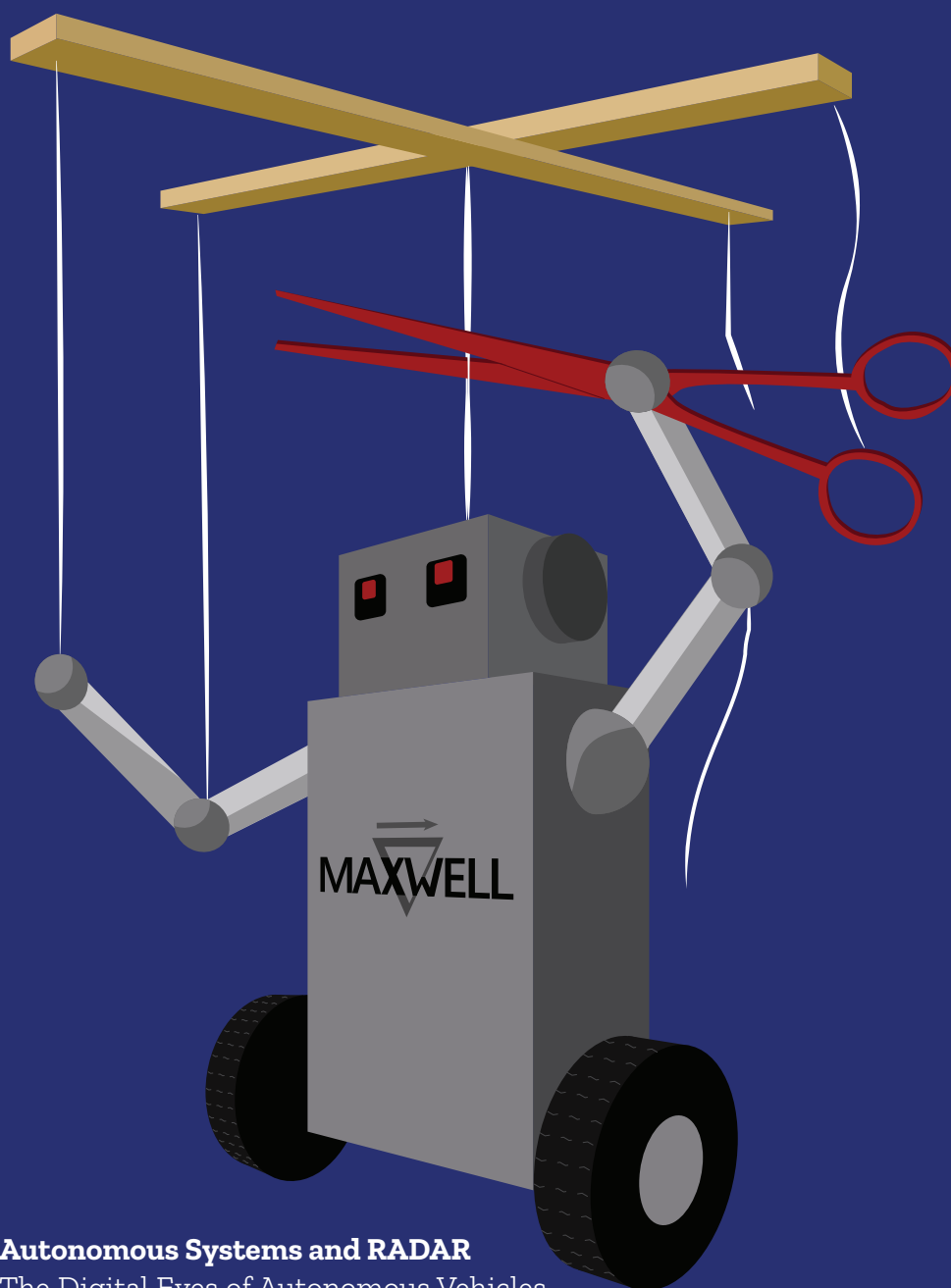# MAXWELL

Issue 22.2 | January 2019

AUTONOMY

Autonomous Systems and RADAR
The Digital Eyes of Autonomous Vehicles
Flexibility of Energy Systems
The Challenges in Balancing the Supply and Demand of Energy
Autonomous Robots
Chris Verhoeven explains why 'stupid' autonomous systems have the future

Ruimte voor talent en ambitie

INGENIEURSWERK MENSENWERK

Onze ingenieurs en adviseurs krijgen alle ruimte om het beste uit zichzelf te halen in projecten op het gebied van water, infrastructuur, milieu en bouw. Wat is jouw talent? **www.witteveenbos.nl > werken bij**

From the Board

Commisioner of Education

Lotte Zwart

Dear reader,

The first quarter has passed an everyone has settled in. This is most noticeable in the amount of questions we receive. Just before the holiday it was almost eerily quiet. However, sometimes we notice that students have complaints with which they don't know where to go. For this problem I'm designing a complaints roadmap for all possible complaints. Starting the 3rd quarter you can expect it outside the ETV boardroom on the bulletin-board.

As announced, we are definitively switching to a different book supplier. From the 3rd quarter on we will expect books from the VSSD (Student Union in Delft). On Monday the 28th of January is the last day to buy books from this quarter. Monday February the 11th, we will reopen after the February break and you can get your new books then.

Last year Chris Verhoeven was not only best lecturer of Electrical Engineering, but he was also lecturer of the year for the entirety of the faculty. Afterwards he was also nominated for best lecturer TU Delft. Unfortunately, he didn't win, but he received a lot of compliments on his teaching style and the faculty is proud to have him.

At the beginning of the year we've organised the LaTeX workshop. We were happy with the response, as a lot of first year bachelor students showed up and also a surprising amount of master students. Next year, we'll organise it earlier in the year, so master students can use it for their course on Profile Orientation and Academic Skills.

Past quarter there were also a lot of Focus Groups for the master students. The attendance this year was much higher than past years, which we're very happy with! From the Focus Groups it became clear that the changes implemented this year are well received. There were also some points of criticism which we'll take with us in next year. If you have any complaints (or compliments) regarding the educations, please don't hesitate to email me on education-etv@tudelft.nl or walk by the boardroom!

Secretary

Philip Groet

Dear reader,

The past couple of weeks have been about working on extra projects for the ETV. The Board is looking into expanding its alumni network and activities for alumni and also has sent out its first newsletter.

The ETV board thinks that alumni can and should play a vital role in the education and career of students. Currently only one edition of the Maxwell is sent to the alumni each year. In the future, a yearly alumni event will be organized and graduating students will be given shoe polishing sets to encourage them to become an ETV alumni. New alumni social and career events will ensure that students come in contact with alumni, and that alumni can meet up with their old study friends. All in all, more attention will be given to alumni and alumni will have the opportunity to exchange their experience with students and other alumni. Are you interested in becoming an ETV alumni? Mail the board at board-etv@tudelft.nl!

Editorial

Dear readers,

As a student you are living an autonomous life. There is nobody that tells you when or how much you should study. You make these decisions yourself and the consequences of these choices will become clear after the exams.

The consequences of the decision an autonomous car makes are almost immediate. For this reason, cars can only become fully autonomous once we humans trust these cars to make decisions. To make well-informed decisions, autonomous cars have to be heavily equipped with sensors.

Cars are not the only things that may become autonomous in the future. Other things that are becoming autonomous range from robots, like the Kroboot mentioned in this edition of Maxwell, to complete power grids. If these things are going to become autonomous they all need to be trusted by us humans.

I hope you enjoy reading this Maxwell!

Sebastian Jordan

Dear readers,

Imagine after a night of drinking with your friends, just stepping in your car. The car will just know where you live and drive itself to your home. Now it is still a dream for many, but this incredible future is becoming closer and closer.

From self driving cars to smart fridges. We are desperately searching for autonomous machines. In this search for autonomous systems, the most incredible technologies are being developed and who knows where this will bring us.

Personally I am most excited for the autonomous cars and hopefully, when these cars have arrived, the jokes about who has to 'BOB' that evening will finally stop.
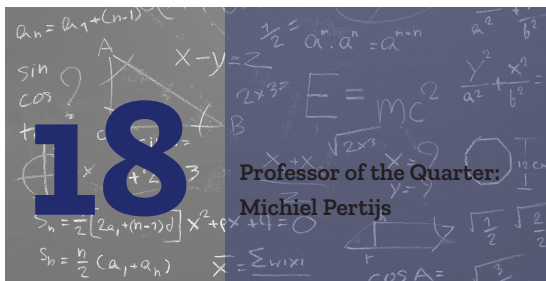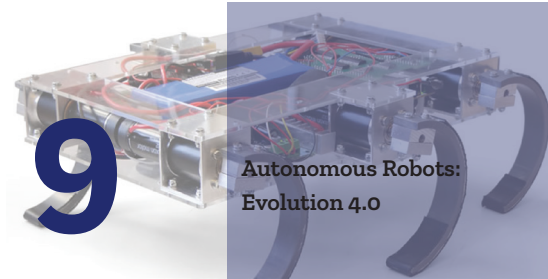
Enjoy reading this edition!

Bob van Nifterik

Index

Flexibility of Future Energy Systems

Dr. Miloš Cvetković

The global commitment to reduce the CO2 emissions, accompanied with the digitalization of the energy sector, has resulted in increasingly interconnected and interdependent energy systems. Decommissioning of fossil-fuel power plants and intentions to phase out natural gas are increasing our reliance on renewable energy resources to ensure security of energy supply. As a result, we see diverse trends for stronger integration of energy systems.

The trends in system and supply

First, the national energy carriers are becoming more interconnected. The North Sea countries have seen installment of many interconnectors in the past decade, with more to come in the following years.

Second, the amount of installed renewable generation has reached the point of frequent oversupply. Thus, there is a strong push to convert the excessive renewable energy into other forms of energy, either to be used in other applications, such as hydrogen-fueled transportation, or as temporary energy storage.

Third, reducing our dependency on natural gas will require other means to ensure warm homes, considering heat-pumps and district heating as the most viable alternatives.

Finally, the wide-spread adoption of solar and storage technologies together with electric vehicles and controllable energy consumption increases the opportunities to integrate additional amounts of renewable energy. At the same time, these trends lead to higher usage of locally-generated energy as well as to an increased appearance of off-the-grid and microgrid energy systems. At the center of the energy transition is the electric energy system, while the electricity is widely considered as the most important energy-currency of the future.
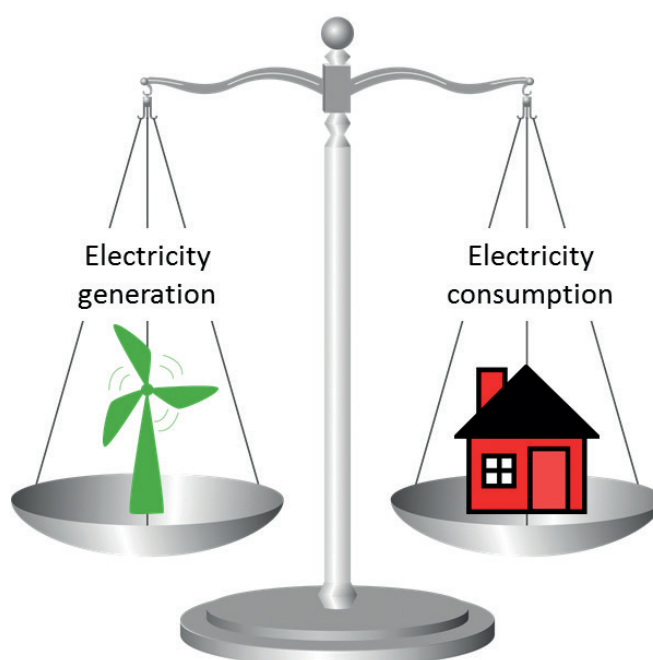
Figure 1. *Generation and consumption must always be in balance in the electricity grid.*

Finding balance in variability and uncertainty

The electric energy system requires an exact balance of electricity generation and consumption at all times. If the electricity supply and demand are not in balance, the equipment in the electricity grid could be damaged and blackouts could occur, leaving large parts of the population without electricity. With the high intake of variable and uncertain renewable energy, the balancing of energy supply and demand becomes challenging to guarantee.

Such balance has to be achieved at all times and for all amounts of electrical energy, in spite of variability. On one side, the fast increase or decrease in wind speed has to be accommodated at short time intervals of seconds and minutes. On the other side, the seasonal variations in wind energy should also be absorbed by the energy system. Similarly, power and energy balancing are needed for both large and small amounts of electrical energy variations, coming from as small resources as household solar panels and as large as offshore wind farms.

Uncertainty is another characteristic of renewable energy resources that has to be planned and accommodated for. It is difficult to say with certainty how windy or cloudy it will be at a given day and time in the future. For example, our current wind energy forecasting methods work with an accuracy of around 20% when looking one day into the future. The accuracy increases for shorter time horizons and decreases for longer time horizons.

by adjustable consumption devices (demand-side flexibility).

Energy storage devices, such as batteries and other forms of energy carriers (Li-ion, heat, hydrogen, etc.), can be used to temporarily or permanently store excessive energy or to make up for an energy shortage if needed. Depending on the type and size of these units, they could be used in various ways.

renewable generation spills sustainable energy, engagement of fossil-fuel plants does not improve our carbon footprint. Finally, demand-side flexibility relies on adjusting consumption patterns in order to accommodate for variability in renewable generation. This is typically done by using demand response schemes, which provide rules for consuming electricity. Although there are different ways in which consumptions assets can be engaged to provide flexibility, we typically differentiate between direct control and price-based control as the two most commonly used categories. Under direct control, a grid operator sends a request to demand responsive unit, asking it to adjust its consumption by a pre-determined amount of power or energy. The main characteristic of this approach is that the exact amount of power or energy consumption to be curtailed is known by both parties. In contrast, with price-based control, a grid operator achieves consumption curtailment by selecting an appropriate price. Higher electricity price, results in higher reduction of consumption. The main characteristic of this approach is that the grid operator can never be certain in the amount of consumption reduction a price signal would create.
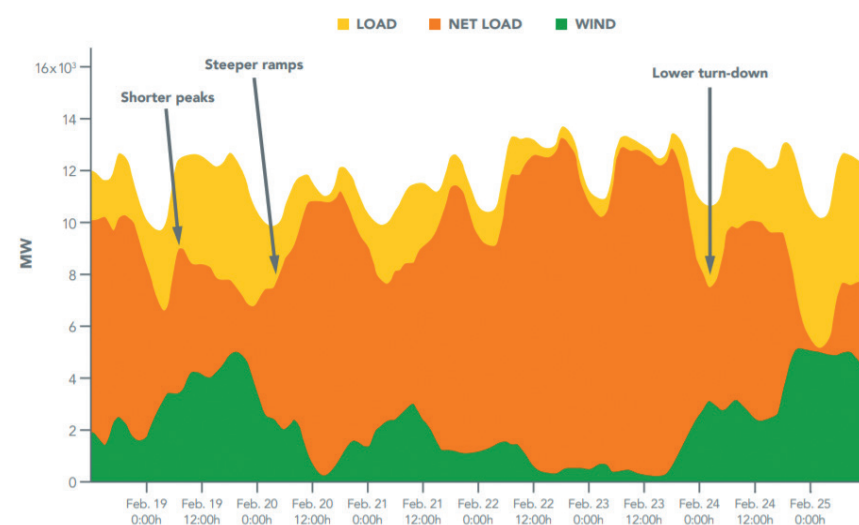
Figure 2. *Greater need for flexibility will result from steep ramps of wind and solar generation, and from the large range in power production in short time intervals [1].*
Net load refers to the difference between the load and wind generation.

The pathways to flexibility

To ensure that generation matches consumption in the presence of variability and uncertainty of renewables, the electric energy system has to be flexible. Flexibility refers to the capability of the electricity grids to match generation with consumption under all conditions. By the term 'all conditions', we usually consider variability and uncertainty of renewable energy resources.

There are plenty of ways in which an energy system could assure flexibility. The flexibility can be provided by storage units (storage flexibility), generation plants (generation-side flexibility) and

For example, while large hydro-reservoirs are used to store the seasonal surplus of energy, electric vehicle batteries can be used to smoothen variations within an hour.

Alternatively, we can adjust the generation to compensate for variability. For fossil-fuel power plants, such as coal and natural gas, this would mean adjusting the intake of the primary fuel. For converter-based renewable generation, curtailing the level of power output would have the same result. However, neither of these two approaches are preferred when compared to the other flexibility options. While the curtailment of

Co-simulation for a better solution

A big research and implementation challenge with measuring the impact of these flexibility solutions is in modeling and simulation. Since the solutions for providing flexibility are relatively new, our existing simulation tools cannot easily represent them, because these tools had been developed earlier and for a different purpose. One approach to improving our modeling and simulation capabilities is by using co-simulation.

Co-simulation stands for 'combined simulation' and it represents a set of methodologies which are used to create better simulation models of energy grids. With co-simulation, we can easily represent multi-energy systems, new technologies like electrolyzers, control algorithms together with ICT and grid dynamics, consumer behavior together with market models, etc. In other words, the co-simulation methodology is suitable for supporting energy transition, because it allows us to model and simulate new technologies and new applications.

If speaking about flexibility, co-simulation helps us to evaluate different flexibility management and control techniques, to quantify available flexibility levels in various technologies, to estimate the impact of flexibility provision on the intake of renewable energy, and so on.

Providing flexibility in the future

In summary, the flexibility of the electric energy system is a highly-desired property that helps to accommodate high levels of renewable energy under variability and uncertainty. The flexibility can be assured from generation-side, consumption-side and storage resources, or by combining all these flexibility types together. In the future, we will witness the expansion of capacities and engagement of more resources in providing flexibility.
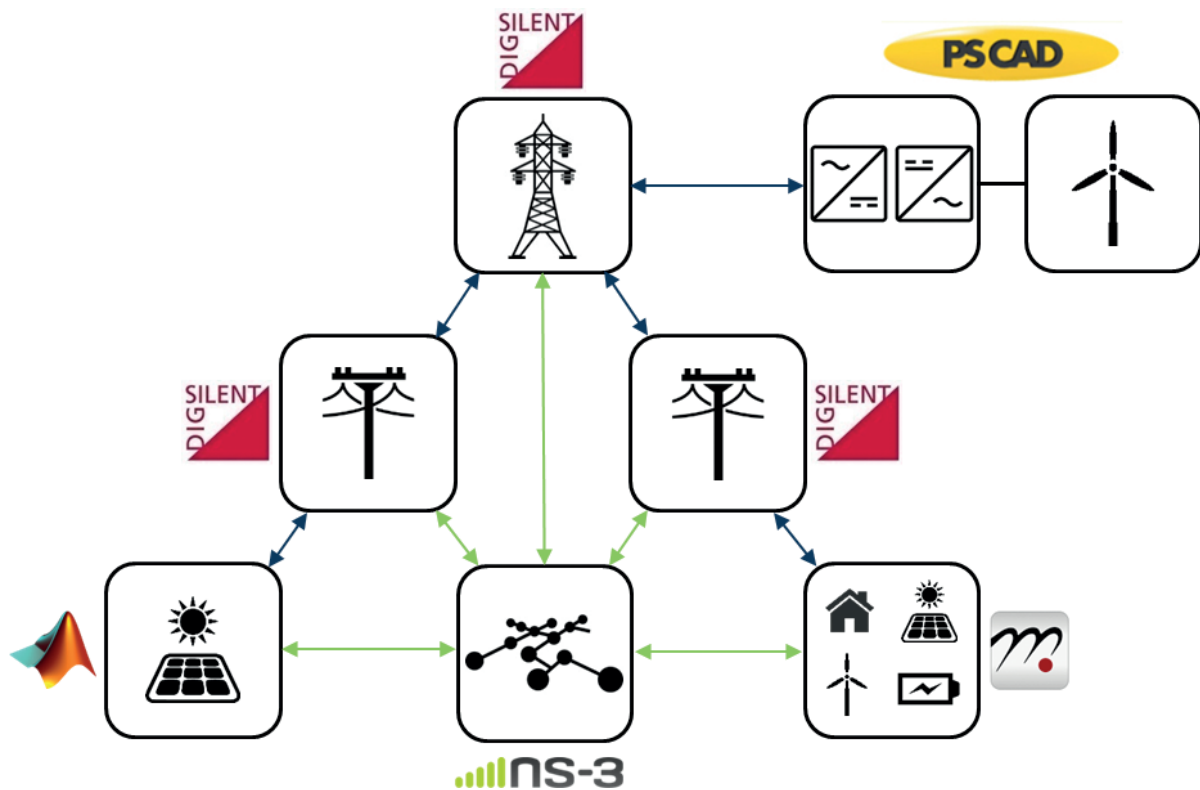
Figure 3. *An example illustration of co-simulation. In this image, we see a wind farm modeled in PSCAD, connected to the transmission grid (DigSilent), which is then connected to two distribution grids (DigSilent). Different renewable and storage resources (modeled in Matlab and Modelica) are connected to the distribution grids. Finally, the communication among them is modeled in NS-3.*

[1]   Jaquelin Cochran et al. "Flexibility in 21st Century Power Systems", 2014.

Autonomous Robots

Why autonomous systems do not need to be intelligent

Dr. Ir. Chris Verhoeven

Autonomy describes a property of entities around us that we have liked since the beginning of human existence. We are used to it. We are addicted to it. We just did not name it 'autonomy' before. That is why we are afraid of autonomous cars, drones and other robots. We are not, in general, afraid of cats, dogs, horses, elephants and other animals that are fully autonomous. We cooperate with them, or in the case of cats are tolerated by them. We like their independence and their ability to keep themselves (and even us) safe. You can drink a lot of alcohol, but your horse will bring you back home safely. It is funny that we accept that our cars are not able to do the same. Horses like that tend to be eaten.

Since the industrial revolution and the emergence of machines the entities in our environment have lost the property of autonomy, and for some reason we did not notice. Perhaps we were so impressed by the power and speed of the new machines that we were happy they did not have the attitude of a cat. We should have thought of dogs. But of course, it would also have been very difficult to technically implement autonomy in a car when the best we could do at the time were the Analytical Engine

> *"What is happening now is Evolution 4.0."*

of Charles Babbage and the automata of Pierre Jaquet-Droz. It is different now. Especially the disciplines we teach at EEMCS have developed so far that there should be no technical show stoppers anymore. However, there seem to be enough legal and societal showstoppers. We have become afraid of autonomy thanks to our own malicious human-projection creations like Terminator.

But we are creators indeed. What is happening now (at least according to me) is Evolution 4.0. Starting with "life" based on a few proteins, the emergence of DNA, one-celled organisms and their cooperation in multi-celled creatures, we have now arrived at the phase where evolution adopts "creative and independent thinking". Because of this, the next step in evolution is being taken now: the emergence of electric animals, the Electroids. Robots are animals.

This means that you can expect that people will react to robots like they react to animals.

▷

Figure 1. *Autonomous truck..*

Figure 2. *Beetle in Blijdorp Zoo.*

When our Zebros (ZEsBenigeRObot) meet the general public at exhibitions and other public events, I think I see this happening indeed. So, I expect people to accept the autonomy of robots in the end and even desire it. I would like to have a few beers and still reach home safely in my autonomous car, like the rest of humanity was able to do in the past. It makes me feel silly that with all our technology, we are not able to make a better horse, and apparently do not even want to. Autonomy was the past and it is the future.

Still, there is a lot of discussion needed on what autonomy is. The first time I started seriously thinking about this was in Blijdorp Zoo. At that time they had a terrarium crowed with Pachnoda Marginata. This is a beetle that lives in Africa and is very easy to breed (so I have around 150 of them at home now...). Next to this article you can see the first, unfortunately blurry, picture of something that really amazed me. There was a beetle lying on its back, moving its legs as if it was walking, but instead it

was rotating a piece of crap that it had in its legs. The beetle did not notice it was on its back, that it was not moving and that is was not touching the ground. And it kept doing this for minutes. Its persistence made me think that it would finally die of starvation because it would never reach any food. And I imagined that this might happen to more beetles. So, I wondered why these stupid creatures did not become extinct. But then I realized that they have been around for about 300 million years, survived mass extinction waves and hardly changed over that period. You could call that a robust design. And the beetle in Blijdorp Zoo survived too. After some time, it got tired and relaxed. So, the piece of crap dropped from its legs and when it was rested it felt nothing in its legs anymore, so it started the "roll-over procedure". The beetle escaped from a deadlock situation via a global reset. I had already recognized the beetle as the carbon-based version of our Zebro and now I realized that making the Zebro autonomous did not mean making it intelligent, nor complex. An autonomous robot (Electroid) must be able to survive in its environment without our help and keep itself and us safe. So, it will co-ex-

ist with us and maybe interact with us, but the latter may be in a very primitive way, for example that it is afraid of us and tries to avoid us. That is why you will see in the Zebro lab that we are trying to keep the Zebros sparse of sensors and restricted in repertoire. They just need to be able to survive and do their little thingy.

> *"I realized that making the Zebro autonomous did not mean making it intelligent, nor complex."*

To achieve something impressive, they do what insects do and that is form a swarm. Zebros seem to be good survivors in the sense that the do not easily get stuck in any terrain. The first hexapod and inspiration for the Zebro, the Rhex, made by Boston Dynamics, was designed for exactly that. The only thing is that the Rhex tries to be smart and I think that is stupid.

There is clearly a niche for Electroid swarms in our society. Swarms can explore large areas even on the moon or
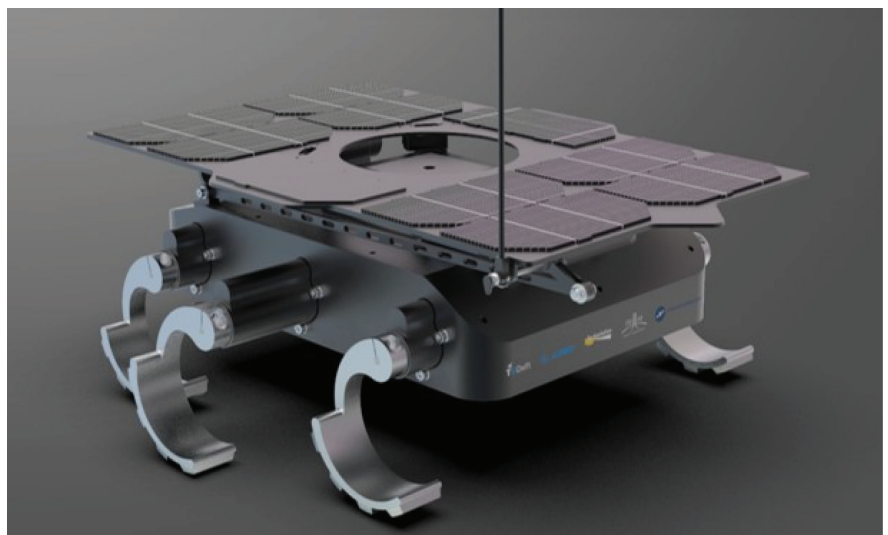
Figure 3. *TU-Delft Moon Zebro. Launch planned 2021.*
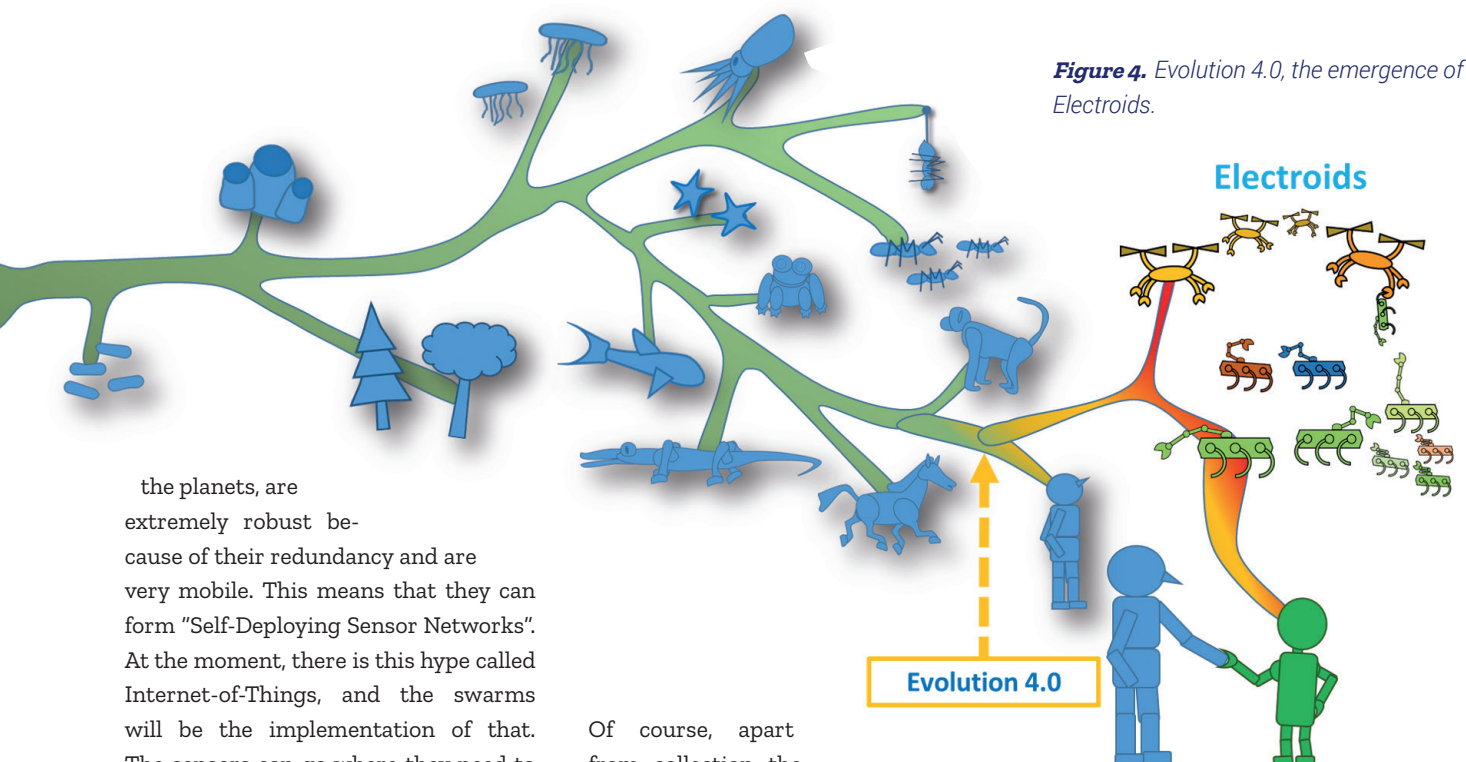
the planets, are extremely robust because of their redundancy and are very mobile. This means that they can form "Self-Deploying Sensor Networks". At the moment, there is this hype called Internet-of-Things, and the swarms will be the implementation of that. The sensors can go where they need to be and can also go away when they are not needed anymore. Self-deploying, self-cleaning and of course self-repairing. When a robot dies and leaves the

> *"Now it is time to think about our man-animal relation with the robots."*

sensor network, its place is automatically taken by another robot. There is a clear need for this and a first spin-off company with a first real launching customer has been started already.

Of course, apart from collection the data, the swarm robots can also exchange and store the data. And since they can still carry quite powerful processors the swarm would be able to do smart things like finding correlations, do interferometry and extract and report detected features. There will be no need to upload to data or the derived information to some cloud. The swarm is the cloud. Internet of Things becomes Internet-of-Robots.

Now it is time to think about our man-animal relation with the robots. We trust animals not because we can control them, but because we can command them. We do not control their muscles with a joystick, a pedal or a steering wheel. We trust them to obey us and translate our ambiguous or erroneous commands into safe action. They do what we want, and not what we say. Autonomy means safety. We do want a better horse.

Zebros

Zebro's are built to copy the cooperative behavior we see in groups of animals in nature. This means Zebro's can only communicate with local neighbours, and have to make their own decisions. There cannot be a central computer that drives the swarm, so that the swarm is not dependent on a single source of instructions. This is quite complex, since all robots now have to communicate with their neighbours and make choices based on this communication. The robots should move autonomously, but still as a group. To achieve this, three types of algorithms are used: Attraction/Repulsion, Obstacle Avoidance and Alignment. More algorithms are being developed to facilitate fully autonomous charging, efficient exploration and data sharing intelligence.

A new route for Nuna9S

Martijn Hoogelander

The Nuon Solar Team is well-known for its achievements in solar racing, both in Australia and in South-Africa. However, there is more than meets the eye: for the Electrical Engineers, there are many more challenges than solely optimizing Nuna's efficiency. This article will give you an overview of all the tasks and events that I have encountered during my year as Electrical Engineer for Nuna9S.

The Solar Challenges around the world

The Nuon Solar Team has a two-year cycle. The World Solar Challenge (WSC) is held once every two years, and for this race, a new car is designed and built. The main focus in these years lies on aerodynamics, structures and the topologies of the electrical power system and the solar panel. The other year, in which there is no WSC, we participate in the Sasol Solar Challenge (SASC) in South-Africa. This year is seen as a great opportunity to do R&D and try entirely new things. My team and I worked towards this race last year.

The Intelligent Cruise Control

The large freedom in (design) choices in my year also meant that it was difficult to choose what projects we were going to work on as a new team. After various lengthy brainstorm sessions, we decided to set our goal in an entirely new field of technology for the Nuon Solar Team: the implementation of Advanced-Driver Assistance Systems (ADAS). The aim:

have Nuna9S equipped with our Intelligent Cruise Control (ICC) to cope with the crowded traffic and the gradients of the route of the SASC in 2018. The ICC was divided into three subsystems: the Adaptive Cruise Control (ACC), the slope optimization and OXII; our new onboard computer that was programmed from scratch. I will focus mainly on the ACC, since this is the part where I had a big contribution.

The Adaptive Cruise Control

A simplified diagram of the ACC is shown in Figure 1. The radar shows up to 150 objects, with each its own speed, distance, Radar Cross-Section (RCS) and movement type data at its output. The software decides which object should be followed. The control, consisting of two PID controllers, maintains Nuna's velocity and distance with respect to the selected target. The output of the controllers is an input power level for Nuna's brushless DC motor.
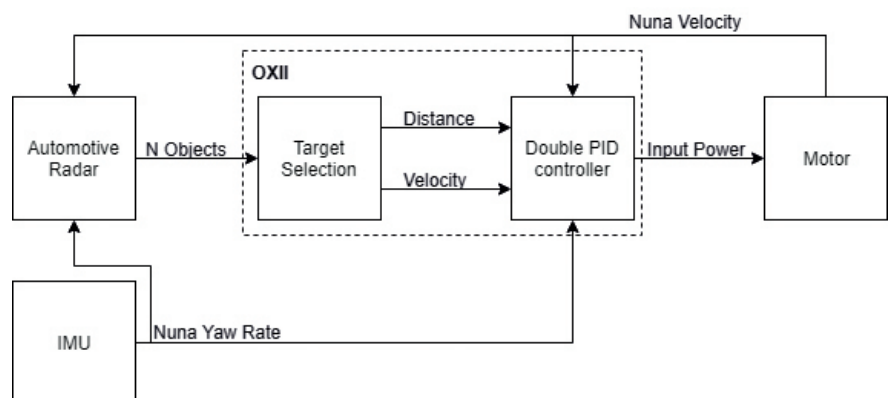

Figure 1. *Block diagram of the control system.*

For the Electrical Engineers, the main tasks regarding the ACC included testing the hardware and designing the software of both the radar sensing system and the motor. An off-the-shelf automotive radar was used, because of reliability reasons and the limited development time of our project.

The integration of the radar with the solar car body was easier said than done. The radar would be placed in Nuna's leading edge, which is, aerodynamically seen, the most critical part of every catamaran-like solar car. A lot of carbon had to be removed from the leading edge and be replaced with polystyrene, because carbon-fiber is not transparent for the radio frequencies used in automotive radar applications. After the replacement was completed, filler primer was applied to smoothen the leading edge again.

The operation of an automotive radar is heavily dependent on the materials in its surroundings, so correct operation of the radar had to be validated with new materials in its surroundings. Would the radar still work properly after applying the filling primer? Would the same be true after placing it in a carbon surrounding, despite all the reflections? Does the radar detect any 'phantom' objects?

All these questions (and more) had to be answered before we could trust the radar to be the eyes of the ACC. Luckily, the radar system did not return any unreliable detections, even though the detections were of a weaker magnitude.

Software design

Another part of the system was the software, where I focused on the target selection. As mentioned before, our radar could track up to 150 objects, including the distances, velocities, RCS and movement types. Of all these objects, only one single object had to be selected – one that is moving with respect to the static environment and is right in front of the Nuna.

After designing the software, it had to be tested, validated and tested again. In order for the final product to be most reliable, the detection and control systems had to provide us with as much feedback as possible. This was a very important aspect, since in the end, one of the drivers will trust the ACC system output to determine the speed of the solar car.

At the end of the route

The ICC project was one of many tasks for the Electrical Engineers. The Nuna9S had to perform optimally during the SASC. That meant that the electrical system had to be maintained properly and be improved where possible. While this sounds like a fairly easy task, it proved to be a very time-consuming one!

When people ask me about the greatest thing I learned this year, I reply that being part of the Nuon Solar Team was a unique chance to truly learn about teamwork, to employ a pragmatic approach to problems, to program in a structured manner and, of course, to validate designs in the testing phase. Many of the skills acquired throughout the year are tested to the extreme during the climax of the year: the race.

During the race, the two Electrical Engineers were drivers. Unfortunately, a few, yet major technical problems were encountered in the electrical system during the SASC. That meant that we had to work very hard to solve the electrical problems during the nights, while driving the solar car during the days.

Together with a few other setbacks, this caused our race to be nerve-wrecking and extremely exhausting. However, these circumstances also made the entire event unforgettable. By never giving up and by continuing to collaborate as a team, we managed to return home with another first place for Nuna!

Figure 2. *Nuna9s in action during the Sasol Solar Challenge.*

Study Collection
The design of a tone generator

Kees Pronk, Otto Rompelman and Piet Trimp

The reader of these regular contributions by the Study Collection of EWI [1] will expect an article explaining the functioning of a piece of equipment from the early days of electricity. Well, the explanation will come later but first the authors would like to ask you to try to design a tone generator according to the following specification:

Designing a tone generator

We would like to have a tone generator for testing audio equipment, loudspeakers, tone control filters and similar equipment. The generator should produce sinusoidal waves from 30 Hz to 16 kHz, have a practically flat output level in this frequency range and have a distortion of less than 0.4%. The output should be delivered into loads of 1000, 500, 250 and 50 Ohms and have a maximum level of 200 mW. At the expense of a slightly greater distortion, the output can be further increased to 1 W such as to drive a loudspeaker directly. The instrument should not be a top-class ultra-precise tone generator, but an easily transportable piece of equipment designed to work in various situations. One particular requirement is that our generator should be able to range through all the output frequencies with only one turn of a dial. A second dial should be used to shift the frequency shown on the first dial with an offset from 0 .. 1000 Hz.

And by the way, we are situated around the year 1940, so the technology should be analog and use vacuum tubes. So, we will be quiet for some time while you, the reader, should try to design such a generator according to the above specifications.

Hoping you have succeeded, we will start the discussion now. By the way, this article is an adapted version of the description of the Philips GM 2307 tone generator by L. Blok [2]. This generator is part of the inventory of tone generators of the Study Collection. The generator intrigued us because of the front
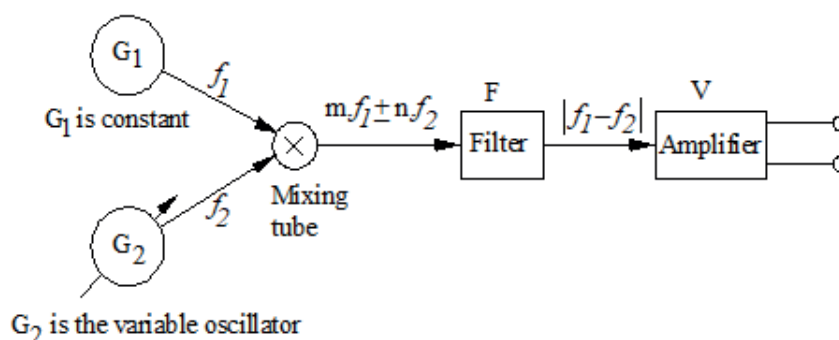
Figure 1. *Heterodyning principle as used in the tone generator.*

panel cathode ray indicator, a device we know as a tuning indicator in radio receivers from the fifties of the previous century of which we have many examples in our collection. We decided to revive this generator and succeeded in getting the generator into a working state again. This article will describe the result of our investigations.

The requirement to range through all the frequencies with only one turn of a dial will rule out conventional tone generators based upon Wien bridges and so

on. Also, adjustable L-C-oscillators are ruled out because of the high values of L and C needed for the audio range, so we will have to look for another mechanism.

The heterodyning principle

Heterodyning is a signal processing technique that creates new frequencies by combining or mixing two frequencies. Heterodyning, for example, is used to shift one frequency range into another, new one. The two frequencies are combined in a nonlinear (multiplying)
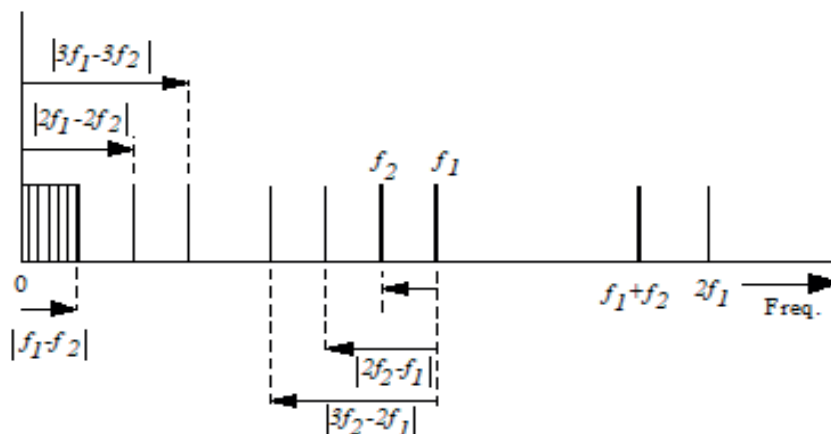

Figure 2. *The frequency spectrum resulting from the mixing process*

Figure 5. *Heterodyning principle as used in the tone generator.*

electronic device such as a special vacuum tube, usually called a mixer. Suppose we have two signals $x_1(t) = \sin(2 \pi f_1 t)$ and $x_2(t) = \sin(2 \pi f_2 t)$, and the nonlinear device performs a pure multiplication. Then, the output signal xr(t) is found to be

$$x_r(t) = x_1(t) \cdot x_2(t)$$
$$x_r(t) = \{cos[2\pi(f_1\text{-}f_2)t] - cos[2\pi(f_1+f_2)t]\}$$

or, in terms of the spectral components

$$X_r(f) = 1/2\ (f_1\text{-}f_2) + 1/2\ (f_1+f_2)$$

From this equation, it becomes immediately obvious that we may generate a low frequency
$f_0 = (f_1 - f_2)$ by multiplying two relatively high frequencies f_1 and f_2 and suppressing the high-frequency component f = $(f_1 + f_2)$ by means of a low pass filter. Usually, the nonlinearity involved deviates from being purely multiplicative, which is the case in almost all nonlinear

devices, such as the vacuum tube in the instrument described here. In this case, the output signal will also comprise components with multiples of f_1, f_2, as well as $(f_1 - f_2)$ and $(f_1 + f_2)$, or in general: m. $f_1 \pm$ n.f_2 (m, n = 0, 1, 2, ...). However, the basic principle is maintained, since all generated components apart from the desired component $f_0 = (f_1 - f_2)$ have frequencies far beyond f_0. It should be noted that, based on the choices for f_1 and f_2, the value of ($f_1 - f_2$) might become negative. In this case we need to write $| f_1 - f_2 |$.

A variable low frequency can now be arrived at by generating one fixed and one variable frequency. Hence, in a variable low frequency signal generator we employ one fixed and one variable frequency generator, respectively G1 and G2. The principle of such a generator is depicted in fig. 1. Both generated signals are fed into the mixer and the desired signal is obtained by means of a low pass filter (F) and amplified by V.
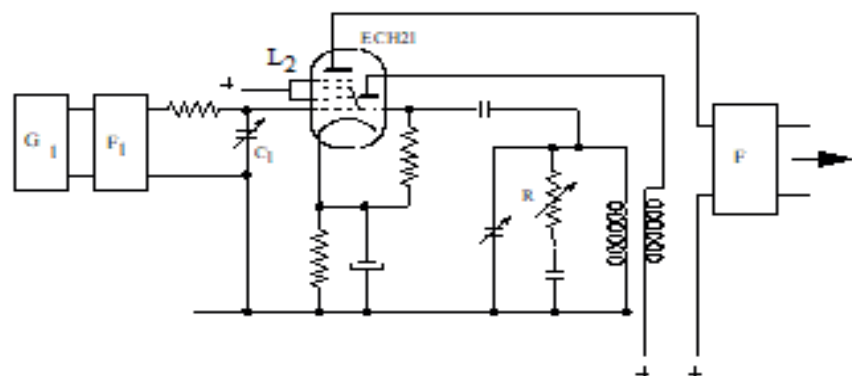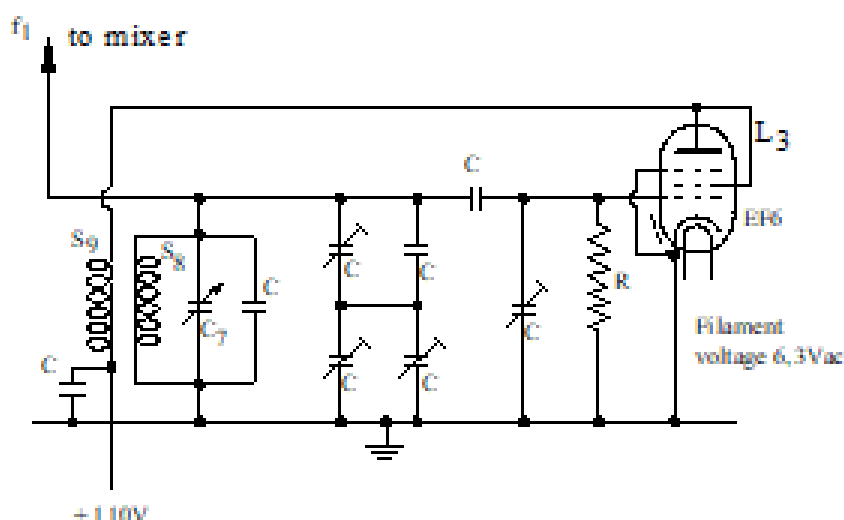
▷

Figure 3. *Diagram of the mixing stage and the G2 oscillator for f2.*

Figure 4. *Diagram of the tunable oscillator G1 for f1.*

From the spectral representation of the output signal of the mixer (fig. 2), it may be clear that high values f_1 and f_2 will allow for easy removal of the generated yet undesired high-frequency components. However, it should be noted that a small deviation (in terms of percentage) from the set values of f1 and f2 will result in large absolute frequency deviations, resulting in the same large deviations of the desired frequency f0. This imposes high demands on the stability of both generators.

In the case at issue, f1 is chosen to be 100 kHz and f2 is variable between 85 kHz and 100 kHz. To enable the functionality required by the second dial, (i.e. allowing for calibration with respect to the scale of the variable oscillator) the frequency f1 is not constant: it is allowed to be varied between 100 kHz and 101 kHz. More information on the heterodyning process is available from [3].

Details of the diagrams

Figure 3 shows the details of the oscillator G2 and the mixing stage. The triode part forms the oscillator G2, the hexode part performs the mixing function. The frequency of the oscillator is determined by a regular LC-circuit using a rotating capacitor with air as isolation. The signal from G1 is coupled to the first grid of the hexode and the signal from G2 is coupled to the fourth grid of the hexode. The anode current of the hexode is the product of the two frequencies f1 and f2. The filter F1 removes the harmonics produced by G1, while at the same time preventing a reaction of G1 on the signal from G2. The capacitor C1 serves to regulate the distortion and the output level of the generator. Resistor R serves to adjust the zero point correction of the frequency scales and will be described below.

Figure 4 shows the oscillator G1, producing the frequency f1. The frequency is determined by an LC-circuit; the variable capacitor C7 regulates the frequency being between 100 kHz and 101 kHz.

The zero point correction

In order to make the calibration of the frequency scales agree with the frequencies actually obtained (in spite of any frequency variations from fluctuations in the temperature of the housing,) another small capacitor with an adjustable resistor R in series is connected in parallel with the rotating capacitor of the oscillator G2 (see fig. 3). By varying R, the small capacitor is made to contribute more to the total capacitance,
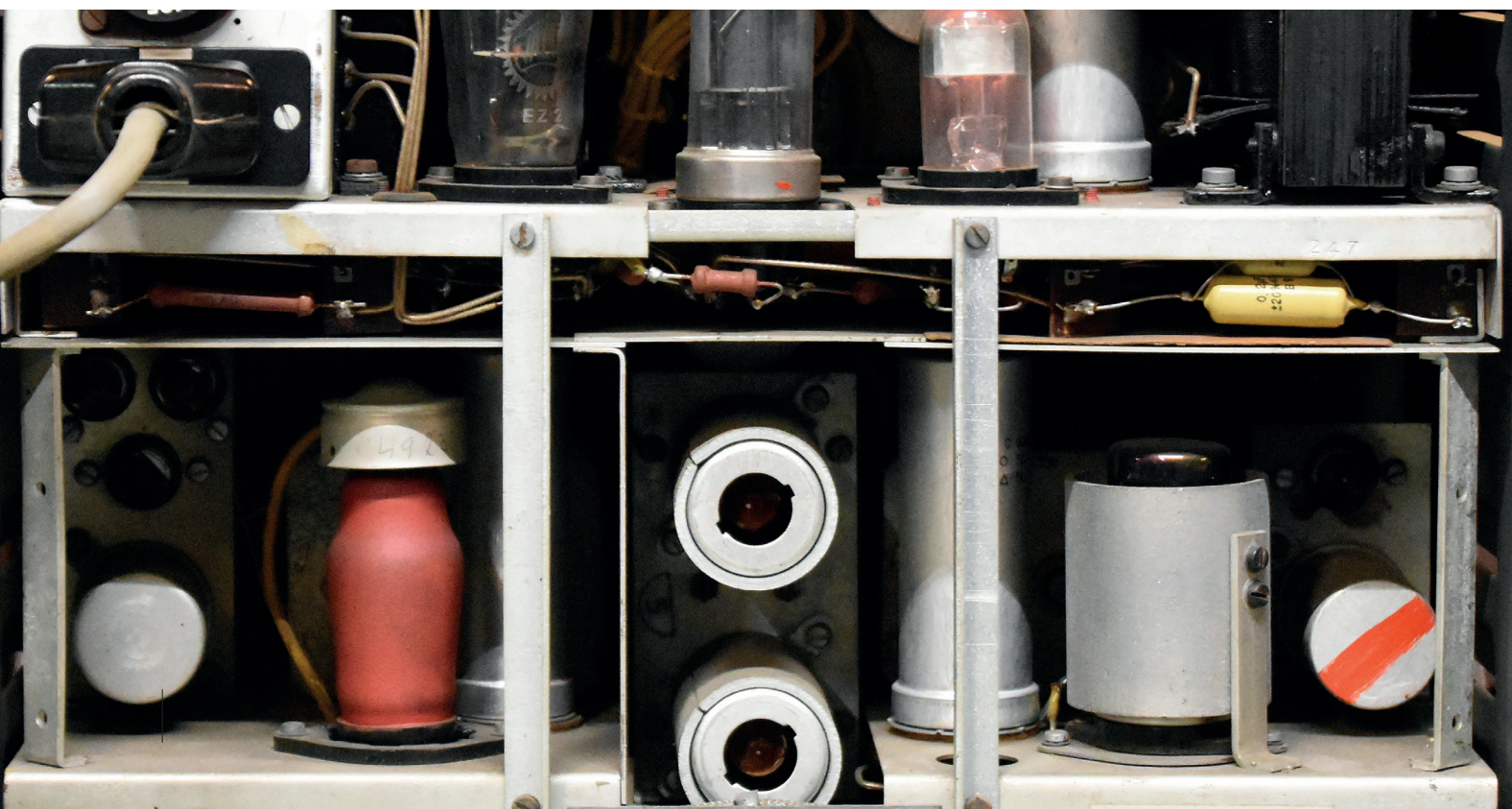
and in this way the frequency of G2 is slightly affected. When the two rotating capacitors are set at the zero position of the frequency scales, f2 can be made exactly equal to f1 by means of this fine regulation and therefore f0 = 0 Hz. The equality of f1 and f2 can be ascertained by means of a cathode ray indicator in L1; a circuit derived from a tuning indicator in a radio receiver. More details on this tube can be found in [6].

The output amplifier

The output amplifier will not be described here in detail. It is constructed as a regular output stage of a radio receiver from that era. The pentode part of L1 is used as a preamplifier and the power pentode (L4) drives the output transformer. Negative feedback is used to reduce distortion in this amplifier. More details may be found in the full diagram reproduced in [4].

Figure 5 shows the front view of the GM 2307, the two frequency scales, from 0 to 1000Hz and from 0 to 15.000 Hz and the dials of the rotating capacitors. Above in the middle we find the cathode ray indicator.

In Figure 6 the rear view of the generator shows that the heat-producing elements (the power supply and the power amplifier) have been placed at the top level. In order to reduce the temperature sensitivity of the generators G1 and G2, the two oscillators have been placed at the bottom level.

Figure 7 shows the cathode ray indicator. With both frequency dials placed in the zero position, the resistor R (see Figure 3) will be varied until the observed beat frequency equals zero and the display will be stable. The green bands of the indicator will fluctuate according to the 'beat frequency' of the oscillators f1 and f2. When | f1 − f2 | = 0, the green bands will be steady.

Conclusion

We have discussed the design of a remarkable tone generator, the Philips GM 2307. We started the discussion with a question to the reader: How would you design such a tone generator from the specifications given? We want to end this article with another question:

Could such a design be implemented with either transistors, an analog IC, or through digital technology? Or could we arrive at the desired specifications by applying a completely different approach using contemporary methods and technology?

⏚
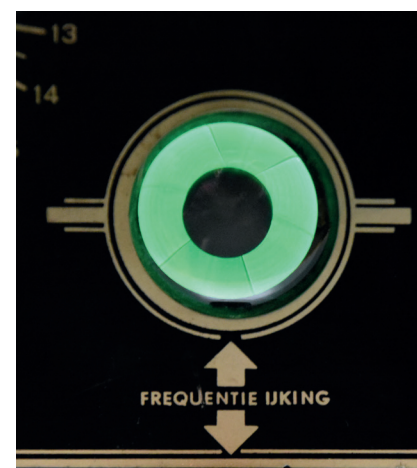
Figure 7. *The cathode ray indicator.*

[1]   Study Collection EWI, TU Delft.   https://studieverzameling.ewi.tudelft.nl/

[2]   L. Blok, A Tone Generator; in Philips Technical Review, Volume 5, No 9, 1940   http://www.extra.research.philips.com/hera/people/aarts/_Philips%20Bound%20Archive/PTechReview/PTechReview-05-1940-263.pdf

[3]   More information on the heterodyning principle may be found in: https://en.wikipedia.org/wiki/Heterodyne

[4]   Full details and diagrams of the GM 2307 are given in: https://www.pa3esy.nl/Philips/meetinstrumenten/html/gm2307A/pdf/GM2307_1.pdf

[5]   The vacuum tubes used in the tone generator GM 2307 are:

L1 = EFM1	Pentode + cathode ray indicator	LF-amplifier and indicator
L2 = ECH3	Triode + Hexode	Oscillator and mixer
L3 = EF6	Pentode	Fixed frequency oscillator
L4 = EL3	Pentode	Power output stage
L5 = EZ2	Double diode	Rectification for power supply
L6 = 150A1	Neon stabilisation tube	Power stabilisation

[7]   Information about the EFM1 tuning indicator may be found here: https://www.radiomuseum.org/tubes/tube_efm1.html

Professor of the Quarter
Michiel Pertijs

Stefanie Brackenhoff
Karen van der Werff

Every quarter, the Maxwell Committee interviews a Professor of the Quarter. This professor is chosen by asking Bachelor students which professors from the upcoming quarter they like best. The professor of this quarter has been chosen to be: Michiel Pertijs.
Michiel Pertijs is an associate professor at the Electronic Instrumentation Laboratory within the Department of Microelectronics. His research currently focuses on ultrasound and its applications in medical imaging. Additionally, he teaches the courses 'Amplifiers and Instrumentation' in the Bachelor's programme and 'Measurement and Instrumentation' in the Master's programme. We visited him to ask more about him and his research.

What attracted you to the field of microelectronics, and more specifically sensors?
What I like about sensors is their multidisciplinary nature. They make the link between electronic systems and the world around us, functioning as the ears and eyes of these systems. Our environment does not consist of 1's and 0's, it is an analog world with all kinds of physical phenomena that, in the end, generate the information that goes around in computers and on the internet. Sensors are capturing these phenomena. This implies that when you work on sensors, you also have to learn about various topics beyond the scope of electrical engineering.

"Sensors make the link between electronic systems and the world around us, functioning as the ears and eyes of these systems"

I have worked on temperature sensors for my PhD, but nowadays I mainly focus on ultrasound and ultrasonic sensors for medical imaging. When I started working in this area, a whole new world opened up. I had been working on

microelectronics and integrated circuit design for several years, but suddenly I had to learn about acoustics, transducer design and medical imaging. Of course, a single person cannot manage to become an expert on all these fields. However, it is interesting to gain insight into these fields and interact with people who are experts. By working together in a team, you can then make something happen. While this is true for many areas of electrical engineering, sensors make bridges to other domains very naturally.

What is the most interesting project you have worked on?
It is difficult to choose one! I would probably say the work we have been doing on echocardiography, which is the imaging of the heart. We are making very small ultrasound probes, small enough to fit at the tip of a catheter. This enables a doctor to make real-time 3D images from the inside of the heart, which are crucial in minimally invasive procedures. For example, a patient who needs a valve replacement would traditionally have had an open-chest surgery, which is very expensive and demanding. Nowadays, this replacement can be done by catheter-based devices. These devices allow artificial valves to be inserted via the arteries and unfold in the heart – it is quite like magic! However, imaging is crucial in such operations, as the physi-

cian would otherwise have no view on what he or she is doing. Ultrasound is a good fit for this application, as it has no harmful ionizing radiation and can be used real-time.

We are contributing to a project that works on such a probe. It is a good example of a medical device that you would not be able to make without the microelectronic technology and knowledge that we have here. This is because for such a device, many individual sensors are needed to be able to make a proper 3D image. Trying to realize the catheter without miniaturized electronics would not be realistic.

If there is anything you were to invest in, what would it be?
I think that we should work towards smart ultrasound devices. When we talk about smart sensors in our lab, we talk about sensors that can talk directly to a computer. All the relevant information is directly digitized in the device itself. Where we currently are with regards to ultrasound devices can be compared to the old-fashioned analog telephones: everything is wired. Taking that analogy further, then the smartphone is where we should go.

However, making ultrasound devices 'smart' is not the only step. Another im-

portant aspect would be to get the sonographer, the required expert, out of the loop. For instance, you could use the cloud to upload your ultrasound image and some artificial intelligence, that relies on the collective knowledge of various patients, can give relevant feedback to the general practitioner to improve diagnoses.

Thus, there are a lot of opportunities that will have a positive impact on people's lives; an upcoming revolution that is worth spending money on. Investing in the technologies to reduce cost and the required level of expertise would enable a more widespread use of ultrasound. In turn, relevant applications, such as health screenings, could be developed better and faster. Nowadays, more and more start-ups are arising that are doing just that. Think of ultrasound devices that connect straight to your phone. Every emergency physician could wear it next to their stethoscope, enabling them not only to hear, but also to see.

The theme of this Maxwell is Autonomy. Are there bridges between your research and autonomy?
We have several research themes in our department, one being 'autonomous sensors'. The focus of this theme is to make sensing system devices that can work without maintenance, collecting and processing data and sending information to the cloud. One of the big challenges in these miniature devices is the power consumption, as every action requires power. Even though my research fits naturally within the 'health'-theme, in one way we are heavily investing in research on low power design techniques. While this is crucial in autonomous sensors, it is important in medical probes too – these might be battery-powered or not allowed to get hot, which is the case for intracardiac catheters.

Thus, the techniques we develop here are also relevant to autonomously-operating devices.

A different sense of autonomy relates to the user, who is using a device to help him or her become more autonomous and stay independent of medical care

over the world. One of the main conferences on chip design is the European Solid State Circuits Conference, where I have been involved in the organization as well. Furthermore, I have had the honour of being an associate editor of the Journal of Solid State Circuits. As

Of course, there is room for improvement in that, as you need to find the balance between academics and education. That is the struggle in the academic world: we are driven to publish and at the same time we teach. While 'publish or perish' is a well-known saying among researchers, preparing material for teaching also requires time.

"It will have a positive impact on people's lives; an upcoming revolution that is worth spending money on"

for a longer amount of time. Our group is involved in a European project that develops ultrasound devices for various such applications. What we are currently working on is a sensor for bladder monitoring. A plaster is stuck on a patient's belly, sending pulses into the body. These pulses are reflected back from the front and from the back of the bladder. The time difference between these pulses can be used to estimate the volume. For young children, this device can be used to help and train them, so they will learn to realize independently when it is time to go. In homes for elderly or ill people, the current way to go is to wear diapers. This device could replace this need and give these people a little more sense of independence, or autonomy. Thus, the technologies developed through ultrasound can help people become more autonomous.

You mentioned a European project, do you do more on a European level?
Our field is very international, people present their work on conferences all

an associate editor, you are responsible for building the journal, maintaining the quality and making sure it stays a top journal. You get to see the review process from close by and you learn a lot from that. This is because the review process is what keeps us sharp – research results will only appear in good places if it has been rigorously reviewed and criticized. When you submit a paper, it might be frustrating to get back the first reviews in which experts ask all the nasty questions. However, at the end of the day, your paper really gets better.

Besides research, you also teach a few courses, and according to the opinions of the students, with enthusiasm. What do like most about teaching?
I think it is about getting a message across, getting a story told. Take an idea that you understand and try to help others to gain that understanding as well. I enjoy thinking about the right way to build up the story, to break up a complex topic into meaningful steps and present these in an elegant and appealing way.

What advice would you give to students?
I would say: get your hands dirty! Build something, do an internship, contribute to a research project and gain experience by doing so. Find opportunities to get exposed to the real world, where you run into new things that you will not learn during the lectures. That is very important, since engineers work on real-world problems. Almost always when you have designed something, no matter how many simulations you have done, surprises will pop up once you build it that no one had foreseen.

Therefore, the above mindset is also characteristic for the kind of research work we do. You can present your work at conferences and in journals, but if you have not built and tested it, people will not accept it. It might be a nice idea, yet you need to do your homework and get your design demonstrated. They say, the proof of the pudding is in the eating. That is because reality always has surprises in store, and that is where you learn.
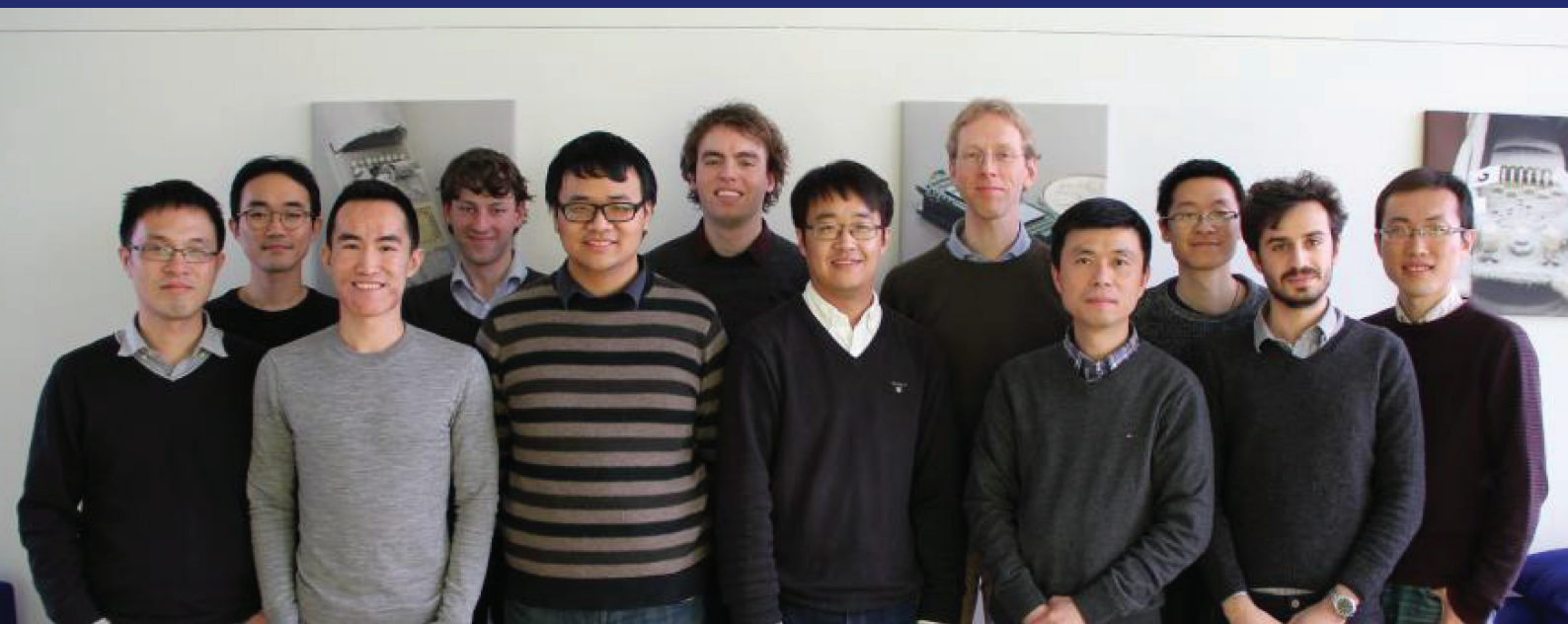
Autonomous Systems and RADAR

The Digital Eyes of Autonomous Vehicles

Dr. Faruk Uysal

Autonomous systems have been subject to massive developments, especially with the increasing interest in autonomous vehicles. A fully autonomous vehicle (such as a self-driving car) must be capable of sensing its environment and moving without any human intervention. Some of the current vehicles are already being deployed with autonomous functionalities, such as autonomous parking, collision avoidance and even auto-pilot systems that support drivers in their task to increase traffic safety. Nevertheless, until a vehicle can drive truly independently, it is not genuinely an autonomous vehicle.

The rise of radar

Among all technologies applied to the autonomous vehicles, different sensors are utilized to sense the environment. Lidar, radar, sonar and optical sensors act as the 'digital eyes' of an autonomous vehicle. Some modern vehicles have already been equipped with a variety of these sensors. For each different sensor, corresponding algorithms are required to provide the information for an advanced control system that interprets the information and determines strategies in different scenarios, such as identifying the appropriate navigation paths in order to avoid obstacles.

Among the sensors, radar is becoming a key element for autonomous vehicles due to its all-weather and day-and-night capabilities. Radar outperforms optical sensors in low-vision conditions and severe weather. Also, unlike a Lidar sensor, radar can provide precise velocity measurements. Recent advancements in the semiconductor industry have made the low-cost mass production of single-chip automotive radars possible. Millimeter-wave radar is the most widely used sensor for automotive radar systems, which has been well-developed in the past decades and has been widely used in current Advanced Driver Assistance Systems (ADAS). ⯈
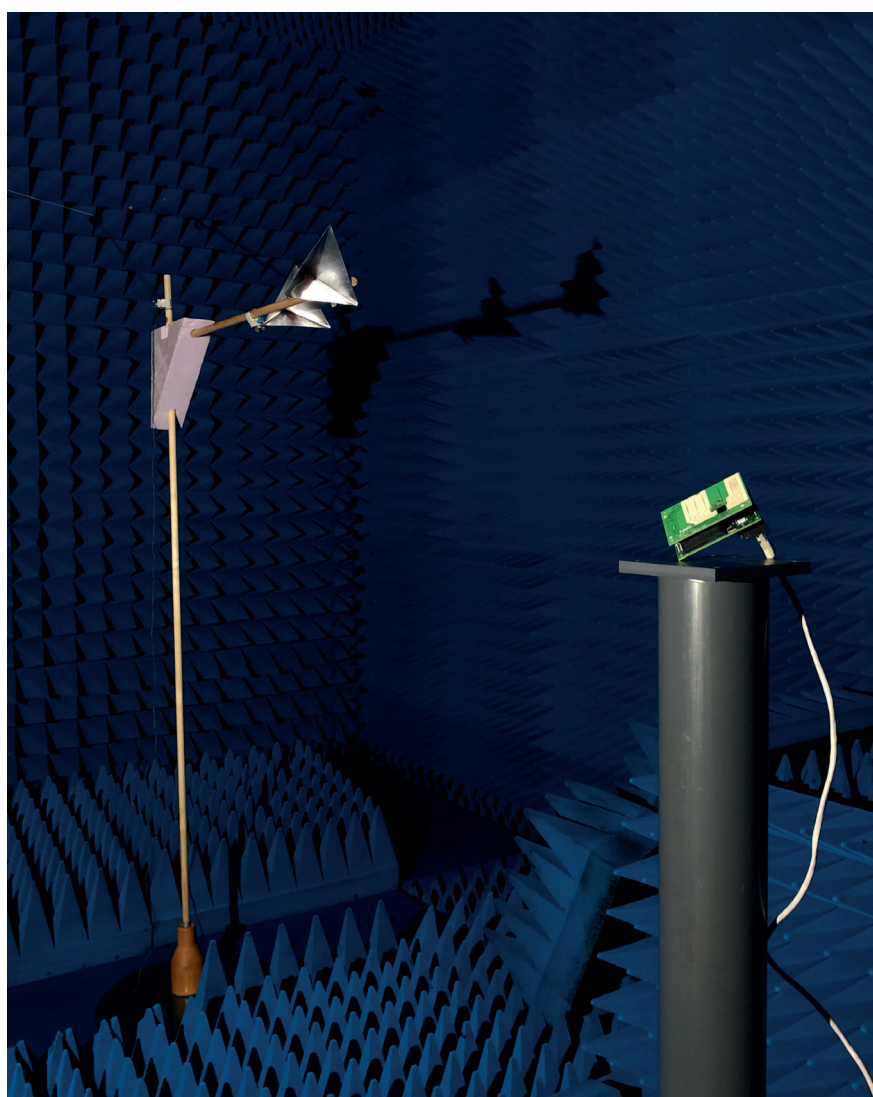
Figure 1. *A typical fully integrated RFCMOS Radar Transceiver (right) for automotive radar application, shown in a test setup in an electromagnetic anechoic chamber.*
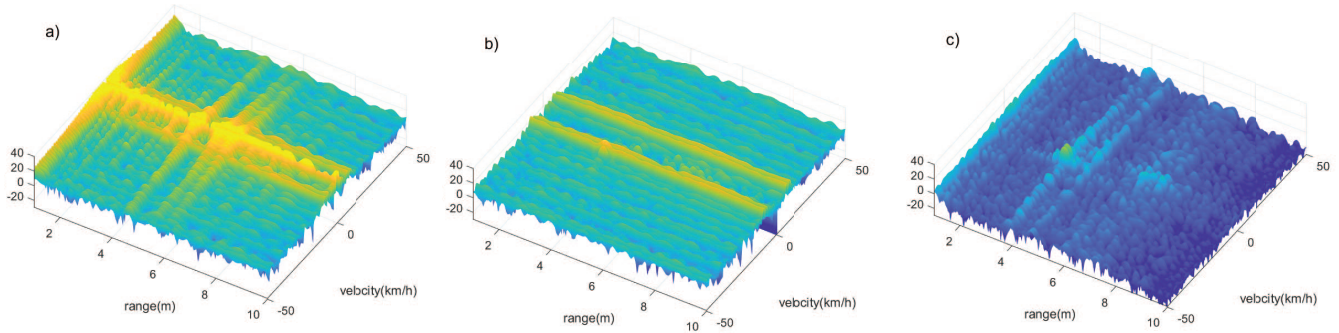
Figure 2. Typical output of an automotive radar at range vs velocity domain. a) received radar signal, b) interference signal and c) target signature after interference mitigation [2].

The Frequency-Modulated Continuous Wave (FMCW) radar system is the most common automotive radar system to detect the range and velocity of targets through stretch processing. Moreover, recent automotive radar systems are taking advantage of multiple-input-multiple-output (MIMO) antenna arrays to provide the azimuth information of targets. Depending on the MIMO antenna configuration, it is also possible to exploit the elevation information of the targets.

Challenges in Automotive Radar

Current mm-Wave automotive radar sensors (such as shown in Figure 1) share a spectrum space from 76 to 77 GHz (up to 81 GHz in some geographical regions) [1]. Soon, the co-existence of multiple radars in congested traffic will be an issue with the increasing number of radar-equipped vehicles on the roads.

Since a lot of equal or similar waveforms and transmission strategies are presently used in automotive radar applications, interference will occur between multiple radar units.

Under the influence of interference, objects with low radar cross sections (RCS), such as pedestrians or cyclists, will not be detected or will be completely lost during tracking. Therefore, interference will lead to dangerous situations and will become a bottleneck for driving assistance and autonomous vehicles. Especially in fully autonomous vehicles, the dependability on the sensors is extremely high and there is absolutely no tolerance for sensing failures since any human intervention will no longer be present.

Figure 2 shows a typical automotive radar output for range versus velocity domain, which is used to estimate the range and velocity of the object in the scene of interest. A received signal that is under the influence of strong interference, is illustrated in Figure 2a. As seen from the figure, it is not possible to detect a target, since it is masked by the interference. Figure 2b and Figure 2c show the interference and target components of the input signal, which are achieved through the use of a signal separation algorithm for interference mitigation as proposed at [2].

Trends and research directions

Besides providing range, velocity and angle information of the targets, radar systems are often used for the classification of targets and/or their activities. Most of the real world targets are not rigid bodies. Micro-motions or vibrations induced by different parts of the targets produce additional Doppler shifts, which is known as micro-Doppler effects [3], and can be used to identify target features. For instance, micro-motions induced by human body parts produce a unique micro-Doppler signature which can be used to identify human activities. A typical micro-Doppler signature of a walking person as seen by an automotive radar is shown after time-frequency analysis in Figure 3.

Even though radar is one of the key sensors for autonomous systems, there is still a need for other sensors to achieve maximum safety and security. This is
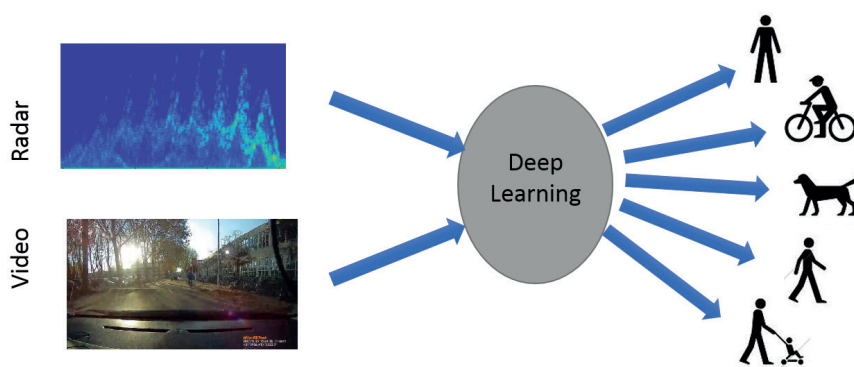
Figure 4. Multimodal machine learning for human activity classification [4].
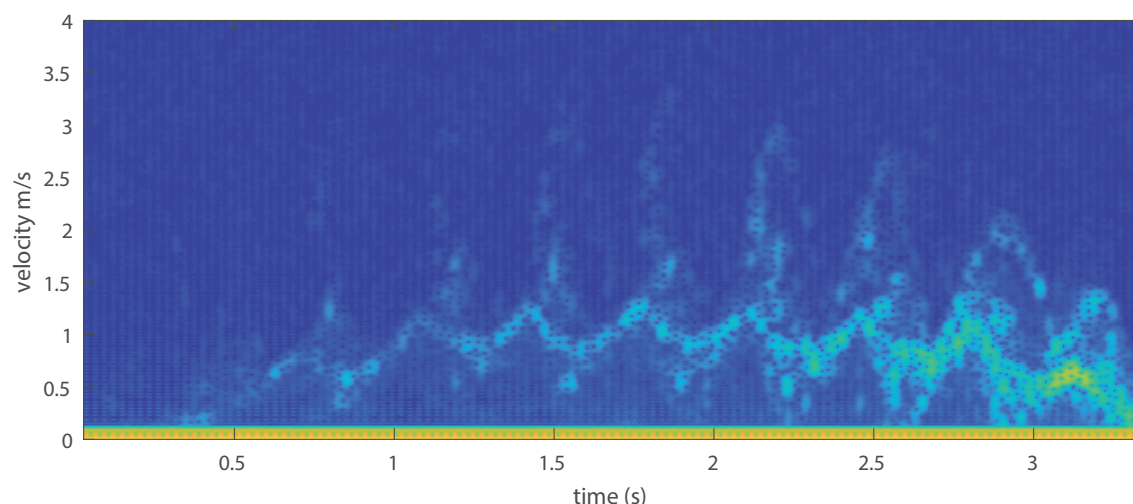
Figure 3. *A walking human's micro Doppler signature as seen by an automotive radar. Swinging arms and legs create a unique signature since they moved with a different velocity.*

because each sensor has its own advantages and disadvantages. The most appropriate approach to overcome the inherent weaknesses of different sensors is to deploy a combination of different sensors and fuse their data before the decision-making process. Most of the current systems use late-fusion strategies, which combine the final product from each sensor. However, there is a great interest in early-fusion strategies such as multi-modal machine learning, which aims to train a network using different sensor data such as radar and optical sensors as illustrated in Figure 4.

Other works in Progress

The Microwave Sensing, Signals and Systems (MS3) Group at the Faculty of Electrical Engineering Computer Science and Mathematics (EEMCS) at Delft University of Technology is collaborat-

"Hopefully in the near future, radar will not only be the digital eyes, but also the digital voice of autonomous systems."

ing with NXP Semiconductors N.V. in the "Coded-Radar for Interference Suppression in Super-Dense Environments" (CRUISE) project to tackle issues related to spectrum crowding. CRUISE will fully support the future of autonomous driving by exploiting spread-spectrum techniques to ensure proper radar signal detection and object classification in a highly-occupied frequency spectrum, as well as accurate ranging, velocity and azimuth measurements under all circumstances.

Moreover, the MS3 group is working towards the "Integrated Cooperative Automated Vehicle1" (i-CAVE) to ad-

dress the current challenges regarding throughput and safety with an integrated approach to automated and cooperative driving. In the i-CAVE project, radar-based communication will be realized to achieve a more robust and synergetic approach for joint sensing and communication during high-speed automated and cooperative driving. To address interaction capabilities between vehicles and the environment, our research focuses on radar processing methods with signals that allow for communication functionality.

[1]   J. Hasch, E. Topak, R. Schnabel, T. Zwick, R. Weigel, and C. Wald- schmidt, "Millimeter-wave technology for automotive radar sensors in the 77 GHz frequency band," IEEE Transactions on Microwave Theory and Techniques, vol. 60, pp. 845–860, March 2012.

[2]   F. Uysal and S. Sanka, "Mitigation of automotive radar interference," in 2018 IEEE Radar Conference (RadarConf18), pp. 0405–0410, April 2018.

[3]   V. C. Chen, The Micro-Doppler Effect in Radar. Artech House, 2010.

[4]   R. de Jong, "Multimodal deep learning for the classification of human activity," Master's thesis, Delft University of Technology, 2019.

KROBOOT.

From minor to start-up

Detmer Bosma

An excessive amount of duckweed is a huge problem in Dutch canal cities like Delft, The Hague and Amsterdam. Duckweed ensures that sunlight is not able to reach all the animals and plants living under water. Therefore, plants are not able to do their photosynthesis and no oxygen will be produced for the animals, so they won't live any longer. This will result in bad water quality, since the duckweed consumes all nutrients without leaving any for others. This will also result in odor nuisance, because of the decomposing animals and plants. Another problem of an excessive amount of duckweed is the danger of drowning of dogs and little children, as they see the carpet of duckweed as a field of grass and try to walk on it.

Today's most water authorities and municipalities do not remove the duckweed actively. Because of the growing speed of duckweed - it doubles in three days under optimal circumstances - it looks like an impossible job to have duckweed-free canals. Removing the duckweed is very labor-intensive and expensive for municipalities/water authorities. We have the solution: the Kroboot. By using the Kroboot water authorities and municipalities from the Netherlands (and other West-European canal cities) save a lot of money and time. For example, the municipality of The Hague pays €564,000 per year for removing duckweed, all by hand or with a huge inefficient machine/boat.

How it all started

The Kroboot all started as a student project of the Minor Robotics in September 2016. For 1 semester long, six engineering students designed and built the first prototype of the Kroboot in cooperation with the Delft Water Authority (Hoogheemraadschap Delfland). The Delft Water Authority was very enthusiastic about the idea of the Kroboot, so one year later (September 2017) the same project was part of the Minor Robotics. Six new students designed and built the second prototype, led by one of the first team members: me! When the minor was finished, a mixed team of member from the first team and members of the second team was settled to develop this idea from a concept to a product.

These six students have different backgrounds, such as mechanical engineering, electrical engineering and software engineering. The first step was the hardest: starting your own "company" and get a financial income. To apply for financial grants, you have to have a registration at the Chamber of Commerce (Kamer van Koophandel). When the registration at the Chamber of Commerce was successful, we realized that the Kroboot was now officially our own start-up! As start-up we have been invited for a lot of events, such as the year event of Innovation Quarter, International Festival of Technology (IFoT) and at the Innovation Pavilion of the Volvo Ocean Race 2018 in The Hague/Scheveningen. Those are excellent events where we can show our idea to the community and where we can get the attention of other municipalities and water authorities.

Sensing and control

But let me introduce the technology aspect of our prototype. The Kroboot is an autonomous boat and therefore uses a lot of sensors. For example, it uses a LIDAR to analyze its own environment by laser imaging and so it is able to prevent

Figure 1. *The Kroboot at the Volvo Ocean Race 2018 in The Hague.*
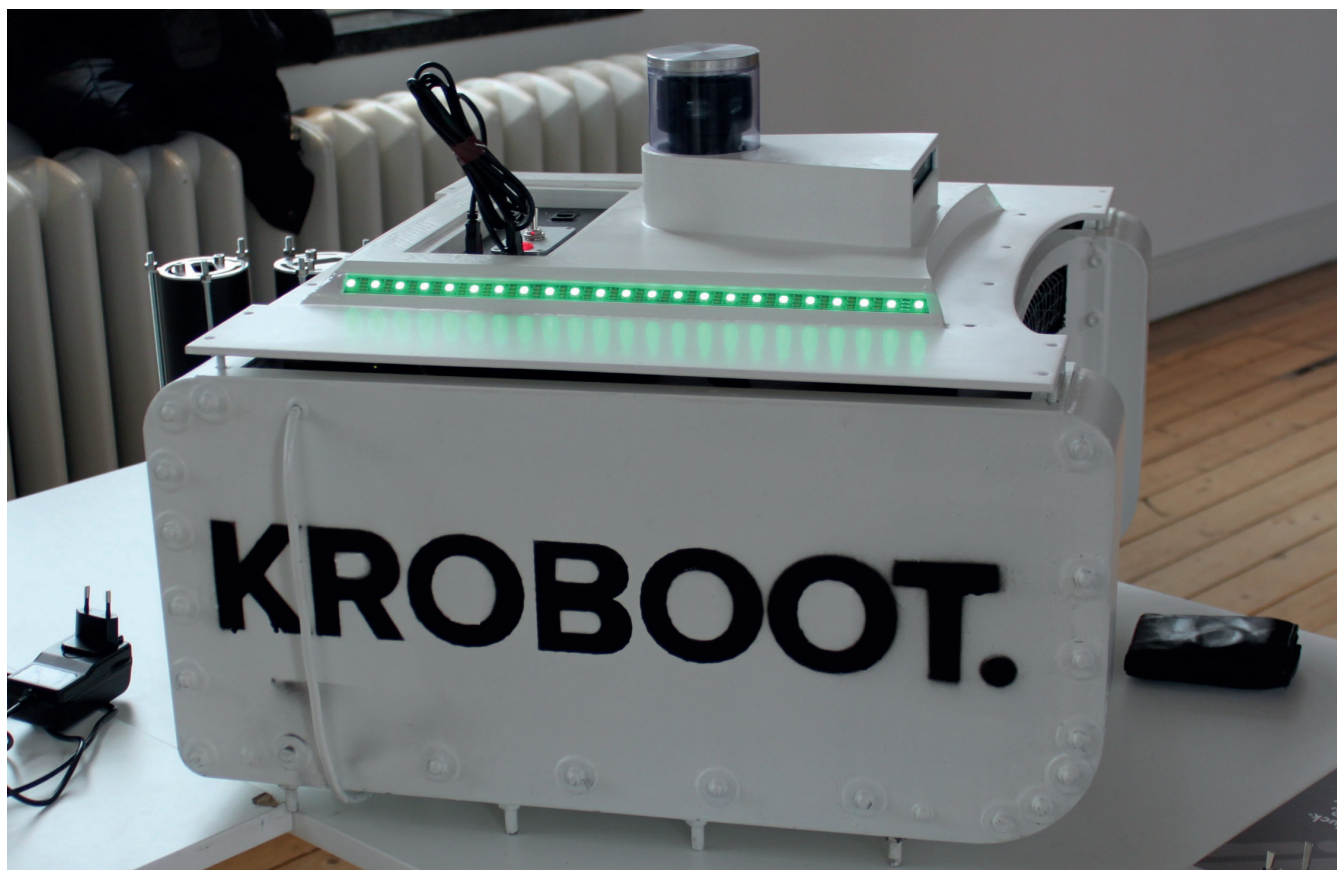
Figure 2. The current version of the Kroboot.

collapsing against the canal walls or against other boats. It also uses an Intel RealSense camera to detect duckweed, but also water lilies to prevent damaging these plants. A GSM-sensor is used for the localization of the robot. Inside of the Kroboot a destroy mechanism is designed, where duckweed will flow through and will be cut and destroyed by two gears. Two electrical thrusters powered by six batteries are used for navigation and a duckweed searching algorithm will control these thrusters. In this algorithm, the view of the camera will first be cropped using an edge detection mechanism. This will detect the edge of the canal, which ensure that the robot will only see the things on the water surface and for instance not a tree next to the canal. Afterwards, a simple color filter will be applied to the view, where all green objects will be detected.

Since duckweed is not the only green object on the water surface, another edge detection mechanism will be used to detect the green lilies. With this algorithm the robot will not destroy other plants than duckweed and other small green plants. Our biggest challenge will be the testing, since it is hard to have a clear environment to test and in winter, we will have to wait until the duckweed will flow back into the canals of Delft.
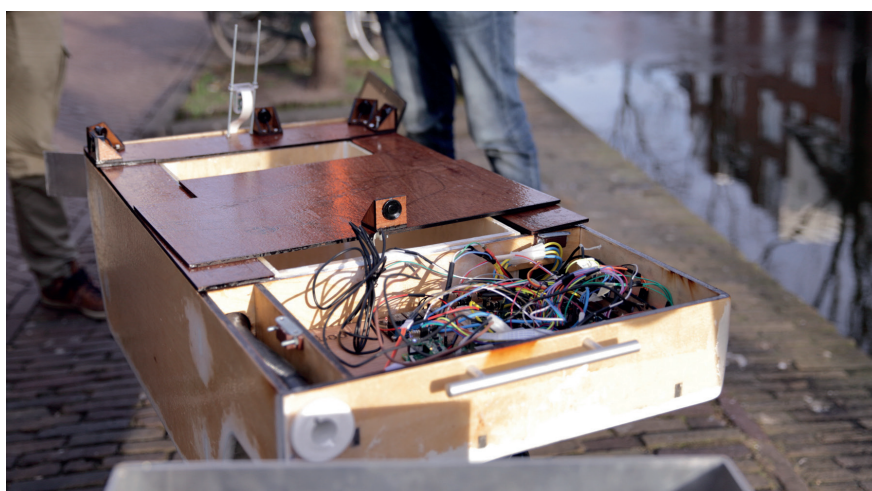
Figure 3. Testing of the Kroboot V1.

Doing a minor at DUT19

Bachelor column: a peek into the world of Electrical Engineering students

Mathijs van Geerenstein

Hey everyone! This edition of the Maxwell, we are trying something (sort of) new: the columns! From this edition onwards, every Maxwell will have one column written by a bachelor student, and one by a master student. To get some continuity going, the author will start by answering the questions asked to him/her by the previous author, after which the column is concluded by formulating the questions which the author for next edition will answer. Are you still following me? Don't worry, you will see it in the next edition of this year. There is only one problem however; there is no previous author for the bachelor column! Therefore, I will be interviewing myself in this article, after which the chain of columns can start.

How is your road to becoming an electrical engineer coming along?

I'm in my third year of the bachelor, currently attending my minor. When choosing which minor to follow last year, I was trying to find something challenging, but I didn't come across anything extraordinary at the minor event in the auditorium. Luckily, I ran into some guys from Formula Student Team Delft (also known as DUT Racing) when leaving the event. There is no actual dream team minor anymore, but you are allowed to configure your own "free minor" with a dream as an external

project. You still have to pick courses for 15 EC, but the other half is rewarded for work at the dream team. I was immediately sold, since this seemed challenging enough for me, and also allowed me to keep learning stuff related to Electrical Engineering. So far so good, I'm really enjoying the experience working there!

What parts have you been working on at Formula Student Team Delft?

Almost everything regarding electronics in the accumulator. This 600V, 150kW battery stores the energy, and provides the power that the car needs to race. The design process began with the actual cell selection, since the accumulator is build out of almost 300 Lithium Polymer cells. This meant finding a way to select the best cell out of more than 800 options. This was done with a Matlab script that sorted the options based on the highest energy density, after filtering out for our desired capacity, power output and volume. After cell selection, I started on something really exciting: designing my own PCB! It is part of the Accumulator Management System, and measures the voltages of all Lithium cells together with their temperatures. Now that the design is final, it's time for production! From Q3 forward, I will be doing full time work at DUT as Chief Accumulator Production. Together with a crew of 4, we're going build the actual accumulator.

What other activities do you do?

I'm part of the WinterWedstrijden committee at the rowing association Proteus-Eretes. Next to that, I'm building this magazine every quarter, with the Maxwell committee!

Shea Haggerty is also a member of Proteus-Eretes. As far as I know, she rows a lot. Shea: what kind of team are you in currently? How do you like it so far? How do you time manage it together with your studies? Do you already have an idea which minor you would like to do? I would like to find out!

Specialization choices

Master student column: a peek in the world of Electrical Engineering students

Getssy Prathiba

In the previous column, Sagar Patel told you about his experiences as an intern at NXP semiconductors. He talked about his department: Smart Interface and Power, and getting acquainted with the Dutch working culture. This time, Getssy Prathiba will tell you a little about her life as a second year master student in Electrical Power Engineering. Want to learn about her experience working as a Product Engineer in Indai, get some study advice or learn about the "Sterkstroomdispuut"? Continue reading!

Greetings!

I am a master student from Electrical Power Engineering track specialising in Power Electronics and Electrical Machines. I am currently in second year working on my master thesis.

As the third quarter is about to kickstart from next month for the first-year master students, they might be busy in choosing courses based on the specialisation profiles. Henceforth, I would like to briefly share my experience on my considerations while choosing the specialisation courses. I was a working for 3 years prior to my master's program as a Product Engineer in Medium Voltage Drives at ABB, India. My primary role included Reliability engineering, Failure analysis and Mitigation of the power electronic components in the drive. Henceforth, the coursework was a timely opportunity to further strengthen the skill set pertaining to power electronics and drives. Additionally, I had always been interested in high voltage and followed two courses in that profile. This choice of courses has now helped me to work on cross-functional thesis topic involving power electronics and high voltage. Throughout this journey of coursework, I faced difficulties in terms of handling workload, understanding the advanced concepts, designing of circuit for experimentation etc. But at the end of the day, I feel accomplished.

My humble request would be to never back out from a course that you would like to specialise upon because it is hard to follow. Instead, try to maximise the effort in learning the course in a better way. Every course is structured in a unique manner which introduce different perspectives in the specialisation. My favourite part was the laboratory work which was a part of the course "Advanced Power Electronics", wherein I paired with another student to design, build and test a power electronic converter. This exercise helped us to inculcate the knowledge acquired during the course while designing the converter.

Apart from my academics, I had a wonderful opportunity to work as secretary for "Sterkstroomdispuut der Electrotechnische Vereeniging (SSD)" which is a student association for Master students pursuing Electrical Power Engineering. It is always a demanding job to handle academics with the extracurricular activities. However, many students tend to manage them effectively. So, I would like to ask Adithya Vemuri about his contribution towards a non-academic activity, and strategies to handle them effectively along with the daily academic schedule.

Autonomy and consent

On privacy and informed consent

Jan Smits, Chair Law & Technology, TU/e

Consumer protection in the US is modelled around the so called 'Notice & Choice' mechanism, meaning that as long as a firm gives you NOTICE (telling you exactly what to expect with this firm) and allowing you to CHOOSE (now you know you can make an informed choice) then the firm has done everything necessary. So, if you then afterwards complain that the firm did not behave correctly then you cannot be protected as a consumer by the appropriate overseeing governmental institutions, usually the Federal Trade Commission. It is this model that predominantly has become the way of operation by all big internet companies also in their way of operating in the EU market. You read their privacy policies (on average at least 10 pp) and think about it, and you then click OK because you really know what you are doing. Your consent is informed! Isn't it?

With the advent of the GDPR implementation (May 2018) this behaviour of these US firms in Europe will have to change. Let me try to convince you that even with stricter rules of the GDPR your consent is hardly ever INFORMED. Your addiction is being played, so I am convinced that despite the common conviction among internet users you are no longer autonomous, you are being nudged!

Privacy

The German Bundesgerichtshof (Leserbrief) acknowledged in 1954 that individuals have a fundamental right to Menschenwürde, human dignity.[1] The judges derived this right from the right to privacy and the right to develop one's personality. The objective of this human dignity right is to adequately protect the attributes (including the data collected) of the human person and including the right to control one's personal data as part of the right to privacy, that as such should protect against all kinds of violations of the personality of a person. Human dignity usually manifests itself in the personality right. The merits of the Leserbrief-case lie in that the general personality right and human dignity are inextricably intertwined.[2]

The European Union has included human dignity in its laws, thereby acknowledging the importance of this right. The first Article of the European Charter of Human Rights states that "Human dignity is inviolable. It must be respected and protected." When the merits of the Leserbrief case are applied in the context of Union law, it could be argued that a European personality right exists, because human dignity is recognised within the Union. In Omega the European Court of Justice recognised human dignity as a general principle of Community law[3]. We can therefore conclude that human dignity functions as the foundation of the personality right because having human dignity implies a personality right, collecting data on a person by internet service providers needs to be seen in the context of human dignity.[4]

To understand privacy as a concept, one of my former PhD students B.J. Koops,[5] nowadays a full professor of regulation and technology at Tilburg University has won a NWO grant allowing him to study (the concept of) privacy. His research group published about a year ago *A typology of privacy*.[6] In this publication they make clear that there is no one dimension to privacy. Privacy protection needs to be understood in a very private almost physical way when dealing with data surrounding our body, extending it to the place where we live and stay as well as walking the streets. In the publication a distinction is made

[1]   BGH, Urteil vom 25.5.1954, ZR 211/53, NJW 1954, 1401 (Leserbrief).

[2]   Conform E.C. (Eva) Heeger, Controlling your online profile: reality or an illusion? A research into informed consent as a mechanism to regulate commercial profiling, Thesis Utrecht University, School of Law, August 2015, p. 6.

[3]   ECJ 14 October 2004, Omega Spielhallen- und Automatenaufstellungs GmbH v. Oberbürgermeisterin der Bundesstadt Bonn (C- 36/02). Omega wished, as a service provider from a firm in the United Kingdom, to open a game hall in which individuals could use laser guns to simulate homicide. The ECJ ruled that the German prohibition of this service, which was based upon human dignity, was justified, even though no similar restrictions existed in the United Kingdom.

[4]   Ibid. nt 26, p. 7.

[5]   Koops, B.J. (1999). The crypto controversy: a key conflict in the information society. Eindhoven: ECIS. ((Co-)promot.: M.S. Groenhuijsen, Jan Smits & Henk van Tilborg).

[6]   Bert-Jaap Koops, et. al., A Typology of Privacy, in U. Pa. J. Int'l L. [Vol. 38:2, 2017] pp. 483-575.
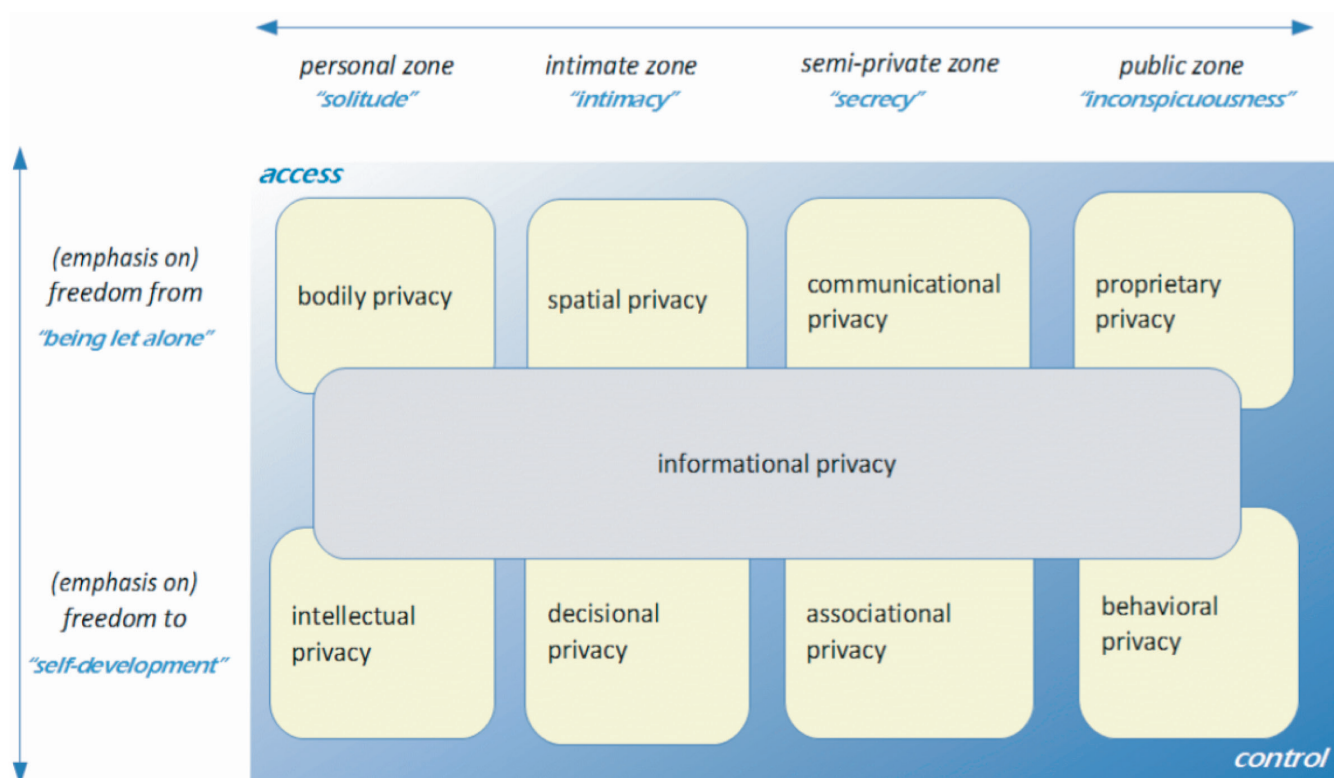
Figure 1. *Koops's Typology of Privacy*

in 8 different dimensions /spheres and one all-encompassing one, namely informational privacy (see Figure 1).

Informational privacy, i.e. privacy concerned with the collection of data in all kind of different spheres in which we as humans 'are' and/or 'operate'. The merits of this research are that we, both engineers as well as lawyers, can appreciate the enormousness of the data collection that surrounds us, we are be-

coming more and more part of a datasphere.[7] Often, we approve the collecting of (personal) data involving all these spheres/zones. So, it is necessary to analyse in what way the newly applicable EU General Data Protection Regulation (GDPR)[8] is citing our approval through the informed consent requirements. I will try to show that although the idea underlying informed consent seen from the legal requirements, is sound and necessary but that it unfortunately is

not going to make our consent more informed.

Informed Consent[9]
The idea underlying the GDPR concerning informational privacy is that people are invited (seduced)[10] to accept a data processing operation, and as such this invitation and subsequent consent should be subject to rigorous requirements.

▷

[7]   We need dataspherists, i.e. scientists trained in more disciplines, such as programming, app design, information security, law, ethics and data science.

[8]   REGULATION (EU) 2016/679 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), OJ L 119/1-88, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0679&from=NL retrieved April 26, 2018.

[9]   Consent is given by an individual here in the context of using services from an internet service provider, this service provider has of course the mirrored rights and obligations. This lecture is too short to also deal with their role in obtaining the individual's consent, and the obligation to be able to prove that consent.

[10]   See on Facebook being a 'Dopamine Machine' https://www.quora.com/Is-Facebook-a-dopamine-machine. Ot van Dallen, De zeven privacytrends van 2017, in Mediaforum, 2018-1, p. 2-5, and his references in notes 44, 45, 46 and 47, see also hereunder notes 40 and 52.

[11]   By way of example: the TU/e being my employer is the controller in the jargon of GDPR, the firm they ask to process the

The GDPR is aimed at protecting the fundamental rights of data subjects.[11] The controller wishes to engage in a processing operation that would be unlawful without the data subject's consent. The crucial role of consent is underlined by Articles 7 and 8 of the Charter of Fundamental Rights of the European Union. Furthermore, obtaining consent also does not negate or in any way diminish the controller's obligations to observe the principles of data processing enshrined in the GDPR, especially Article 5 of the GDPR with regard to fairness, necessity and proportionality, as well as data quality. Even if the processing of personal data is based on consent of the data subject, this would not legitimise collection of data which is not necessary in relation to a specified purpose of processing and fundamentally unfair.[12]

Pivotal to the informational privacy is the collection of personal data, and whether we gave our informed consent. Informed consent is one of six lawful bases to process personal data, so says Article 6 of the GDPR. Let me mention the other five before I go into more detail about Informed consent. Processing shall be lawful (1) only if necessary for fulfilling a contract, (2) as a consequence of a legal obligation a controller has to comply with, or (3) when the processing is necessary in order to protect the vital interests of the data subject or of another natural person, (4) in case a task is carried out in the public interest or in the exercise of official authority vested in the controller, (5) when the control-

ler/a third party pursues a legitimate interest, except where such interests are overridden by the interests or fundamental rights and freedoms of the data subject which require protection of personal data, in particular where the data subject is a child.

Informed consent is, as said, pivotal to privacy protection. After all, if the data subject (you and I) have given our consent to a website, an app provider, Google, Facebook, Marktplaats, etc., our informed consent is almost a general permit for these organisations that got our informed consent to do whatever they like, with handling, selling re-selling, allow usage and or make profiles (based on) of our data.

April 10, 2018

Senator Lindsey Graham asked Mark Zuckerberg: 'You'd embrace regulation?'
***Zuckerberg**: The question is, as the internet becomes more important in people's lives, what is the right regulation, not whether there should be or not.*
***Graham**: You, as a company, welcome regulation?*
***Zuckerberg**: If it's right, yes.*
***Graham**: Do you think the Europeans have it right?*
***Zuckerberg**: They get things right'.*

Obviously, the EU did not get things right: less than ten days later Facebook

moved 1.5 billion users to the US.[13]

Article 4(11) of the GDPR defines consent as: "any freely given, specific, informed and unambiguous indication of the data subject's wishes by which he or she, by a statement or by a clear affirmative action, signifies agreement to the processing of personal data relating to him or her." Article 29 Data Protection Working Party (Art. 29 WP)[14] released Guideline WP259 on Consent under the GDPR, and they stated on consent: 'Generally, consent can only be an appropriate lawful basis if a data subject is offered control and is offered a genuine choice with

April 11, 2018

Senator John Neely Kennedy of Louisiana came in peace so he said, but his remarks were in strong language: "Mr. Zuckerberg, I come in peace. I don't want to vote to have to regulate Facebook, but by God I will," Sen. Kennedy began his short exchange. "In fact, a lot of that depends on you. I'm a little disappointed in this hearing today, I just don't feel like we're connecting."
He was also quite upset with the way in which Facebook communicated its user data policies with its users. "Your user agreement sucks," he went on. "The purpose of that user agreement is to cover Facebook's rear end, it's not to inform your users about their rights. Now you know that, and I know that. I'm going to suggest to you that you go back home and rewrite it."

salaries of all TU/e employees is called the processor and I am the data subject.

[12]   Ibid. nt 26.

[13]   Facebook, just a few days after the congressional hearing after the Cambridge Analytica scandal, The Guardian, April 19, 2018, Facebook moves 1.5bn users out of reach of new European privacy law (Company moves responsibility for users from Ireland to the US where privacy laws are less strict) https://www.theguardian.com/technology/2018/apr/19/facebook-moves-15bn-users-out-of-reach-of-new-european-privacy-law , retrieved April 26, 2018.

[14]   Article 29 Data Protection Working Party is an advisory body made up of a representative from the data protection authority of each EU Member State, the European Data Protection Supervisor and the European Commission Privacy professionals work in EU in the so/called art 29 WP. http://ec.europa.eu/justice/article-29/documentation/index_en.htm

[15]   http://ec.europa.eu/newsroom/article29/news.cfm?item_type=1360, Guidelines on Consent under Regulation 2016/679 (wp259) http://ec.europa.eu/newsroom/article29/item-detail.cfm?item_id=615239 on p. 4. The Guidelines were adopted

regard to accepting or declining the terms offered or declining them without detriment'.[15]

EU users have to agree to the same USA originating user policies. So, I am asking you: 'Are we indeed giving freely, specific, informed and unambiguous our consent when we click OK on a question asked by a service provider'? If you as my audience apply this test on your own behaviour over the last five years when clicking OK to an app-provider and/or service provider would you then conclude that your consent, was informed? I would argue it was not! Let us assume that when your consent was indeed informed: Were you as data subject offered control and genuine choice in accepting or declining? Again, I would argue you were not in control and did not have the feeling of a genuine choice.[16] Reading the EU law as it became applicable on May 25, 2018 this means that no lawful processing of our personal data can be done, due to the lack of a freely given, specific, informed and unambiguous indication of your and my wishes.

Some observations

From a legal perspective GDPR defines the requirements so that we give our informed consent. Practically speaking it will not work, so we will keep giving our OK without really knowing to what we consent. Here standardisation could be helpful. Engineers and lawyers working together on devising a standard to ask questions of a user so that after answering them, real and genuine consent has been given.[17] Also, a tool developed by consumer organisations or under data protectionist control could help: a little program, available in our browser, that 'carry' or contain our individual wishes concerning the amount of data we want to share when visiting a certain website, or use a service.[18]

⏚

BREAKING NEWS
SEN. KENNEDY TO ZUCKERBERG: "YOUR USER AGREEMENT SUCKS... PURPOSE IS TO COVER FACEBOOK'S REAR END"
CNN 4:56 PM PT

but not finalised, when consulted on April 28, 2018.

[16]   If we add this to the way in which psychology is being used to lure us first into the service provision and second to keep/make us addicted. Sean Parker, in an earlier life Facebook president, said in an interview with the Guardian in November 2017 that Facebook is made in such a way that it exploits human vulnerability. Google, Twitter and Facebook workers who helped make technology so addictive are disconnecting themselves from the internet, they did so because they worked on high jacking our minds, see https://www.theguardian.com/technology/2017/oct/05/smartphone-addiction-silicon-valley-dystopia, April 2, 2018

[17]   In 2017 a tool, an automated decision tree based upon the requirements of the GDPR concerning informed consent was developed under my supervision by two bachelor students (Zoetbrood & Mohan) as an assignment for Fourtress. If you want to find out what questions should be asked to genuinely ask for your consent and/or what data can be collected lawfully by a company or organization, go to www.gdpr-informedconsent.eu, to check for yourself. Depending on the answers either a user perspective or an organization perspective is being supported.

[18]   Ghostery, see https://www.ghostery.com/, but also privacy badger by Electronic Frontier Foundation https://www.eff.org/nl/privacybadger, or duckduckgo.com provide already some protection from being tracked all over the internet, or startpage.nl that does not 'record' anything.

EEMCS Recruitment Days

FAQ on the biggest faculty career event

Karen van der Werff

Who can join the event?

The Recruitment Days are organized annually for all master- and PhD-students within our faculty. This means that the students from all tracks of Electrical Engineering, Applied Mathematics and Computer Science are heartily invited!

Where do I sign up and how much does it cost?

You can register online at our website, www.eemcs.com. Registration is easy and completely free!

Where will the event take place?

The event will take place in the meeting rooms on the 3rd floor of our faculty. During the days itself, signs will be put up to show you the way.

How does the event work?

The EEMCS Recruitment Days is all about getting the right students and companies in touch with each other. After a quick, online selection procedure, students and companies are matched. The best matches get to meet each other during the event!

How does the matching work?

The selection happens on our website. Both on your dashboard and in the menu bar, you can find a link to the company selection. There, you get to see an overview of all companies and their information. Do you find a company interesting? Press 'Select company'! Similarly, companies can view the anonymous student CVs. They can rank these CVs from 1 - 3, indicating how interested they are. Based on the interests of both sides, our matching algorithm ranks the results from 'Perfect match' up to 'No match'. The best matches are invited for a meeting. No worries - if you have not gotten a 'Perfect match', you can still get invited for a meeting, depending on the number of available spots.

How many companies should I select for the matching?

The number of companies you select does not influence your ranking for individual companies. For instance, selecting few companies does not give you a higher chance of getting a 'Perfect match' for one specific company. Thus, please feel free to select all the companies you find interesting!

How long do the meetings take?

Every meeting takes about 25 minutes. We kindly ask you to come by our student desk 15 minutes beforehand, so we can confirm your meeting.

Help! I have a meeting, but cannot make it on that specific time slot. What should I do?

Please send an e-mail to our team at info@eemcs.com. We will try to see if we can give you a different time slot. That way, you can still meet your match!

How do I prepare for a meeting?

There are various ways to prepare yourself well:

- Join the interview workshop on March 6th, so you'll be sure to shine during the meetings. Register for the workshop on our website.
- Be sure to have familiarized yourself with the company that you will be meeting! Read about their work online, so you know what they do and what they stand for. That way, you will avoid awkward moments during the meeting.
- Be your confident self and have fun! While the meetings may sound a little overwhelming, they are meant for you and the company to personally get to know each other. So, ask all you want to ask and enjoy yourself - your possible future employer will do so too.

Looking for a thesis project, an internship or a job?

EEMCS
RECRUITMENT DAYS

Sign up now!
www.eemcs.com
Registration closes February 3rd

Interview Days
March 18th - March 22rd

f /EEMCSRD

THALES · ANALOG DEVICES · AHEAD OF WHAT'S POSSIBLE™ · MI COMPANY BUILDING AI APPS & SKILLS AT SCALE · Technolution · HedoN Electronic developments · PINEWOOD on top of security

Allseas · ENGIE · ELEQ mastering electricity worldwide · TNO innovation for life · Movares adviseurs & ingenieurs · bam

accenture · RH MARINE · alliander · ARCADIS Design & Consultancy for natural and built assets · V.O. · SIOUX SOURCE OF YOUR TECHNOLOGY

Witteveen+Bos · YER TECHNOLOGY TALENT DEVELOPMENT · Xeelas · ASML · Brunel · TenneT Taking power further

MAPIQ · HyTEPS ENERGY SAVING POWER QUALITY · TOPIC EMBEDDED SYSTEMS · PRODRIVE TECHNOLOGIES · riscure Challenge your security · ENTER. tech with a heartbeat

Agidens · ROVISYS Automation & Information Solutions · Momo Medical · innovattic · IHC · MAINBLADES INSPECTIONS

A Klushok-project
Plant monitor

Bram den Ouden

An easy way to brighten small dorm rooms is to add some plants. Of course, these plants will need some care, which I, admittedly, have forgotten many times. Unfortunately, my plants have developed a habit of dying after not receiving water for well over a month. Luckily there is an easy solution: let the plants water themselves!

General idea

The general idea for this project 'grew' when I added a fast-growing plant to my balcony. Since it grew so fast, it required a lot of water. The plant also required a lot of sunlight, causing me to put the pot near the edge of my balcony where it would receive the most hours of sunlight. This caused a conflict with my laziness: I didn't want to get up to the balcony to check whether the plant needed more water or not, yet I really liked this one and wanted to keep it alive as well.

The solution: Create a device that measured the soil moisture and could communicate this to me. Additionally, this device could use a pump to water the

plant from its attached reservoir. This meant that I only needed to get up when this reservoir would be depleted.

The components:

So far, both the general idea and a proposed solution have been discussed. In order to realize this solution, I chose to use the following components:

- Pump: a very simple 3-6 V from AliExpress, this cost me around €1,50.
- Tubing: the silicon tubing I used came from the Intratuin, it cost about 20 cents per meter.
- Soil moisture sensor: I chose the expensive capacitive soil moisture sensor from AliExpress over the cheap resistive sensor, since the resistive sensor is prone to corrosion and needs to be replaced very fast. This cost me about €1,-.
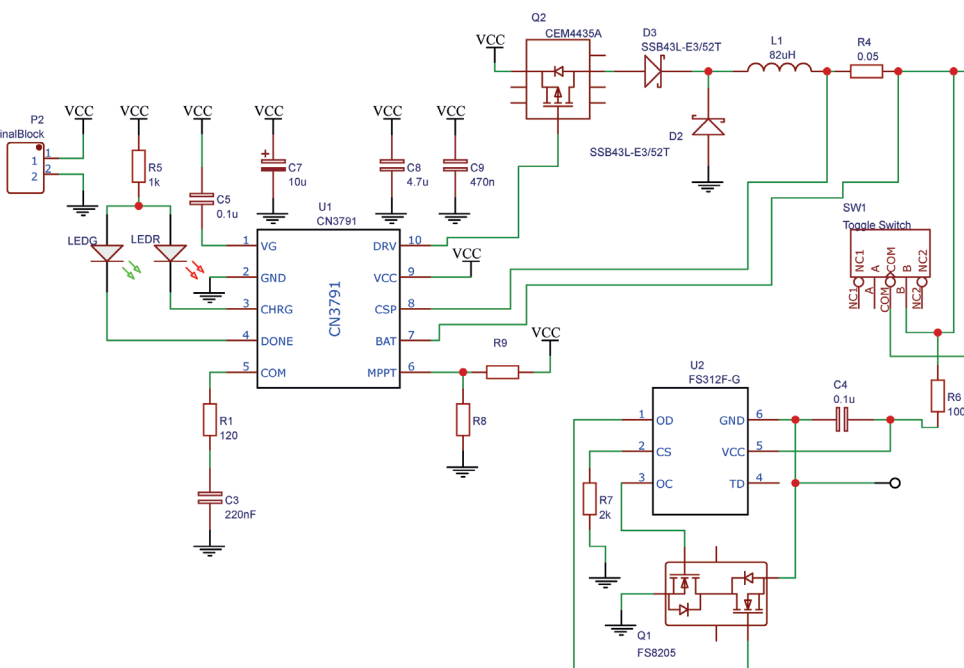- Temperature and relative humidi-

Figure 1. *Solar charger with boost function. [2]*

ty sensor: adding these sensors to your project provides a lot more information about weather circumstances, but is not necessary. A standard DHT11 holds both sensors and would cost you about €0,70. Its big brother, the DHT22, is a lot more accurate but will cost you about €2,50.
- Microprocessor: the choice for this part is highly-dependent on the chosen way of communicating to a server and will also be discussed in more detail. It will set you back about €3,- to €5,-.
- Solar charger with DC boost and LiPo battery: this part will be discussed in more detail later on, the

costs for this part are around the €3,- mark.

A reservoir can easily be made from any bucket laying around and is therefore not included in this list of components.

Microprocessor

As the brains of the operations, you could choose something like an AtTiny84 and add a 433MHz transmitter and a real time clock module, replace all these components with a Wi-Fi-based microprocessor like the WEMOS D1 mini, or use Bluetooth. All of these options have their advantages and disadvantages:

- The AtTiny84 is very small, cheap (it only costs about €1,-) and, com-

bined with a 433 MHz transmitter, has a much greater range than a Wi-Fi-based device. Although the price advantage is nullified by the need to buy a separate RF transmitter and RTC, the range advantage makes this a real competitor: the free path loss at 433MHz is about 15dB lower when compared to a 2,4GHz signal. [1] Consider this option if you either
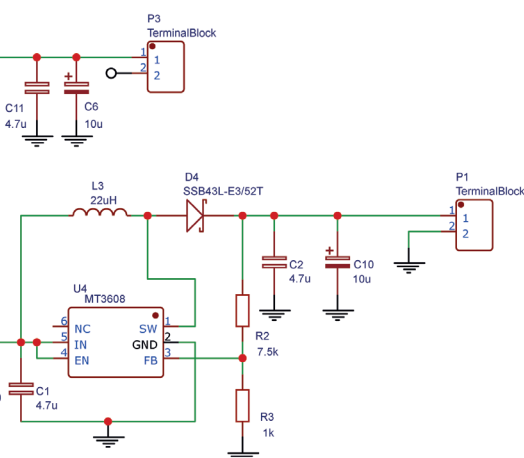
have these parts laying around or find your plants having a bad Wi-Fi reception. Keep in mind that you will also need to create a receiving station for the 433MHz transmitter, which could input the received data into a computer or server. Despite these awesome features, it is the only device listed here using one-way communication: if a package gets lost, you have to wait until the next one is sent.

- A WEMOS D1 mini is a well-known ESP8266-based board and will cost you around €2,- at AliEx-

press. It has the advantage of being well-documented, with a massive online community which can help you if any trouble occurs. To use this board, you will need to connect it to your Wi-Fi network and set up a server to receive and process the data. Advantages are its simplicity in use and the features added by the internet. Not only will the WEMOS be able to easily send the data to any webservice, it is also able to use these services to receive the current time and date. It is for example also possible to connect to a weather service and automatically decide to either water the plant now or wait until the afternoon rains have passed. The biggest disadvantages of this device are that it consumes the most power out of the three listed here, and that it is highly-dependent on a good Wi-Fi connection.

- A Bluetooth module uses by far the least amount of power out of the three options mentioned here. Two-way communication is possible and almost every device nowadays has a Bluetooth transceiver built in so setting it up is relatively easy as well. A major disadvantage can be found in its range: about 10 meters in a free space path and this range rapidly decreases when objects get in the way.

Power supply
Since this project will be applied to an outdoor plant, it would be ideal to use the same source of energy as the plant itself: the sun. Using solar power means that it is also required to add a battery since this form of power is unreliable. The obvious choice for a battery would be either a LiPo or Li-Ion battery. Both output a maximum voltage of 4.2V when

fully charged and a minimum of about 3.3V when completely discharged. Since all my sensors and microprocessors accept 5V, a boost circuit is required. We could go on and design and test our own circuit, but that takes a lot of time and iterations. Instead a quick Google search resulted in a complete design of such a circuit made by our German friend: GreatScott. [2] Figure 1 shows his design, it is based around the MT3608 boost IC featured on most Chinese boost circuits up to 2A output and the VN3065, a very common solar charge IC. Both these ICs can be bought for a very low price at most vendors. For a detailed explanation on this circuit, please watch his video on youtube: 'Solar Battery Charger (LiPo/Li- Ion) || DIY or Buy'. As for the battery: I would like to be able to continue 2 days of transmitting data without receiving any solar charge. This would mean no continuous transmissions, but probably hourly or two-hourly updates. Whether this is possible has to be determined during later tests.

Conclusion
By now you must think "When will he finally show the results?" - and rightfully so. Unfortunately, my previously-mentioned laziness combined with a lot of different interesting projects have prevented me from building it so far. Despite this, most individual components have been successfully tested and the final project is a matter of creating the PCB and ordering it.

I hope you enjoyed this little project and look forward to hearing your thoughts about it ,or to see your versions of it!

Bram den Ouden
The Klushok Committee

[1]   433MHz range: https://devzone.nordicsemi.com/f/nordic-q-a/6621/how-to-compare-power- consumption-of-433-mhz-and-2-4-ghz

[2]   Solar charge and boost: https://easyeda.com/GreatScott/SolarLiPoChargeProtectBoost

Activities

An overview of last quarter's events

FeeCie parties with Emile & CoDe
27 November & 19 December

In a little more than three weeks in the second quarter, the ETV organized two parties in Leiden together with study associations there. The first one was on the 27th of November with Emile, the study association of pedagogy. The theme of the party was "Back to the Childhood", which is very suitable for a party with pedagogy students. A lot of people were dressed according to the theme, which means that they were dressed as for example a cartoon from their childhood. It was very funny to see all the teletubbies, Pokémon and fairies! The second party, on the 19th of December, was a party with Corpus Delicti (CoDe) from criminology. We turned "COC de Kroon" into a self-made circus with clowns, circus directors, an animal tamer and people dressed in animal outfits as usual. It was a much cheaper location than "the Next", where the first party was, since the drinks were a lot cheaper. It was a very successful party thanks to DJ VanHox, a freshman of the ETV, who took care of the music for some hours.

Joris van Breukelen

Christmas lunch
21 December

On the 21st of December, one of my favourite traditions of the ETV took place. The annual Christmas lunch, where the smell of gluhwein and delicious fried snacks fill the /PUB, is dear to most members as it is one of the last moments together before the Christmas break. Like every year, the Board went out of its way to send some letters to the North Pole and invite Santa Claus himself, who gladly honoured our wishes with a visit. He took it upon himself to fill the room with laughter, by sharing a funny anecdote from his book full of stories. I enjoyed myself during the lunch and left for the Christmas break with my belly full and my spirits high. The classic Christmas evenings spent with family, who already have inquired about your studies for the tenth time the same evening, sometimes require a little exhilaration after all.

Sam Aanhane

CV-check
14 January

On Monday January 14th, Brunel came by to host a CV check for all Master and PhD students. This event is part of the EEMCS Recruitment Days, the largest career event within our faculty. A delegation of three representatives took place in the v/d Poelzaal to browse through the various CVs that the students brought along. They gave professional feedback, tips and suggestions, to enable each student to have a CV of high quality. Looking at the queue that persisted throughout the day, it can be concluded that it was a popular event. After all, a CV is often one of the first things a company gets to see from you in an application process! Nevertheless, this is not the only event that will be organized in preparation of the EEMCS Recruitment Days - an interview workshop will follow soon. More information on that can be found on the website!

Karen van der Werff

EESTEC Autumn Congress
12 - 16 November

At the start of the second quarter, Philip, the Secretary of the ETV, and myself, the President of the 147th Board went to the city of Budapest for a very special Congress. It was a congress organized for all the Local Commitments (LCs) of EESTEC. Two times a year, the Representatives of these Commitments come together to discuss the current situation of the association and make the important decisions about the future of EESTEC. The Congress lasts from Monday up until Friday and always ends with an International Motivational Weekend. By day, there is a General Assembly (GA) much like we have at the ETV. At the end of the day, fun activities are always hosted to enjoy your stay in another city to the fullest. For Philip and me, it was the first Congress we participated in. We met a whole bunch of new people and had an amazing time in Budapest.

Laurens Vergroesen

EESTEC IMW in Budapest
16 - 18 November

Last November, the annual Autumn Congress of EESTEC was held in Budapest. After each Congress, an International Motivational Weekend (IMW) is held, where Electrical Engineering students from all over Europe can hang out and party together. After arriving on Friday, we had a very nice dinner and a really great party organized by EESTEC. Everybody there was really kind and it was an amazing opportunity to meet people from many different cities. The next day we went into the city for some sightseeing, which was a lot of fun as Budapest is a really beautiful city. After seeing the city we had another party. Unfortunately I already had to leave for the airport before it ended. All in all, it was a really great weekend with lots of great people and I would advise everybody to visit an EESTEC event if you get the chance!
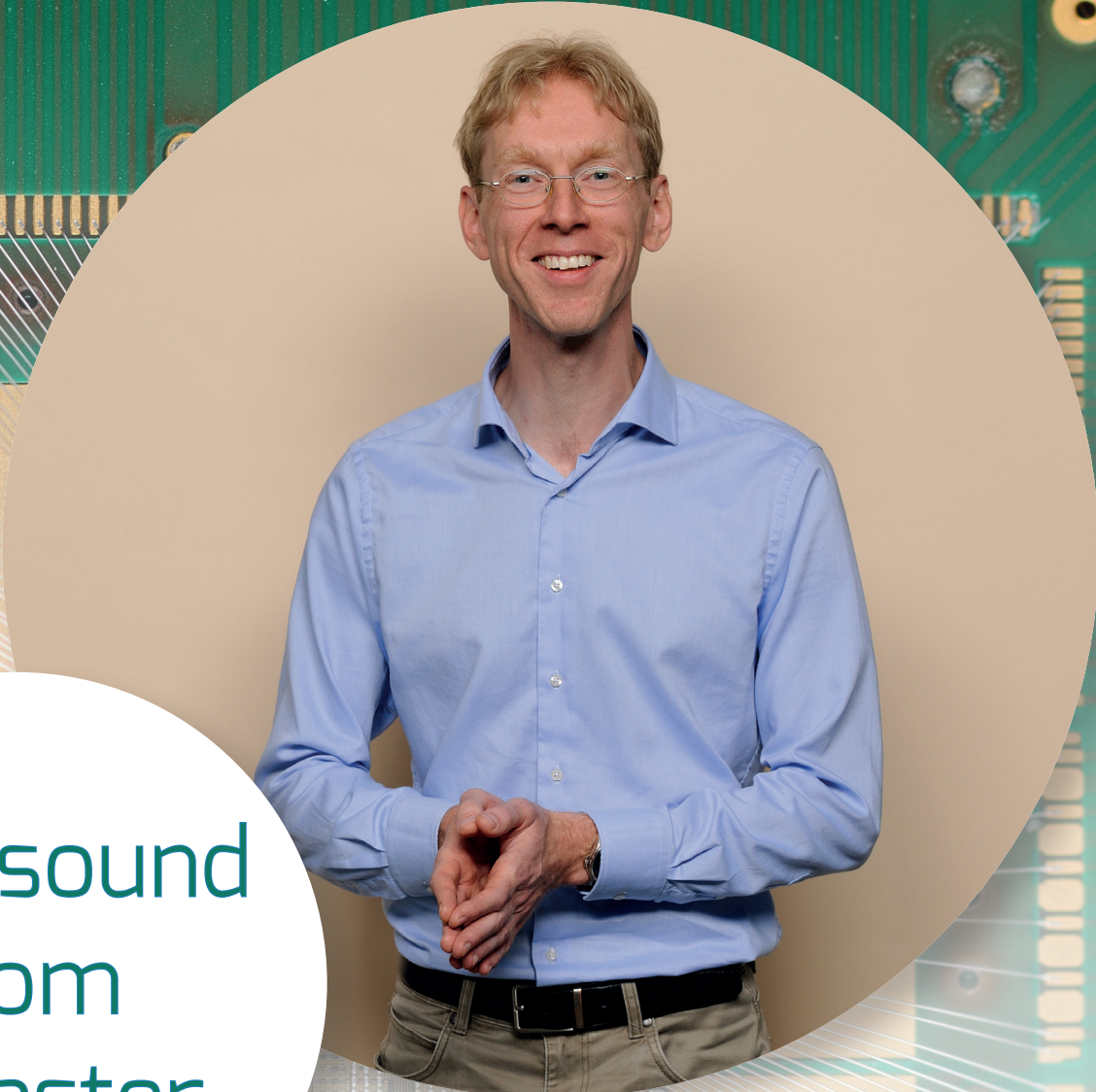
Joos Vrijdag

What is EESTEC?

EESTEC stands for *Electrical Engineering Students' European Association*. In short, the aim of EESTEC is to connect Electrical Engineering and Computer Science students all throughout Europe. With 53 participating cities, or Commitments, the association has a broad network ranging from Dublin to Istanbul and from Milan to Tampere.

These Local Commitments, often abbreviated to LC, organize a variety of events. The focus of these events varies from academic to cultural and social. Examples of events include:

- **Workshops**: during one week, you will learn more about an Electrical Engineering or Computer Science related subject. Examples include Vision & Reality, automotive systems and Arduino programming.
- **EESTech Challenge**: a local hackathon. The winning team can be sent to the international Final Round.
- **Exchange**: a week-long cultural event in which you will get to know the city and its traditions better.
- **IMW**: a weekend focussed on having fun and meeting new people!

Delft is also part of the EESTEC network, with its core nestled within the ETV. In fact, we are one of the proud founders of the association! As a member of the ETV, you are automatically a member of EESTEC. This means that you can freely join their events. If you decide to join one of the academic events, the ETV can support you financially. Ask the Board for further information!

Ultrasound from a plaster

Ultrasound scanning via a plaster or catheter:
Michiel Pertijs sees real possibilities for reducing the
size of ultrasound equipment to millimetre format.
And it's all thanks to smart chip technology.
*"Ultrasound probes are the old-fashioned analogue
telephones. In medical equipment, the digitisation
of data is still in its infancy."*

Michiel Pertijs
TU Delft associate professor in the Electronic Instrumentation Lab
in TU Delft's Microelectronics department

Read more on: tudelft.nl/en/eemcs/current/nodes

Upcoming activities
For members of the Electrotechnische Vereeniging

Lotte Zwart

Lunch Lectures

This quarter there will be a lot of lunch lectures again. We will start off with TenneT on the 11th of February, then HyTEPS on the 22nd and lastly TNO on the 7th of March. Of course there will be delicious sandwiches from Leo!

To attend these lectures you need to subscribe to the Facebook event posted on the ETV Business page. Keep a close eye, because new ones are posted every week!

When: To be determinded
Location: Lecture halls
Price: Free!

Motivational Drinks

Motivation is a powerful, yet tricky beast. Sometimes it is really easy to get motivated, and you find yourself wrapped up in a whirlwind of excitement. Other times, it is nearly impossible to figure out how to motivate yourself. The ETV will help you out with the motivational drinks!

So join us in the /pub after your first lectures and tell everyone your epic Wintersport stories!

When: 12th of February
Location: \Pub
Price: Beer €0,50 cents, pizza €5

Weekend away

The Weekend Committee has started off with some good ideas about a wintery weekend away.
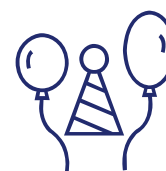
This year the trip will lead to the efteling and many more awesome activities! We will stay in a large farmhouse and go to these activities from there.

Registration for this trip is still open, but will close in week 2.10.

When: 15th until the 17th of February
Location: Kampeerboerderij de Heikant
Price: €70

Electrip

Two weeks after the weekend away, the annual Electrip takes place. This trip aimed at bachelor students will take us to Berlin this year. Underway and in Berlin we will visit numerous companies and will also have a Cultural Day.

When: Februari 25th untill March 1st
Location: Berlin
Price: €110

Recruitment Days

In March the annual EEMCS Recruitment Days will take place. To attend you'll need to upload your CV to *www. EEMCS.com* before February 3rd. In this week master students can take place in interviews to look for internships, a master-thesis project or a job.

When: 18 untill the 22nd of March
Location: EEMCS faculty
Price: Free, but register on the website

ETV Dies Natalis

Every year our asociation turns a year older. To celebrate this we have a Dies Week in the fourth quarter. However, we cannot let this day go by unnoticed! To celebrate, the board will hand out free cake, enough for the enitre faculty.

When: March 26th
Location: Central hall of EEMCS
Price: Free!

Head in the cloud, feet on the ground

Kom bij ons werken

Voor ons Pinewood Security Operations Center (SOC) zijn wij altijd op zoek naar enthousiaste en ambitieuze studenten met een grote passie voor techniek en security. Vanuit het SOC monitoren wij de IT infrastructuur van grote organisaties. Je werkt met de meest geavanceerde tools om de dreigingen in de kaart te brengen. Daarnaast maak je gebruik van de actuele Threat Intelligence informatie en ga je proactief op zoek naar cyberdreigingen. Op basis van jouw analyses breng je advies uit naar de klant. Met behulp van de Pinewood Academy wordt je opgeleid tot security consultant en stemmen wij de functie af op jouw capaciteiten en jouw toekomstplannen. Wij bieden een carrière binnen een hands-on en praktijkgerichte organisatie waarbij veel ruimte is voor persoonlijke groei.

Zoek jij een goede baan binnen de cyber security en wil je meewerken aan de verdere groei van onze dynamische en professionele organisatie, kijk dan snel op www.pinewood.nl en wie weet word jij onze nieuwe collega.

Kijk op www.werkenbijpinewood.nl

PINEWOOD
on top of security