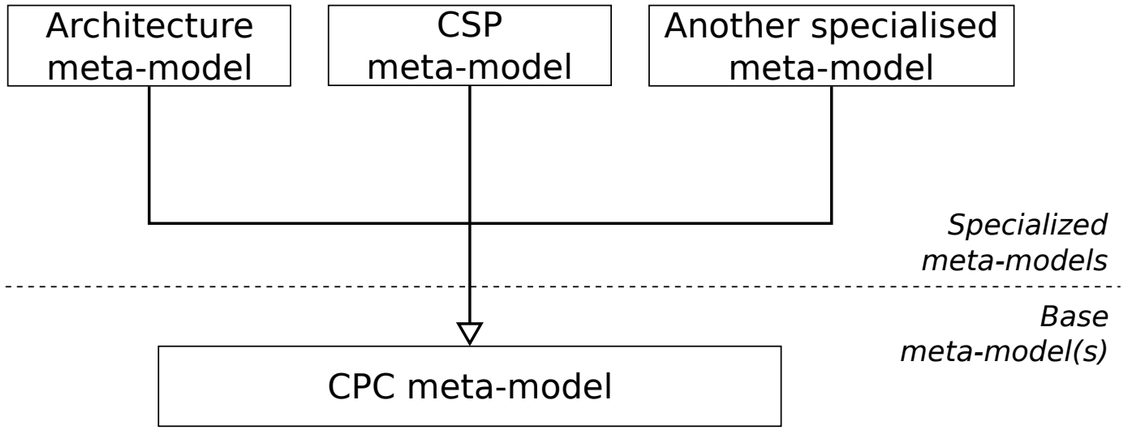


Figure 4. Inheritance diagram of meta models [5, Figure 3.6].

mulation with 20-sim and also with Matlab / Simulink, via the tool Crescendo. VDM is a textual language. Despite its functional-language facilities, its structuring for robot software is quite insufficient. Due to the nature of the existing discrete-event simulator, co-simulation for embedded control software is rather slow. The DESTECS project, however, gave a lot insight in co-operative and collaborative modeling [27].

In the STW project ViewCorrect, we did a test using POOSL [28], the parallel object-oriented description language developed at the TU/e. We have modelled our production-cell test case in POOSL, and generated code for its PC104 RT-Linux control computer [29, 30]

In the BRICS project, we have worked on tool integration between 20-sim for the algorithms and the BRICS architecture editor BRIDE [31]. The conversions between 20-sim and BRIDE are designed such, that the 20-sim part is reused for the conversion from 20-sim to TERRA. The 20-sim code generation produces C files of the model embedded for use with TERRA / BRIDE. Another conversion is started from within the TERRA / BRIDE environment, to incorporate this 20-sim generated code as submodel in TERRA / BRIDE. Extra glue code and diagram parts are generated to elegantly reuse this generated model in TERRA / BRIDE. It can then be used as contents of a 20-sim submodel specified in the TERRA / BRIDE editor.

Our current development is using Eclipse EMF and Ecore for the development of TERRA [32]. By formulating possible modeling constructs in a meta model, and using that as a specification for the tool, we can produce a rather reliable and consistent tool. Extensions and further development is rather straightforward. However, the meta-modeling approach is quite abstract, causing some start up work for newbies.

3.2 Meta-Modeling approach to ECS tool development

As TERRA, and its future extensions, supports graphical modeling, we need to start with a basic meta-model of a graph. This is the Component Port Connection (CPC) meta model [33]. From this generic meta model, several specializations can be made, for instance, to accommodate the global architecture or the CSP process structure of the software. See Figure 4. The CSP meta-model was the first realization. The architecture meta-model is now used to further prototype an architecture editor.
Next to a basis of meta models, also transformations are needed to transform the models expressed in a meta model to another meta-model formalism, or to generate code. The structure of meta models and transformations, as is used in our TERRA tool, is presented in Figure 5. The CPC meta model is the basis of all other meta models, as is shown by the inheritance relations in the figure. The large open arrows indicate interaction of the tool with the model, resulting in several transformations and interactions. The 20-sim to TERRA link as explained in Section 3.1 is an example of external model / tool support.

4. Conclusions

A model-driven approach indeed supports the more effective way of producing embedded control software. In our lab, next to the software itself, the models serve as documentation, which is quite relevant; because our 'personnel' changes quite often (student projects are short compared to positions in industry).

In projects with quite some industry collaborated, the industrial partners earned a considerable amount of shorting of their development time by using our model-driven approaches. In some cases, a complete design and test cycle could be left out, as using modeling and simulation revealed far more mistakes and inconsistencies than before. This counted for a few weeks to some months of shortening the design work [e.g. 23]. This is still using our tool prototypes!

Especially, the work on the tools and meta models is not finished, and we can accommodate students for (MSc) projects with different flavor: on tool design using the meta-modelling approach; on fault-tolerant ECS architectures; on test driving the tools, making robot demonstrators, and further enhancing the methods.

Acknowledgements

I would like to thank my PhD students - Klaas, Gerald, Dusko, Bojan, Marcel, Xiaochen, Yunyun, Oguzcan, Maarten, Yury, Zhou, who have been contributing to the method and tool prototypes. Further thanks to fellow researchers in the nationally and internationally funded research projects: DesignTools, ViewCorrect, DESTECS, BRICS, R-CPS, and especially Robert. Also thanks to numerous MSc / BSc students for testing and contributing to the tools.
Furthermore, I would like to thank my guinea pigs - the students of my courses, for testing the always almost finished tool chains: CAMAS / 20-sim ('90s), gCSP ('00s), TERRA, LUNA ('10s).

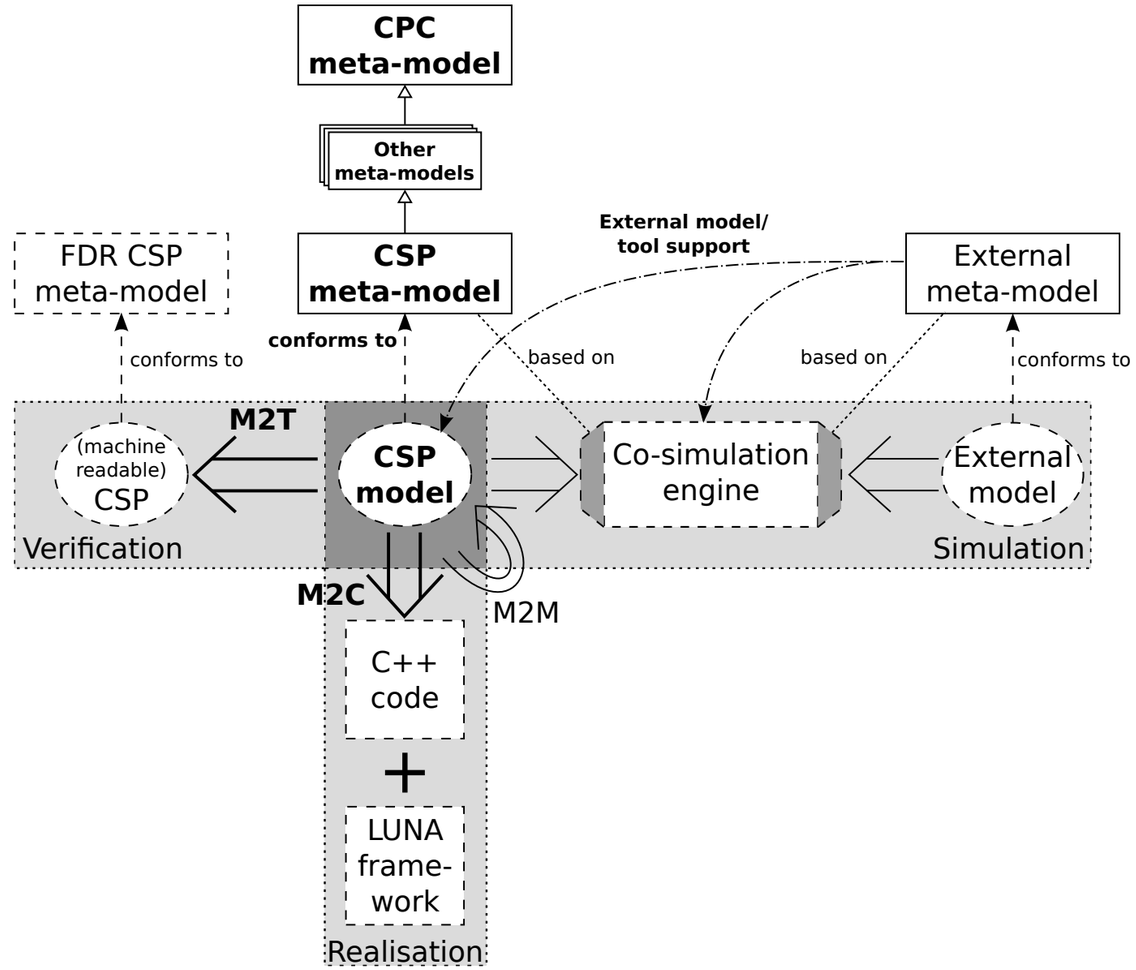


Figure 5. TERRA tool suite overview. The bold parts are available in the current version [32, Figure 1].

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SKIC

Author: Steven Gies

Good day readers of the Vonk! It's that time of the year again; the last courses and projects of this academic year are running, and you've probably been wondering why you're sitting in a cold lab, fighting with oscilloscopes or calculating the divergence of a coaxial cable's electric field, while outside the sun is shining bright. Fortunately there are also things to look forward to. Barbecues... Vacations... More barbecues... Perhaps you're even one of those lucky students who are getting close to a Bachelor's or Master's degree. And then on a longer term there's also the Kick-In. Such coincidence; that's exactly what I was going to write about.

As "the chosen one" I would like to introduce the latest configuration of Scintilla's Kick-In Committee (aka SKIC'14) to you. Led by chairman Jermain and assisted by Dieuwertje and Robin, this team will be doing their best at organizing the three days of activities around the far fields of farmer Frans during the introduction period of the next generation of freshmen. However, there's a lot more work to be done beforehand.

Tense meetings with contacts of the faculty of EWI have taken place, current freshmen need to be forced to become a do group parent and there's the never-ending battle with other Kick-In committees about how parts of the Edu-café are divided among the studies. A lot of food has to be ordered from various companies. Currently we are making sure that there will be enough meat and beer during the Thales End-P Event, as well as a bouncy castle. Furthermore we need to make sure that our committee clothing gets a fancy SKIC'14 logo and a striking bright color to make us look more important. Of course all these actions need to be taken by one of us so during our own meetings we have proven the effectiveness of the commonly used "anti-dibs-dakje". This method is, by the way, indeed the indirect reason why I am writing this article. I can notice that people are improving their reaction time every week.

Anyway, back to the Kick-In. I guess most of you know what Scintilla's Kick-In is about. After some exhausting days during the regular program the freshmen will or will not have time to wake up while listening to some opening talks and colleges. Next they will probably get lost on their way to De Lutte after which they might discover that they'll be sleeping next to the cows for a couple of nights. A dropping, the Highland Games and the Cantus are of course all traditionally part of the camp. A new addition this year is the "PreEFBA" which is held in the afternoon on the last day for those who don't have a home to go to or for the die hards who refuse to go home and rest. After all the regular Kick-In continues with a concert and an afterparty when dinner time is over.

There are also some things that can't be prepared yet. Because of some new rule – upcoming students have to sign up for Bachelor studies before May – we are currently facing a total of 115 EE pre entries. How many of them will be left in August? How many do groups do we need? How are we going to fit everyone in the cantus room? Will there be any women?

I guess we'll just have to stay calm and let time do its work here. After all that's what students are best at. For now, I'd like to wish everyone a successful end of the college year and a great summer break.

See you during the Kick-In!
Steven
SKIC'14

green team

Green Team Twente at the eco-marathon

Author: Sander Schotman

From 12 to 18 May, Green Team Twente was on the Shell Eco-marathon together with around 200 student teams from all over Europe. What happened during the competition, and how was it like to take part in such an event? Find out in this report from the eco-marathon 2014.

Monday, the 12th of May the team departed early from Enschede to arrive on time in Rotterdam. The tents of the team had to put up and the all our tools had to be stalled in our paddock. On the camping site, the team had a nice place on top of a hill together with the team of the technical university of Eindhoven.

> "The inspection was finished in one day"

On the second day, the technical inspection took place. In this inspection, the dimensions of the car are checked, the brakes are tested, the hydrogen systems is checked on safety and so on. The weight is measured at 78 kilograms, which is the same as last year. This year, a lot of weight is saved by producing the carbon fiber rims but weight is added by an extra electric motor. This is done because by accelerating with one motor, the motor is loaded above its specs and consumes a lot of energy. The inspection was finished in one day and the team was very happy with that. A lot of teams had to come back for additional checks and were still busy finishing the last points of their vehicle.

The next day, the team could start with test runs on the track. The wireless data connection worked fine. Until 3 quarter of the track there was a connection, but behind the Ahoy the connection was lost.

This is no problem, all the data are stored locally and are transferred as soon as connection is restored. On the graphs of the data, the shape of the track and its height differences are seen well, this helps a lot in deciding what the best strategy is. Unfortunately, the efficiency turned out to be disappointing.

Afterwards the whole system was measured to see if something was wrong. To exclude what was wrong, one of the motors is taken from the wheel so the car would be the same as last year. After a second test run, it turned out that despite the fact that one motor consumes more energy during accelerating, one motor is more efficient. This is because one motor is more efficient on cruise speed and this turns out to be of a higher importance.

On Friday, a new fuel cell came in from China. Last year, a new one is purchased but it turned out it was of poor quality. The system was leaking hydrogen and therefore it was unusable. Because also other teams on the eco-marathon use this type of cell, the lead designer of the stack flew to the match to support the teams. The team decided to drive with the old one on Saturday first in order to set a result and then to build the new one in afterwards.

In the morning the team was early in line to set its first result. After being in the line for one hour, it was time to go on track. Just before start, the battery of the secondary system was changed because it was already running for one hour and would probably fall out during the race. Something that turned out to be painful afterwards. By changing the battery, all the safety valves close for a short time.

As a result, the fuel cell encountered an error and already after the second corner it became clear that the buffer was not recharged by the fuel cell. Because the cell was still making noise in the error state, it was not noticed that this was the case and it was decided to start.

After coming off the track, it was chosen to use the extra time to build in the new fuel cell stack together with the lead designer. After having all connections hydrogen tight, it turned out the stack was leaking between the cell plates. A problem that the team had earlier this year. The stack is taken out again and given back to the designer with the request of refund. Without this stack, the 1 : 1000 km/l was not possible, but because until this moment no result was set, this was of minor importance. A result had to be put on.

> "The loss is taken well. Time to gather a new team and to realize new ideas!"

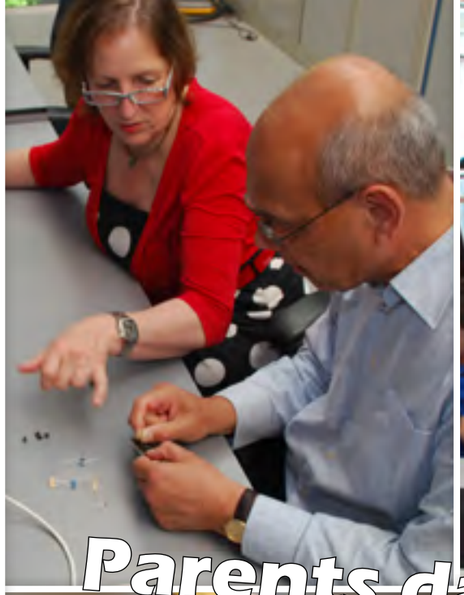
The next attempt, the fuel cell was checked again before going on track and the consumptions of the different systems seemed alright. After a couple of rounds, the consumption of the car started to rise slowly, probably because of rising temperature in the motor. This rise turned out to be too much. During measurements earlier, the DC/DC converter which regulates the rate at which the buffer is being recharged, is set a little tighter. This was done to gain efficiency but during the race the buffer did not recharge fast enough to reach top speed. The UTmotive finished 30 seconds too late and the attempt was declared as invalid.

At Sunday, the last day of the competition, the team was early in line. A result had to be set. The restriction of the DC/DC converter was restored to its old value to overcome the problems of the day before. The first rounds on the track seemed good and at least improving the result of last year seemed possible. After the 4th round, the fuel cell fell out, meaning the end of the last run. It remained silent on the radios for a while and the dejection was felt strongly.

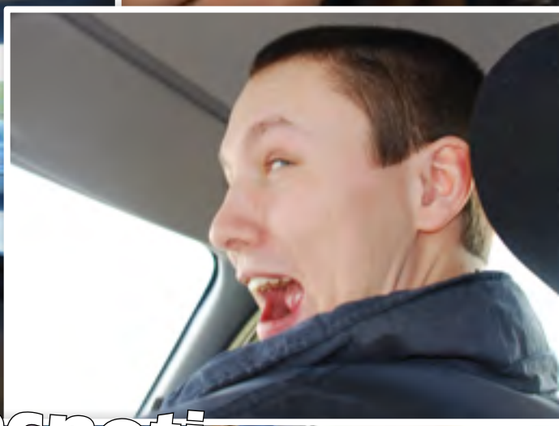
During that round the power supply of the fuel cell broke down, because of a piece of electronics that was used earlier and that was tested. The team had hoped on a second place during the eco-marathon, something that could have been reached knowing what the other teams had done afterwards.

The loss is taken well. Time to gather a new team and to realize new ideas! For next year, a couple of relations are already being made together with companies in order to develop a new fuel cell and electric motors. The team will come back next year! Interested in a function in next year's Green Team (part/fulltime)? Send us an email at the address info@greenteamtwente.nl.

Eind-P BBQ



Parents day



Tecnotion

Staftournooi

A bio-inspired hair-based acceleration sensor

Author: dr. ir. Harmen Droogendijk

Crickets use so-called clavate hairs to sense (gravitational) acceleration to obtain information on their orientation. Inspired by this clavate hair system, a one-axis biomimetic accelerometer has been developed and fabricated using surface micromachining and SU- 8 lithography. Measurements show that this MEMS hair-based accelerometer has a resonance frequency of 320 Hz, a detection threshold of 0.10 m/s2 and a dynamic range of more than 35 dB. The accelerometer exhibits a clear directional response to external accelerations.

Introduction

In biology, mechano sensors, equipped with differing hair-like structures for signal pick-up, are sensitive to a variety of physical quantities like acceleration, flow, rotational rate, balancing and IR-light. As an example, crickets have various types of hair-like receptors for measurement of several environmental quantities. For sensing of low-frequency flows (typically <1 kHz) to obtain information about the environment and avoid e.g. predator attacks crickets use filiform hairs, which are situated on the dorsal side of two abdominal appendages called cerci, and which are able to sense airflows with velocity amplitudes down to 30 μm s-1 and operate around the energy levels of thermal noise. Crickets gather also information about their environment by means of bristle hairs which activate interneurons that respond to tactile stimuli of the cercus and abdomen.

It are these intriguing aspects of biological sensors that inspire engineers on developing artificial counterparts and exploiting the field of biomimetics and bio-inspiration. For example, taking the cricket cercal hair sensors as a source of inspiration, several research groups have worked on the development of bio-inspired hair-based airflow measurements by exploiting MEMS technology. In this article, the bio-inspired approach is applied to bio-inspired inertial sensors developed using MEMS-technology.

Cricket's clavate hairs

In addition to flow and tactile perception, crickets have club-shaped sensilla, called clavate hairs, located on their cerci (figure 1), with hair lengths of 20–250 μm. These clavate hairs turn out to be sensitive to (gravitational) acceleration, providing the cricket information on its orientation. For example, a cricket uses its clavate hairs to compensate head movement when it is rotated around its longitudinal axis, for which such rotations can be measured with a resolution of about 0.1 degree. Additionally, these clavate hairs can respond to harmonic accelerations with frequencies up to 300 Hz.

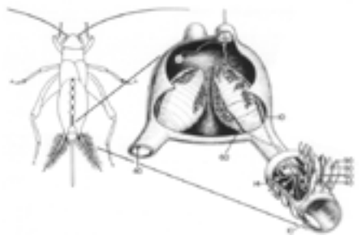


Figure 1: Artist's reconstruction of the clavate hair-based sensory system of the cricket (Acheta domesticus).

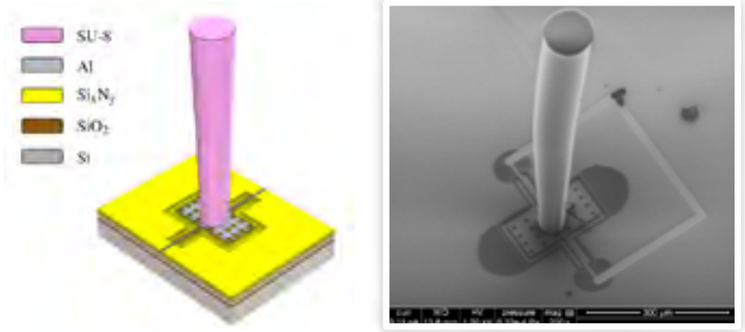


Figure 2: Design (a) and fabrication (b) of the MEMS hair-based accelerometer fabricated by surface micromachining and using SU-8 lithography.

For measuring (gravitational) acceleration, numerous types of accelerometers have been realized over the past years using MEMS technology, with applications in e.g. the automotive industry and navigation. Current state-of-the-art commercialized MEMS accelerometers show formidable performance in range, resolution and noise floor. In contrast to the cricket's clavate system, MEMS accelerometers are usually not hair-based systems and frequently contain feedback electronics. To explore some of the intricacies of the clavate hair system and assess its potential to engineering applications (e.g. automotive industry, robotics and motion tracking), we aim for the design, fabrication and characterization of a bio-inspired accelerometer. Bio-inspired hair-based structures have been exploited earlier with applications in both actuation and sensing of physical quantities, but seldom for inertial measurement.

Design

Mechanically, the hair-based accelerometer can be understood as a so-called inverted pendulum which is subjected to external accelerations. It is described as a second-order rotational-mechanical system with moment of inertia, a rotational stiffness and a rotational damping. Usually, in the models the hairs are treated as cylindrical structures, causing the moment of inertia to depend strongly on the hair diameter and the hair length.

Since the hair mechanical system behaves like a classical-second order system, it consequently exhibits the trade-off between responsivity and bandwidth. To achieve a 'good' hair-based accel-erometer, the sensor should have a long and thick hair, as well as a compliant mechanical suspen-sion.

Fabrication

The fabrication process for the bio-inspired accelerometer is based upon the process for cricket-inspired bio-inspired hair flow sensors, previously developed in the TST-group. A schematic overview of the bio-inspired accelerometer with the materials indicated is shown in figure 2a.

The sensor is fabricated on a silicon-on-insulator wafer. Trenches are etched in the silicon device layer using DRIE. A layer of 200 nm stoichiometric Si3N4 is used for covering and protecting the trenches. The device layer contains two electrodes, which are used for capacitive readout of the acceleration-induced movement. On top of the Si3N4 layer, a sacrificial layer of poly-silicon (1.5 μm) is deposited by LPCVD. The sensor membrane and springs are constructed by depositing and patterning a 1 μm SiRN layer on top of the poly-silicon. Aluminium (80 nm) is sputtered on top of the membrane to create the electrodes for capacitive read-out. Our artificial clavate hair is created by two layers of SU-8, to realize both the centre of mass towards the top of the hair structure and a total hair length of about 800 μm with an average diameter of about 80 μm. Finally, to release the membrane the sacrificial poly-silicon layer is removed using XeF2 etching. The fabrications results are shown by the SEM image in figure 2b.

Experimental

First, the frequency response of the hair-based accelerometer was measured using capacitive read-out in the direction perpendicular to the rotational axis. Frequencies within a range of 50–1000 Hz were applied to a shaker used for applying accelerations. A reference accelerometer was used to de-

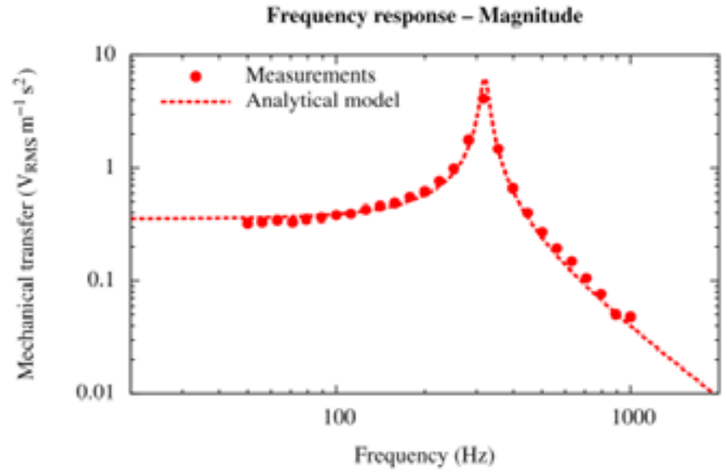


Figure 3: Measured mechanical transfer of the hair-based accelerometer using capacitive read-out.

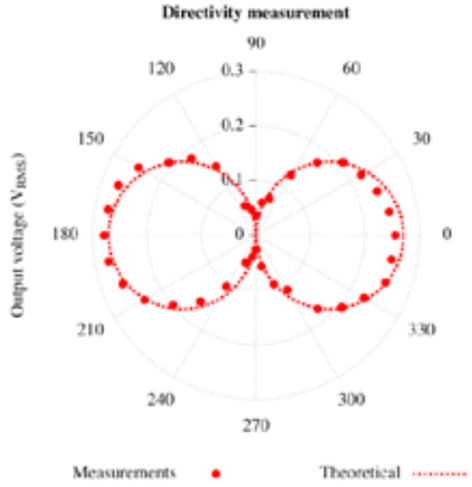


Figure 4: Measured directivity of the hair-based accelerometer using capacitive read-out at an acceleration frequency of 80 Hz.

termine the externally applied acceleration amplitude. The resulting measured magnitude response of the bio-inspired accelerometer is shown in red in figure 3. Here, the circles represent the measurements and the dashed line exhibits the analytical model base, where the resonance frequency and the quality factor were fitted. We observe good agreement between model and measurements, where the resonance frequency is found to be about 320 Hz.

The sensor's directivity was measured by rotating it over 360 degree, with steps of 10 degree, with respect to the direction of the applied external acceleration, while using capacitive read-out. To this end harmonic acceleration with a frequency of 80 Hz was applied and the output voltage was measured by a multimeter (Keithley 2000). The obtained results are shown in figure 4. We observe that the measurements are in close agreement with the theoretical response for a so-called figure-of-eight. The measurements indicate that the hair-based accelerometer has a maximum responsivity for both 0 degree and 180 degree, which coincides with the direction perpendicular to the rotational axis of the hair sensor.

To describe the sensor's signal-to-noise ratio (SNR) as a function of acceleration amplitude as well as the sensor's detection threshold, the signal and noise powers are considered. The signal is assumed to have a linear relationship with respect to the acceleration amplitude, given by a coeffi-cient. This coefficient is directly related to the sensor's rotational angle and therefore has a dependency on the acceleration frequency.

Experiments to determine the sensor's linearity were performed by choosing first a specific ac-celeration frequency (80 Hz) and then by varying the acceleration amplitude. Subsequently, from the measured output rms-voltage the sensor's detection limit and linearity are derived. The results are shown in figure 5, where the points represent the measurements, the solid line represents the analytical model, and the dashed lines indicate the constant equivalent noise amplitude and ideal linear response asymptotes. We observe that for accelerations with amplitude of more than 0.10 ms-2, indicated by the intersection of the asymptotes, the hair-based accelerometer exhibits a clear linear relationship with the applied acceleration. Below this amplitude, the sensor's output is dominated by noise (SNR<1).

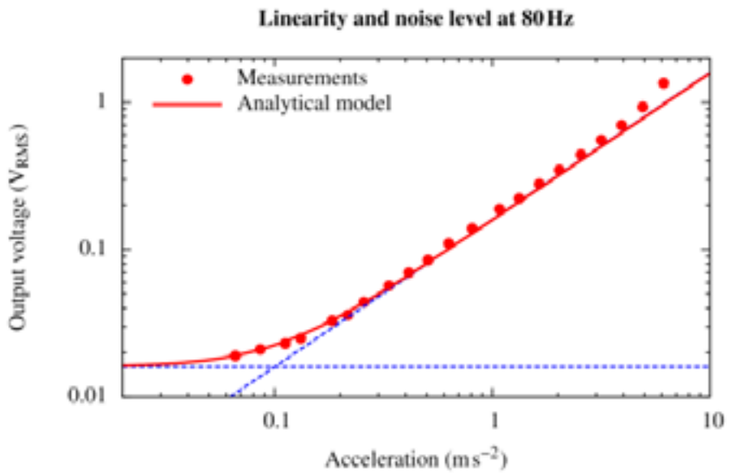


Figure 5: Measured response versus acceleration amplitudes at a frequency of 80Hz using capacitive read-out.

To get some insight in the accelerometer's noise performance and stability, an Allan variance measurement was performed. The zero-acceleration output rms-voltage was measured with a time interval of 20 ms for a period of 2 h using a multimeter (Agilent 34401A) connected to LabVIEW. The results of the subsequently calculated Allan deviation are shown in figure 6, together with asymptotic lines for both the velocity random walk and the bias instability.

From the linearity measurements, the error on full-scale (i.e. the measurement taken at highest acceleration of 6.12 ms-2, see figure 5) was calculated and found to be 3.3%. By considering the detection threshold and the full scale acceleration amplitude, the dynamic range of the hair-based accelerometer is about 35.6 dB. The Allan variance results showed a velocity random walk of 1.67 ms−1 √"h" −1 and a bias-instability of 5×10-3 ms−2.

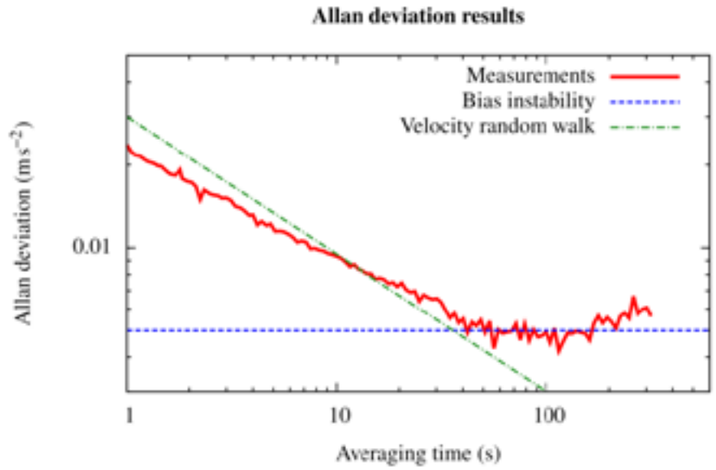


Figure 6: Measured Allan deviation using capacitive read-out.

Discussion

Generally, the susceptibility for (gravitational) acceleration is used by crickets for determination of their position and orientation. The hair-based accelerometer described in this work allows in principle also for determination of orientation using the Earth's gravitational field. That is, by measuring the projection of the Earth's gravitational acceleration, the angle of rotation of the accelerometer with respect to Earth can be determined. However, since the fabricated accelerometer has limits with respect to resolution, an error in this angle will result. Based on the experimental data, this error is calculated to be in the order of 0.7 degree for accelerations well below resonance, which emphasizes the potential use of this accelerometer to determine orientation. Notice that this value approaches the resolution of the cricket's clavate hair system of 0.1 degree.

As we have shown in figure 4, the hair-based accelerometer has a strong directivity. In our MEMS version, this directivity stems from both the mechanical design, which primarily allows rotation around the torsional axis of the sensor, and the differential capacitive read-out, which causes a strong reduction of signals caused by tilting of the hair. As a consequence, multiple hair-based accelerometers may be used simultaneously to sense acceleration in 3D. In crickets, filiform hairs have been shown to have preferential directions of rotations with ratios in stiffness of 'hard' over 'easy' directions between 4 and 8. It was demonstrated previously that such directivity exists in the cricket's clavate hairs. Additionally, it was shown that crickets use the many clavate hair-sensors on their cerci for determination of their orientation relative to the gravitational field and that they do so both with respect to roll (rotation around longitudinal axis of the animal) and pitch.

Conclusions

A biomimetic accelerometer has been developed and fabricated using surface micromachining and SU-8 lithography, inspired by the clavate hair system of the cricket. We showed that this MEMS hair-based accelerometer has a resonance frequency of 320 Hz, a detection threshold of 0.10 ms-2 and a dynamic range of more than 35 dB. Further, the accelerometer has a clear directivity and a bias instability of 5×10-3 ms−2.

Further reading:

[1] H. Droogendijk et al., "A biomimetic accelerometer inspired by the cricket's clavate hair", J. R. Soc. Interface, 2014.

Parent-day

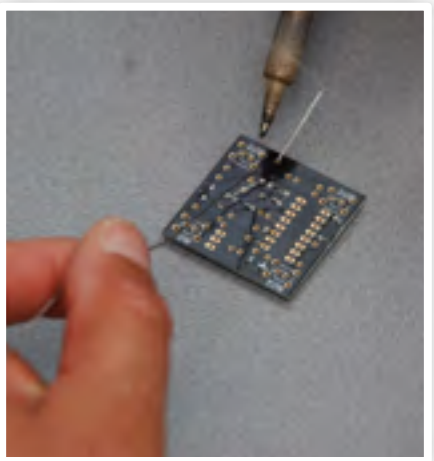
Author: Nathan Reiling

Parents often want to know what happens at university, what you learn and why it's such a nice study program. This is why the parent-day is organized each year. This year it was organized by five first-year electrical engineering students, under the guidance of Roel Mentink and Dieuwertje ten Berg. On the 10th of November 2013. The committee met for the first meeting. The chairman was chosen, as well as the secretary and the treasurer. After this first meeting, others followed each week. As time passed, the parent-day raised from the ground: tutors were asked to give a short lecture, locations were reserved, shirts were printed and food was ordered. Finally, the day had arrived, the parent-day had started.

It was Saturday the 17th of May. Five first-year students walk into the Educafé and start with a cup of coffee. Afterwards, the Educafé was cleaned quickly, everything was put in place and organized. The moment the W-zaal should have been made ready, the alarm went off of course, despite it having been mentioned beforehand. After Charlie came by, both the SmartXP and the W-zaal could be made ready. The first parents arrived whilst the preparation was in motion, given it was already 9.30 AM. The parents were welcomed with a slice of cake and of course a cup of coffee or tea. While part of the committee was busy arranging a few last things, the other part was busy welcoming the parents and the first speakers. At a quarter past ten, a little after our timetable, the day was opened by the chairman of the parent-day-committee, Nathan Reiling, followed by a talk by the president of E.T.S.V. Scintilla, Robert Fennis, and module-coordinator, Cora Salm. Robert started with a talk about E.T.S.V. Scintilla about what the student association does and doesn't. Cora spoke about the faculty, the cooperation between the faculties and the education plan. When the opening formalities were finished, the first class could start. Cora Salm was the speaker, and would tell about Ohm's Law and simple RC-circuits. This was the subject of the first lab exercise.

> "It was a nice and insightful day"

After the short class of 45 minutes, the parents, who were all impressed with the subjects, were brought to the W-zaal. In the W-zaal, all the parents got an RC-box, a guide and equipment. With this equipment, the idea was to measure the RC-time, determine the resistance value, and with that, calculate the C-value. This went quicker than planned, and earlier than expected, the first parents were already outside. Since the weather was great, and the practicum lasted shorter than expected, and that gained the parents a total of one hour for lunch and exploring the campus. After this relaxing break, Ronan van der Zee arrived to give the second lecture. By using water-analogy, Ronan explained the working and origin of transistors. Despite this, for laymen, complex subject, Ronan achieved it to pass over this knowledge excellently.



Finally, the highlight of the day arrived. The soldering lab assignment. In the W-zaal, all the soldering irons were preheated, soldering tin was distributed and the components made ready. Every pair got a bag with components and a PCB, that together would make a die, as long as the parents did it well.

At the end of the day, Wok-To-Go was served, with a cold beer on the side. After the parents had finished their food, they went home. The committee had to stay, to leave the Educafe behind neatly. Besides, we were not allowed to make a profit, so we still had to empty the keg of beer...

In the end, it was a very nice and insightful day, according to the parents.

Advertorial: Omron Industrial Automation

Production and R&D under a single roof

Author: Omron

Omron is a multinational with over 36000 employees in more than 35 countries. It has its business units in healthcare, transportation systems, automotive, electronic components and industrial automation. The industrial automation unit is the largest and has five R&D departments and two factories in Europe. At Omron 's-Hertogenbosch you can find a development center for analog/digital electronics with embedded programming for controllers and the factory in the same building. This gives a dynamic environment where research and customer relations come closer than ever.

The research and development group of Omron in 's-Hertogenbosch focuses on the hardware for industrial automation controllers and the associated embedded software. This means that the customers are machine- and robot-builders who sell their machines to manufacturing plants. Omron focuses on plants for the packaging of food where universal controllers (PLCs), temperature controllers, motion controllers and safety systems determine the intelligence of the system. The industries for semiconductors and automotive are part of Omron's key customers as well. The automation business is competitive and characterized by slow market movements (machines are used for decades), the need for robust products and professionals co-developing with professionals. In addition, customization and modularity is important. As a direct result, R&D engineers in 's-Hertogenbosch dive into the customer needs in order to make special products with smart solutions. These special products help us to contribute to the underlying global roadmap of the "Sysmac" automation platform.

> "The industries for semiconductors and automotive are part of Omron's key customers as well"

A practical example of a project at Omron R&D can be a customization of an existing Omron product for a customer who needs a regular safety button, but benefits from a smart solution where the position of the motors is stored in case of emergency. This customer can then recover from an emergency stop without too many down time of production. To solve this, you have to understand the standardized communication protocols between the servos and the controller and the architecture of the Sysmac system. The investigation starts with a visit to the customer to really understand the problem.

Most people have seen Omron only as a producer of blood pressure measurement systems of the healthcare unit or the relays of the components business unit. You may not realize that you encounter Omron products every day. The first product in 1933 was a timer for an X-ray machine. Later on, Omron achieved successes with the first non-contact solid-state switch (1960), the first automated traffic signal (1964), an unmanned train station (1964), and the first online automated cash dispenser (1971). These products still give an impression of what automation can do for society as Omron is still doing.

> "You may not realize that you encounter Omron products every day"

Omron was founded in Japan in 1933 by Kazuma Tateisi. Already in an early phase, he developed the vision that working is not primarily done for the sake of financial gain, but that it has a function in society. As a result, all companies should exist to support society. Hence the motto of the Omron organization is "Working for the benefit of society". The responsibilities of Omron for the society have a clear positive impact on daily life within the company. For example, on the companies birthday the employees engage in a day of voluntary work for a vulnerable group. Besides that, Kazuma Tateisi had ideas on how science acts as a seed for technology, and technology on its term creates innovation in society.

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Ben van Boxtel, Engineer

Are you curious and do you want to create something? Are you studying Electronics or Industrial Engineering, Industrial Design, Applied Physics, Mechanical Engineering, Mathematics or Computer Science? If so, send your resume!
For more information contact Nicole van Oers (HR Advisor).

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Knowing that you don't know

Author: Bert van den Berg

Afterlife, it sounds like a zombie movie. And then we think back to the "best" years of our lives. For inspiration I have read some recent afterlife pieces and came to realize that I'm getting old. It was the year 1998 when I started my "career" at the University of Twente. I lived on the campus at Calslaan 10. A lot has changed since. Now the gray hairs are starting to show (I'm only 34!!!!), I would like to start this afterlife with a piece of history, current electrical engineering students probably don't know about.

Remembering the life

When I started my study electrical engineering at the university of Twente, I went to EL/TN every day. EL/TN was the name of the building that is now known as Hogekamp and is not in use anymore. I remember the first courses; Calculus and the Introduction to programming (in Maple!). After doing the Maple exam – I thought "is this the University, is this all?". Luckily for me, after these courses the difficulty level increased significantly to the point where one starts to think, in which afterlife would you ever need this knowledge.

During the study program, I actually found the most enjoying part of electrical engineering being able to design electronics. For my hobby, I started with a "looplicht" using only the logic components OR, NAND and a demultiplexer, enabling spectacular (☺) light effects. Later on during my study I made the same kind of electronics, using my home made etched circuit board and replacing all the logic gates by only one microcontroller (AVR).

From 1999 I started to actively participate in de STORES, located in the basement of EL/TN. The STORES was really my thing. I have been the book purchaser, chairman, and also did the components and cable supply (NEDIS) for a while. During my chairman period we did a major redecoration of

> "The STORES was really my thing"

the STORES, painting everything in yellow, red and blue, just after which the real size mister Mu was born (I actually screwed the skeleton together). In the afterlife I remember the STORES every day at home; because when the STORES moved to the current location (2009), the Metal Cupboards moved to my home (☺).

Among other things I remember the many introduction periods, being a "Doegroeppapa", then "Opa", and when I was "Overgrootvader" I also started a new family at

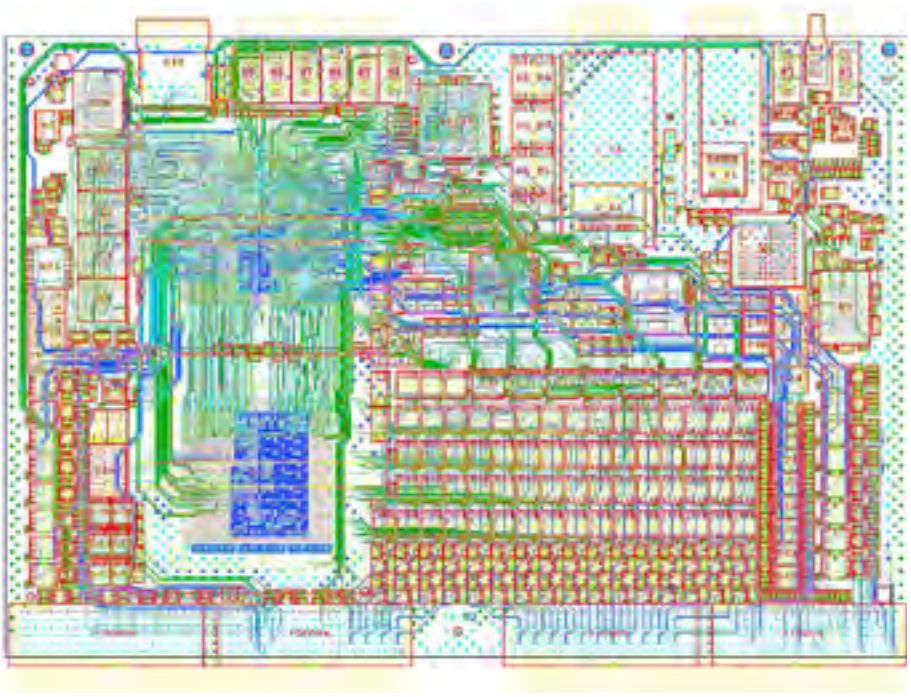
BMT (since the study started in 2001, dads were needed). In this introduction period I actually met my girlfriend, love of my life (soon to be wife) for the first time, being one of the 2 girls at electrical engineering of that year. She is actually the one who finished the body and painted mister Mu making it the one you probably all know.

A few other highlights were the multiple times I participated in CREATECH, the participation in the TNO-robotcompetition during my internship and finally my graduation project the "Design of a Production Cell Setup", which is still in operation at the RAM group, all coming together in me getting my Master Degree in Embedded Systems at Control Engineering (now RAM).

Going to the afterlife

And then the afterlife starts, I left my student flat quite soon after graduation. I had lived there for a happy period of 8 years, in a group of 17 persons. We actually lived together with the same group of 14 persons for about 4 years. But after the graduations and when the new students arrived, I did not have the energy anymore to teach the new ones how to cook and clean. I left the Campus and my student life officially came to an end.

In 2006 I started looking for a job and actually got my first (and till now only) signed contract before graduation. I was quite sure about the kind of job I wanted to have,



electronics designer. But where to find it? Probably using one of the first versions of Google (☺), I found the company 3T and actually ended up working just across the University. I was amazed by the engineering capabilities of 3T on the field of electronics and all that just across the street.

I have done a lot of different electronics designs since, and with every new thing I learned, it was actually quite annoying to come to the conclusion that I still knew so little. With respect to my peer students I had already developed quite a high level of capabilities in the field of electronics and embedded systems. But in the real life, there was a lot to learn. For this reason I would recommend everybody to get a working environment where you can obtain a lot of knowledge, especially for your first job.

During the study electrical engineering the unknown was quite easily labeled "Noise", whereas good design practice will give you equally or probably better performance than the measurement device we used at the university. Working at 3T really gave a new meaning to noise.

Can you imagine designing electronics for measuring on a uA level in one of your first projects? Nowadays we have designs at nA and lower! Or do you still have the (for me scattered) illusion that automatic assembled electronics automatically has a high quality? There is a lot to learn and I believe one is simply not able to know it all (of course we guys pretend we do so).

Nowadays I actually believe people have a higher knowledge level the more they acknowledge the things they don't know. So the more you know you don't know will actually bring you to a higher level. Of course knowing a few things won't harm you either.

The thing I did not really expect was that after only a couple of years I wanted to have new and different kind of challenges. So I started to make the move to becoming a (technical) project leader. The challenges you face as a project leader are quite different from the ones you face as an engineer. But these challenges can also be quite fulfilling, managing a lot of different projects and managing costs on a scale much different from what we used to do in the STORES.

The technology progresses and even though we are quite humble in Twente about our capabilities, we are already capable of achieving quite a lot. Did you know that quite a lot of electronics in the ASML machines is designed in Enschede, having accuracies in the range of nm and mK, which is considered "normal" nowadays. Did you know that the electronics of the first electrical bike (Sparta-ION) were designed in Enschede?

> "Knowing that you don't know will get you to the next level"

We proceed to the next level, being highly skilled in analog electronics (I would almost say a starving craftsmanship), combined with a high-speed embedded interface. I see a future in SoC design (system on chip), combined with model driven design, but always needing highly accurate analog electronics.

As for my own afterlife I have noticed to constantly wanting to have new challenges. When I have done something already and I have the feeling I know the trick, I want to do something new. I just started a project which is quite different from our "normal" designs. Before starting it seemed rather impossible and now I think, let's make it happen! I think we are up for the challenge and I am actually already thinking what the next level of challenge might bring.

Knowing that you don't know will get you to the next level.

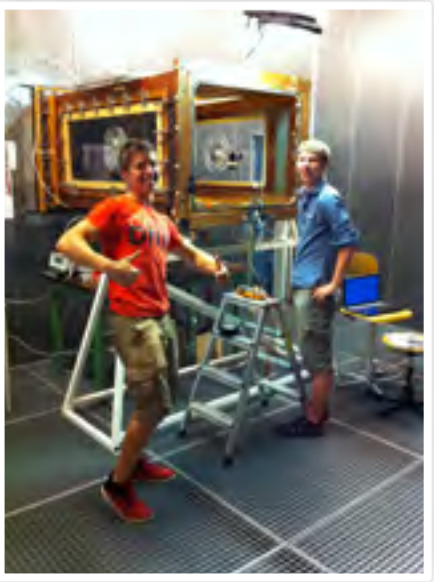
B2 Project

Author: Various

This last quarter the B2 project has been in full swing. It is the last time that this project is done. So we asked the students to provide us with a short text on what they have been doing for the past weeks. This way we can all think back on the awesome project we have all done and seen.

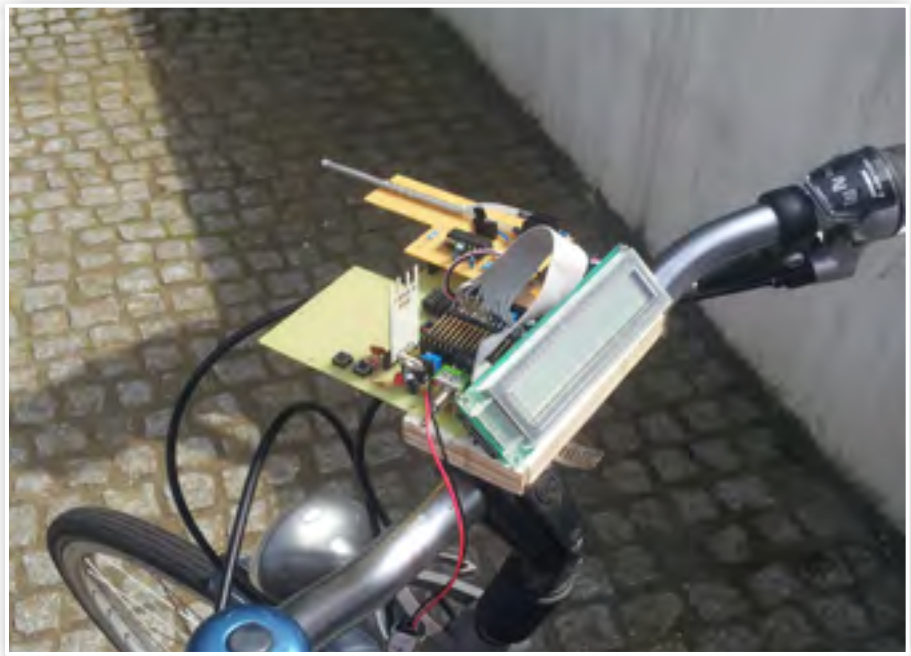
Cycling power measurement

Jermain, Steven, Emil and Paul



For people who need medical rehabilitation it is good practice to cycle, whether on a stationary bicycle at home or on a real bicycle outside. For both situations it is important to know the power delivered by the cyclist. A stationary bicycle has in many cases a power meter and a screen on which the power can be displayed, but for a normal bicycle this is often not the case because of the constantly changing environment. There are certain measurement systems available which can measure the power based on the force exerted on the pedals, but these systems are expensive and require precise calibrations, therefore primarily an option for professional cyclists. A solution for this problem could be an indirect measurement system that calculates the power with the use of different variables like road gradient, ground velocity and air velocity.

A mathematical model was used and all required parameters have been evaluated for their individual influence. How big is the range in which these values occur and how significant would a small measurement error be? Some parameters are difficult to measure and thus have to be estimated or entered as an initial input by the user of the system. Based on these parameter evaluations, sensors are compared and chosen, and readout circuits have been designed for accurate measurements. Pitot tubes and hot wire sensors, both able to measure wind speed, were compared and calibrated in the university's wind tunnel.



Using microcontrollers all sensor outputs are collected via a data bus and used to continuously determine the total power supplied by the cyclist. The most important data is clearly displayed on a small screen that is mounted on the steer.

At the time of writing the full system is being assembled after which we can start testing our prototype outdoors. Finally, the accuracy of this indirect measurement system will be compared with direct power meters to check whether it can compete despite the lower cost and maintenance.

Wireless monitoring of a potentiometric sensor for reinforced concrete applications

Douwe de Bruijn, Arjan Douma
Bas ten Have, Idzard Hoekstra

Nowadays in almost every building reinforced concrete is used. In normal conditions oxidation of the reinforcement bars is not a problem. However, when reinforced concrete is placed in places with salty water, this can dramatically damage the bars and thus the structure. It is common to drill a hole in the concrete and research the grit for salt concentrations to determine the structure's condition. This however is a time consuming measurement and it will also damage the concrete. A sensor is already available to measure the concentration of chloride ions, one of the most damaging salts, in a solution. This sensor can be placed inside the concrete, but reading the data is still a problem. The sensor will generate a potential which is related to the concentration of the chloride ions.

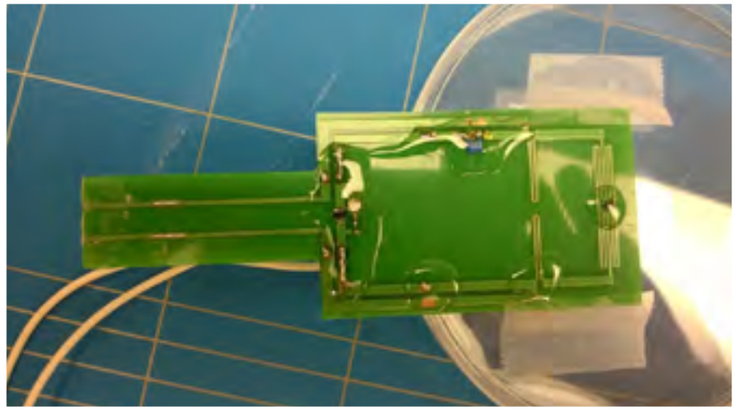


Figure 2: sensor circuit

In this project the goal is to measure the concentration of chloride ions wirelessly over a small distance. A measurement device, "AquaTag" is used which measures the resonance frequency of an inductive coupled circuit. The resonance frequency is around 27Mhz and will have a small variation caused by a varactor. The capacitance of this varactor is depended on the potential of the sensor. So, if the concentration of the chloride ions changes, the potential changes which changes the capacitance and thus the resonance frequency will change. This change is then measured and can be translated back to the chloride concentration.

So far the results are promising. The remote sensor circuit is adapted successfully: a relation with a small uncertainty has been made between the changing concentration and the output value of the measurement device. In the coming week the influence of the distance and the concrete itself on the measurements will be tested.

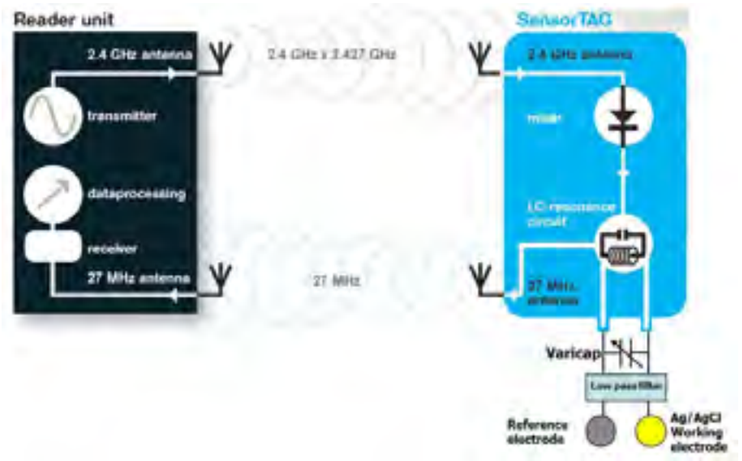


Figure 1: schematic of principle of operation

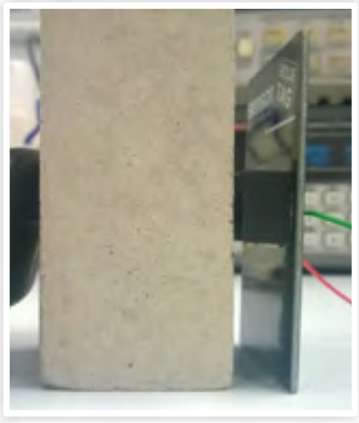


Figure 3: (left to right) readout device, cement, sensor circuit

RFID skimming and eavesdropping

Luuk Grefte, Jos van 't Hof, Gerolf Meulman,
Vera Nauta, Alexander Varwijk

Nowadays, RFID tags can be found in ID cards, passports, chips for pets, bikes, access cards and many other products. But how save are these RFID tags? Is it possible to eavesdrop on communication between a RFID tag and a reader? And is it possible to copy data from a RFID tag from a distance, even though the normal distance of operation is less than 10 cm?
These are questions which are looked into in our project. It was found that RFID readers that control the accessibility at the University of Twente do not use encrypting, and only check the ID of the RFID tag. In the project, it will be determined if this ID can be copied and spoofed, and how this should be done. The goal is to copy the ID of RFID tags from employees of the university to gain access to buildings, lab and hopefully free coffee!

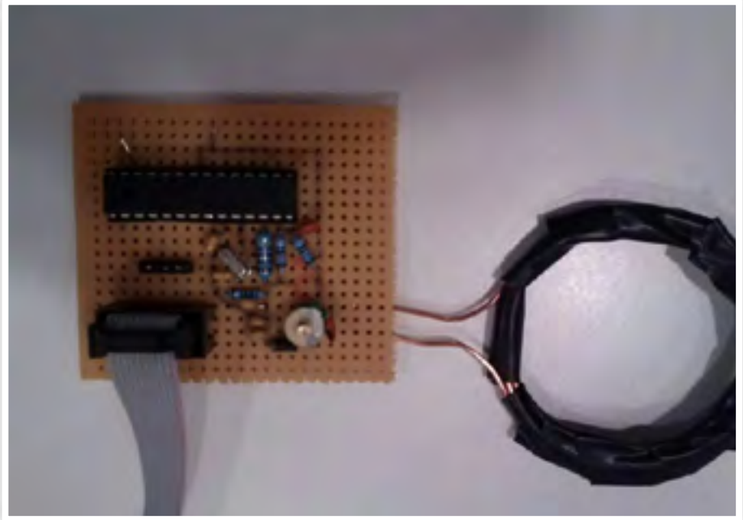


Figure 2: The emulator

There will be looked at two possible ways to find the ID of the RFID tag; with eavesdropping or with skimming. Eavesdropping means that you listen in on the communication between an RFID tag and reader. Skimming means that you use a reader to access information on the victim's RFID tag directly, without permission. This difference is visualized in figure 1.
For both options it is needed to receive a signal from a much greater distance than the normal distance of operation. There will be looked at possible solution for antennas and other hardware to receive and process the signal which contains information about the ID of the RFID tag.
In order to spoof, there will be looked at how the ID of the desired RFID tag can be imitated, when the ID is known. Since it is not possible to edit the ID of an existing RFID tag, a circuit was designed which works like an RFID tag with the desired ID. The emulator can be seen in figure 2.

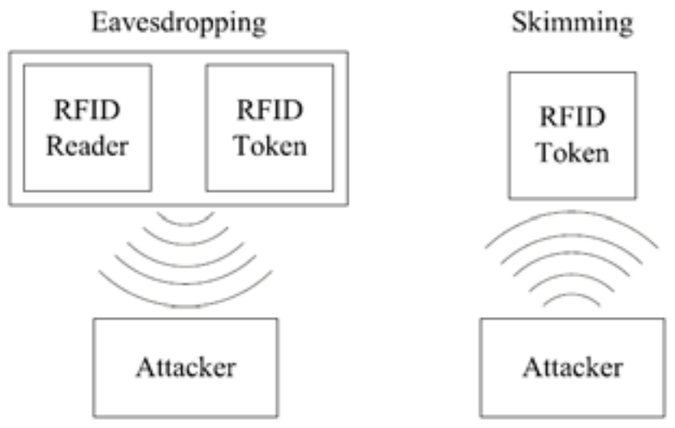
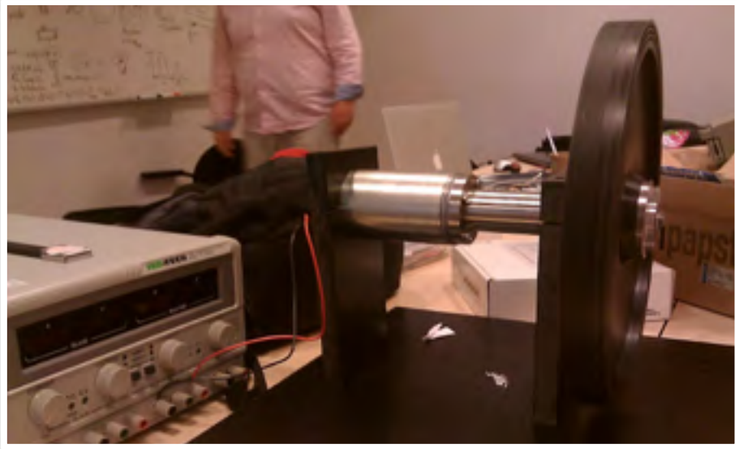


Figure 1: Difference between eavesdropping and skimming

Electro-mechanical N-path Filter

Wouter Horlings

A c ouple of years ago ICD submitted a scientific paper for the concept of N-path filters. High speed solid state switching of low-pass filters resulted in a highly tunable band-pass filter. The switching speed gives the center frequency of the band-pass filter. The RC-time of the low-pass filters give the bandwidth of the filter. Although the idea was brilliant the paper got rejected; this concept was already accepted and published, sixty years ago to be precise. It turned out that in the fifties there was development on this technique. There were two main designs; mechanical switching or with transistors, but these where probably never used. The switching design was way to slow to make the filter of any practical use.
ICD reinvented the N-path filter with solid state switching. After the rejection of the paper and some digging in the archives, Eric Klumperink found the paper about this mechanical switched N-path filter. So he gave us the task to build a mechanical switched N-path filter. We came up with a commutating system that filters up to 800Hz. A disk with contact plates will be spun up to 3500RPM and start switching. With some sliding metal contacts the signal will be filtered. Although we can filter in the human vocal spectrum, it is still not of any practical use. However, it can be used for the open days at the university. With this huge mechanical filter next to the IC N-path we can show the development in electrical engineering and last but not least how awesome it is.



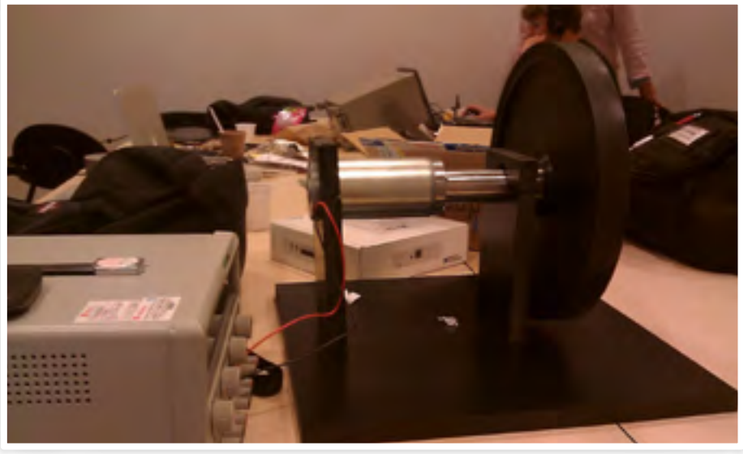


Figure 1: The commutator seen from both sides

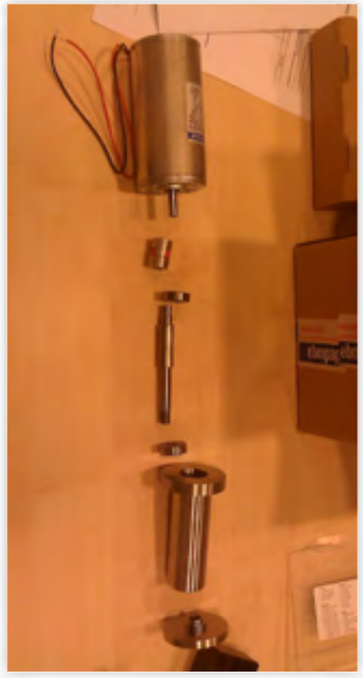


Figure 2: The bearing assembly

3D Printing Passive Components

Erwin Hardeveld, Marius Groen
Diederik van der Valk, Annelieke de Vos

Our assignment for this B2 project is to print passive components with a 3D printer. Our goal is to print passive components on top of a chip to save space. We have decided to use two different printers for this: the Nanoscribe and the Fab@Home.

The Nanoscribe is able to print on micrometer scale, which is wanted for the chip, but it is not able to print with conductive material. The Nanoscribe uses a method called “Direct Laser Writing”. With this method a laser is “writing” in a photoresist material, which causes polymerisation of the material. The polymerised part will remain on the substrate after development. A Scanning Electron Microscope (SEM) picture of one of the coils can be found in Figure 1.

The second printer used is the Fab@Home. The technique that this printer uses, is called material extrusion. This means that a paste is placed in a syringe and pushed out at the desired places. The object to be printed is build up of several layers. The advantage of this technique is the ability to print with a conductive paste, and thus make a conductive object. The printed object, however, will be too big to be used on a chip. So far a coil has not been printed, but some conductive lines were printed, as shown in Figure 2. The resistance at 5 cm distance (full length of the shown line) is about 2 kOhm.

Figure 2: Conductive lines by the Fab@Home

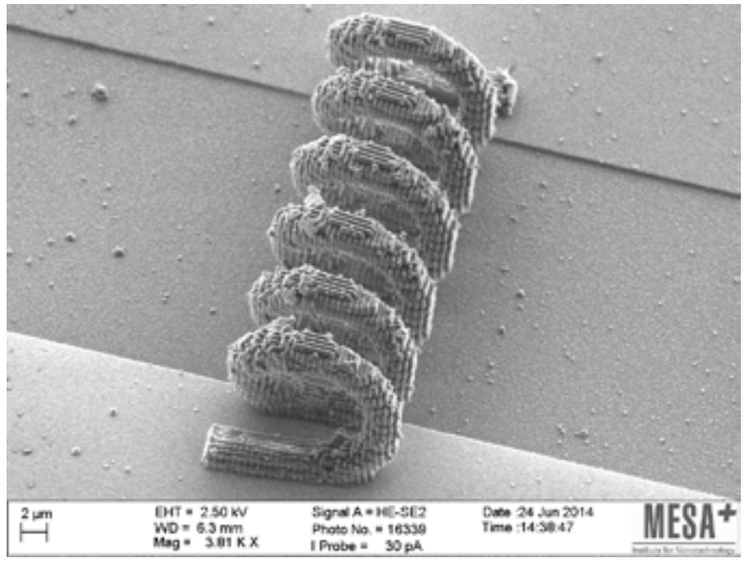


Figure 1: Coil printed by the Nanoscribe

Junction

Author: Ewoud Vissers

Emiel Zijlma is just starting his second year of Electrical Engineering. He has already done some very interesting projects, a lot more than most Electrical Engineering students, and he's looking forward to more already. We invited him for an interview for the Junction to learn more about him and his projects.

What do you do with electrical engineering beside your studies?

I have a job on Saturday and in the holidays at TiePie engineering. This is a company in Sneek which designs and sells USB oscilloscopes. I have also done a few projects, like a self-watering plant using an Arduino. I am also still busy with a very big project: Building a quadcopter from scratch, together with a friend.

What do you do at TiePie Engineering?

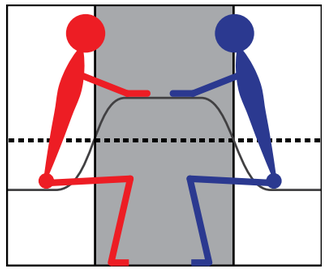
Most days at TiePie I'm soldering the entire day. For example, the prototypes for the scopes being designed right now have to be soldered. This is quite a job, since they consist of a 10 layer pcb and more than 800 components. Luckily pick and place machines exist for production. Since these machines aren't perfect, I also have to fix any possible wrong connections, after which I calibrate the scopes.

What was the hardest thing designing your quadcopter?

The hardest thing, which I already expected, is stabilizing the quadcopter. Even though it uses both an accelerometer and a gyroscope, which means the angle can be calculated easily and accurately. The big problem with the stabilization of a quadcopter is preventing oscillations. We used a PID controller to try and reduce this problem. Using one controller for the X-axis and one for the Y-axis, it would seem easy to do it. It isn't, because there's another thing that needs to be addressed. Because two rotors are turning the other direction as two other rotors, when the force isn't distributed over these rotors properly, the quadcopter will start rotating around the Z-axis. This means that one rotor would sometimes need to turn faster for stabilizing in the X or Y axis, but slower for stabilizing in the Z axis. We still don't know how we should handle situations like those. Maybe I can try to tackle the problem again after I have had the subject control engineering ;).

What part did you find most interesting?

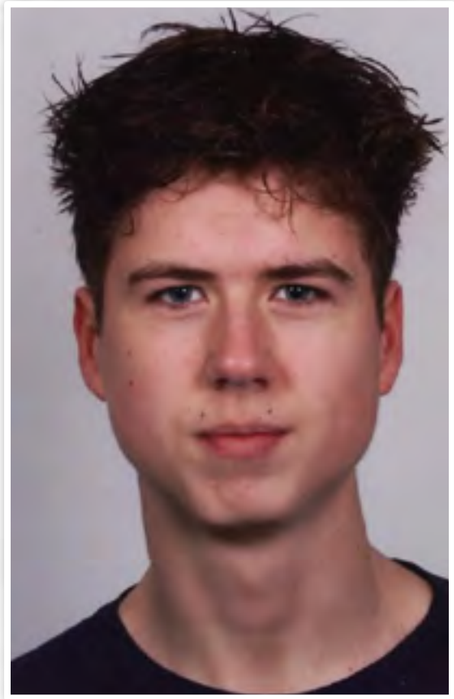
What part did you find most interesting?
When building the quadcopter I was amazed by the ways we could measure the height of it. I thought this would be a very hard problem, but it wasn't that big a deal. Our first idea was to suspend an ultrasone sensor under the copter, but this would cause a lot of issues if the copter would tilt a bit, meaning the height signal couldn't be



used for much. In the end it turned out we didn't really need an extra sensor. We could use the accelerometer. Knowing the tilt of the quadcopter we could then calculate the exact acceleration in the Z-direction, and after integrating this twice we would know the height to a very good approximation. This approximation was held back by the fact that there was a lot of noise in the accelerometer, and not all information in the accelerometer is wanted. Only the acceleration by movement has to be used, and not the acceleration from the gravity of the earth. A gyroscope was used to aid in filtering information from the accelerometer, to improve the approximation.
We also implemented a barometer in the

> "I was amazed by how accurately you can determine the height from the pressure."

copter. I was amazed by how accurately you can determine the height from the pressure. Using the BMP085 sensor, we could theoretically determine changes in height with an accuracy up to 25 centimeters. The turning rotors in the vicinity of the sensor sadly changed the pressure depending on the force they exerted, meaning the sensor did lose some accuracy.



Emiel Zijlma

Age	Twenty
Study year	Second
Birth place	Sneek
Country of origin	Fryslân

Do you have any plans for the future?

This year I joined the Green Team Twente. I think I am going to learn a lot of interesting things there, and I think it'll also keep me motivated on the project. Many projects fail very quickly once the motivation goes away, but working in a team will cause a big boost. The competition will also help a lot I think. I hope I can help the team to win the competition this year. I am scared though that I will do so much for the green team that I don't have time for my studies anymore.

Chicken in a hat

Author: Dieuwertje ten Berg

The end of my board year is already in sight. The days that are left are countable and the candidate-board is making plans for the next year. This is the time that you start thinking, what happened during the year, what was good, what wasn't good. It is the time to get a bit philosophical. So one day I was thinking about all these things and my thoughts were wondering. There are a lot of things that happen during the day when you are in the SK. Some you expect, and some you don't expect. Or as my thoughts said: there are a lot of chickens that appear out of a sleeve. (not translated: er komen veel kippen uit de mouw). I realised that wasn't really how it was said. But my wondering mind thought of something else! It's a delicious recipe, with chicken. So if you are hungry this summer, make this!

Ingredients for 4 persons:

- - Chicken, 500-600 gram
- - Cherries, a large bottle
- - Pineapple, 2 large cans
- - Sour cream, 2 of the large units
- - Powder for curry sauce (not a bottle, powder to make the sauce yourself)
- - 1 pack of grated cheese
- - Croissant pastry (1 large, 1 small unit)
- - Sambal
- - Ketjap
- - Oven dish
- - Pan

Recipe:

1. Pre heat your oven to 180 degree Celsius
2. Cut in the chicken and bake it with the sambal and ketjap (add to taste)
3. Put a layer of pastry in a oven dish (not every thing, leave the small unit closed)
4. Put the cherries, pineapple, sour cream and curry powder in the pan and make it warm.
5. Put the mixture in the oven dish
6. Put the cheese over the filling
7. Close with a layer of pastry
8. Bake for 30 minutes (if the top gets too brown, seal it with aluminum foil)
9. EAT!

p.s. You can make it vegetarian by putting Quorn in it, or chicken from the vegetarian butcher.

So, I hope that you guys try the recipe, it's a personal favourite. Have a really nice holyday, and enjoy the sun!

Huggs and kisses,
The treasurer

Puuzle

Author: Truusje

According to the emails with answers to the last Puuzle, the weather must have been nice. I imagine puzzlers sitting in the sun with a cold drink and the Puuzle. The winner of the last Puuzle is Ronald Wielink, congratulations! In order to take another change to win the apple pie, solve the following question and send the answer to truusje@scintilla.utwente.nl.

There are five different association members sitting on a row. Each member is wearing a different colour shirt, is drinking something, does a different sport and has a different pet. The question is, who has the fish?

Hints

The member of Scintilla is wearing a red shirt
The IAer has a dog as pet
The Abacus member has a cola can
The green shirt sits left from the white shirt
The Fanta belongs to the green shirt
The footballer has birds at home
The swimmer wares a yellow shirt
The sprite belongs to the person in the middle
The Proto member sits in the first position (left)
The person who likes rowing sits next the owner of the cats
The person who owns a horse sits next to the swimmer
The volleyball player drinks Aquarius
The IAPC member does fitness
The Proto member wares a blue shirt
The rower has a neighbour who drinks Fristi

	Red	Green	White	Blue	Yellow	Football	Swimming	Rowing	Volleyball	Fitness	Cola	Fanta	Sprite	Aquarius	Fristi	Dog	Fish	Birds	Cats	Horse	1	2	3	4	5
Scintilla																									
Inter-*Actief*																									
Abacus																									
Proto																									
IAPC																									
1																									
2																									
3																									
4																									
5																									
Dog																									
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Birds																									
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Cola																									
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Aquarius																									
Fristi																									
Football																									
Swimming																									
Rowing																									
Volleyball																									
Fitness																									

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