Maxwell

Magazine of the Electrotechnische Vereeniging

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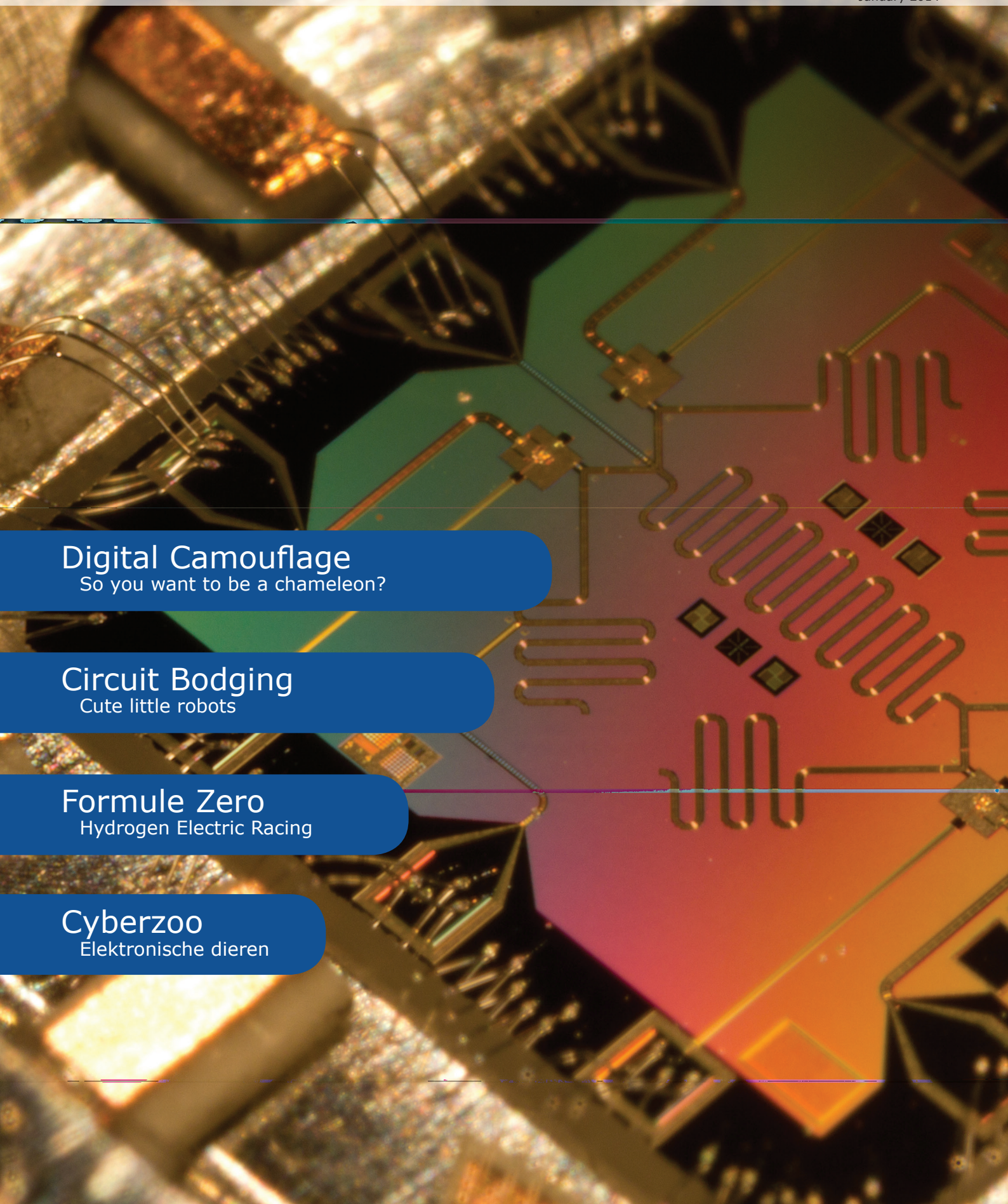

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From the board

An innovative story

Author: Ludo van den Buijs

As time flies by, winter is coming to an end and a new quarter of this year is almost here. This time of year is a unique moment. It is time many people use to watch back on their past endeavours as well as look forward to what is to come. Even though the academic year is shifted half a year form the calendar year the time of looking back as well as looking forward overlaps. Freshmen have made Delft their home and start to know the way everything works around here. They have passed or failed their first exams and, as they now have a better view on what they can expect, will be making plans how to better themselves into passing more of them.

As the board of the ETV, we are at the same crossroad. We have called ourselves the board for almost half a year now and had an amazing time doing so. It wasn't all fun and games though, during the past half year we have all learned a lot, met many people and have grown to become a better team. As much as we enjoy looking back at these last crazy months, we are excited to look forward to what is still left to come. We're attempting to apply everything we have learned so far to what is ahead and there is still a lot ahead.

Several new committees have been installed and have started with their work. The Electrip committee is working hard on their midweek of traveling through Europe while visiting several companies along the way. Moreover, the EESTEC committee has started planning for their weeklong workshop aimed at European Electrical Engineering students. Furthermore, a group of overenthusiastic freshmen have begun their ETV-career taking part of the newly installed winter activities committee. They have already organised a Disney themed drink in our beloved /Pub and they have got many plans for the months to come.

These aren't the only committees who have been recently installed, the Cultural Events Committee (CEC) and the new Sports committee have also started. Don't enjoy a themed drink as much as some of us, keep a close eye to the plans of these committees. They are especially aimed at bringing more diversity to the type of activities available for ETV-members. Do you enjoy anything from Jazz music to a film festival the CEC might be a committee you want to keep informed about. Are you more the sportive type or have made a new year's resolution to be more active the new Sport committee could be aimed at you. You can already enrol for their first activity as the ETV will be participating as one of the teams during the annual Batavierenrace. There is a limited amount of participants though, make sure you enrol soon at the ETV desk if you wish to participate.

As weird as it feels to think about how fast the past half year has passed us by, it still feels as a very long time until the summer break. And thankfully so, as I certainly do not wish to see our time as board members end anytime soon.

The 142nd Board wishing everyone happy holidays!

Theme content

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... and more

Editorial

Dear readers,

First of all, I would like to wish everyone a very happy new year on behalf of the Maxwell committee. Most of you are probably reading this while you actually should be studying for your exams. Nevertheless, some relaxation from time to time is a must and reading the Maxwell is one, if not the best, way to relax!

In this issue, we bring you a lot of new interesting articles which have something to do with nature inspired technologies. For example, how do computers work together in a swarm and what are the benefits of this? Are quantum-computers the future or can they work side by side with the DNA-computer? And by now, we all know that the NSA is watching us and drones are keeping an eye on us. Is the next big thing micro-observents? Robots the size of a fly who will infiltrate your homes and follow you around. This is probably already happening. But can we outsmart these small robots? Maybe an invisibility cloak is the answer. For this and more, continue reading!

But before you skip the rest of this editorial and start with your reading spree, please also check the newly added section called the ETVIP, short for "ETV Very Important Pages". These pages will contain a summary of the activities organized by the ETV that already took place or will take place in the near future. So keep an eye out for these pages in this edition and future editions of the Maxwell.

We hope to see you all after the short break in February.

On behalf of the committee,

Yvo Mulder

Dreamteam

Forze: Hydrogen Electric Racing

Author: Kevin van Giessen

'Working towards a sustainable future' is one of the big challenges in engineering nowadays. Many students are already working on new innovative concepts for this goal. Forze has also accepted the challenge Forze Hydrogen Electric Racing is a student team foundation of the Delft University of Technology. The foundation was established in 2007 and has grown tremendously over the years.

"Due to immense complexity of the electronics and embedded software, Electrical Engineering students are always wanted!"

It is one of the few teams in the world which designs, builds and races Hydrogen Electric racing cars, and the team now comprises about 70 students. Most of these students study at the Delft University of Technology. The team is multidisciplinary; all the faculties are represented by their students and the team is also managed by students. Apart from the technical and managerial challenges, maintaining public relations is done by students as well.

Apart from the board that is fulltime, most of the team members are part-timers. These students are very driven and desire to get hands-on experience with engineering in their spare time. While other team members are interns or graduates. All these students choose to be involved in the Forze project because of its innovative, sustainable, educational and fun character. Every year a new board of students heads Forze, but always with a smooth transition of knowledge and continuity.

The Forze team is located in the D:Dreamhall. At this special building of the campus, different projects are based, all supported by the TU Delft. The university facilitates the team with knowledge, machinery and accommodation. The team has its own office and workshop in this hall. Because of the enthusiastic support of the university, each team has the ability to develop itself into a successful organization.

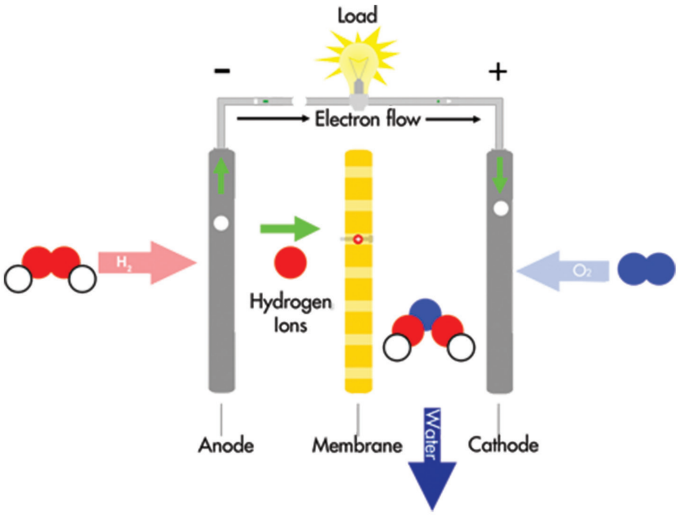
Forze VI

Being a part of Forze can help you gain experience in multiple fields. In this team you will learn to operate in a multidisciplinary team from different backgrounds. Teamwork, deadlines, budget and technical challenges, it is all part of what we do. Since the start up in 2007, the different departments gathered knowledge and experience. You can benefit from all this knowledge and increase your technical know-how or go in depth into a certain part of the complete system.

Besides this, you will join a team culture in which different personalities and cultures work together in a very effective and relaxed way. Different functions are available, varying from being a part-time member that helps out on events or small technical assignments to being a full-time

team manager. You can start as a part-time team member from 5 hours a week.

This year, Forze is continuing the production and fine-tuning of the Forze VI, our very first street-car sized Hydrogen Electric racing car. This summer, the Forze VI will try to break the lap record for hydrogen electric race cars on the circuit of the Nuerburgring, Nordschleife. To do this, the car has a top speed of a staggering 210 km/h.



The basics of the Forze Racecar fuel cell: PEM - Proton Exchange membrane

"The fuel cell in the Forze VI is powerful enough to power over 30 Dutch households"

To get to this top speed, several challenges need to be overcome. One of the biggest challenges in building a hydrogen fuel cell racing car, is to have a proper chemical reaction occurring in the cell. To provide optimal conditions for this reaction, the car is fitted with numerous pumps and sensors, of which all need to be controlled and read. This is the reason why electronics and embedded software are two of the key elements in this car.

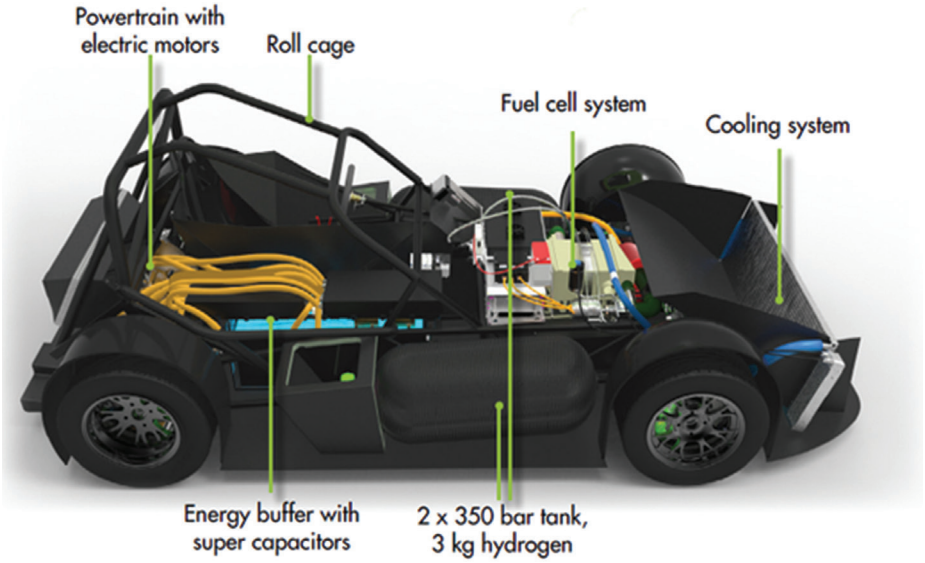
The electric motors have maximum torque of 400 Nm at 7500 rpm, and the torque is linear of the whole range of rpm's. This results in a simple driveline without a gearbox with different gears. The drivetrain has a fixed ratio which is designed to use the electric motors as efficient as possible. A fixed gear ratio means the driver doesn't need to shift gears which saves time and results into a simple, effective and reliable assembly. Each rear wheel is powered by one motor, these motors are controlled in such a way the power is used effectively to push the car through a corner. This smart differential uses multiple inputs like the steering angle, GPS and G-forces.

Due to the incredible torque of the electric engines an acceleration of 0-100 in less than 4 seconds is achievable for the Forze VI. The use of electric engines have many advantages, this is definitely one of them.

Apart from the great acceleration, the car must also be able to decelerate (brake) very quickly. One of the exceptional feats of this car is that the electric engines can also be used as an alternator to convert kinetic energy into electric energy. This electric energy is then stored in an energy buffer. This way the car is more efficient by using braking energy which is otherwise wasted as heat energy.

The fuel cell in the Forze VI is powerful (100kW), this is enough to power 30 households. However, more power is needed to perform and compete on the track. Therefore Forze developed an energy buffer which consists of 156 ultra-capacitors of 2300F each. The size of this buffer is roughly 1 MJ, which is enough to boost the power to 190 kW for approximately eight seconds. The big challenge here it to make sure that this process works as efficiently as possible.

All in all, Forze is a unique opportunity for students to gain some practical experiences with new innovative technologies, especially for the Electrical Engineering students.



A simple layout of the Forze VI

Food for Thought

Brains! Braaaains!

Author: Ben Allen

Consider the following statement: Electronics are a natural phenomenon. So is electricity in the form of lightning, but I'm actually talking about electrical systems. Man has yet to find a naturally occurring transistor, but we do know of an electrical construct that has been provided for us by nature. We use it every day. It's pretty good at a lot of stuff, but still manages to fail in unexpected and surprising ways from time to time.

I am, of course, talking about the Central Nervous System. We are all equipped with nature's information gathering/processing system, and at its core (in our heads) lies the brain. Brains, apart from being a zombie's favourite lunch, have been the subject of intense study and research. They're the most complex natural machine around. One of my favourite brain-quotes reads "if the human brain were simple enough to understand, we would lack the mental capacity to do so".

"Brains, apart from being a zombie's favourite lunch, have been the subject of intense study and research."

It's beautiful, isn't it? By its very nature our own brain is an enigma that looks like it won't be fully understood for several decades if not centuries to come - if ever. It's like we're born with a recursive puzzle built right in to our heads.

Brains consist of a few basic building blocks, but the most important is a cell called the neuron. Wikipedia gives a nice, concise definition: "A neuron [...] is an electrically excitable cell that processes and transmits information through electrical and chemical signals." At its core, a neuron is essentially a repeater. Apply a neural stimulus - the mechanics of which are irrelevant to this particular discussion - and it will repeat that pulse to other neurons connected to its 'output'. Throw a couple of billion of these things together, add almost 200 000 years of evolution and we end up with the soft, spongy, beautiful and astronomically complicated organ we all know and love.

But brains aren't kept in glass jars unless you're watching Futurama. They're connected to our bodies and our bodies exist in the world, where stuff happens. Our brains need to be able to respond to said stuff. In the case of insect brains, behaviours are rudimentary. A flying locust manages to avoid the rest of the swarm because when it sees something close to one of its eyes, neurons involved with vision become active and suppress part of the locust's flight mechanism, avoiding a collision. This is a lot like our modern robots. A sensor might detect, say, a landmine and cut power to the motors powering our little bomb disposal bot towards it. The response is completely automatic and no thought is necessary. The same is true for the nervous system of a locust.

Figure 1: Zombies are also interested in brains, but they don't make good scientists.

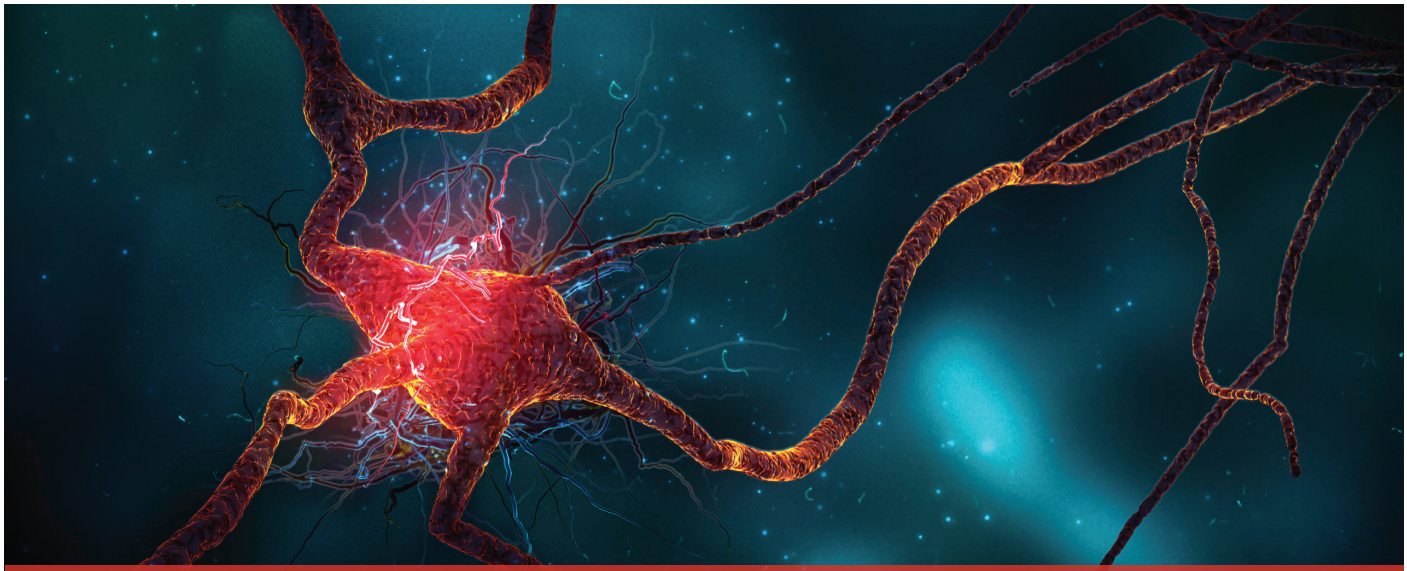


Figure 3: An artist's impression of a neuron.

Fascinatingly though, a locust has a fairly complex nervous system for an insect, but not complex enough to generate intelligent behaviour.

Here's where things become rather interesting. Our brains, like the locust's, are made of neurons. The difference is in the chemicals involved and how they're wired up, but more importantly we also have quite a few more neurons than a locust. In fact, humans are estimated to have a staggering 86 BILLION neurons! In comparison, a cat has about 1 billion neurons, a chimp has 6.7 billion, and an elephant weighs in at 23 billion. Not unexpected, as a larger body requires more neural machinery to operate. Humans, at a fraction of the elephants weight, have almost 4 times that amount. Of this amazing number, approximatedly 16.3 billion neurons are said to be in the cerebral cortex (the part of the brain that makes us Homo Sapiens). That's a lot of neurons, with 16.3 billion of them forming a structure that allows us to do something amazing:

We can think.

Quite fitting for a segment called food for thought. Have you ever stopped to consider the staggering thing you do all day, every day? You don't just react to impulses like hunger and danger, you have plans and execute them. You consider options and alternatives to your choices. You spend every day navigating complex social structures, you change your behaviour based on where you are or who you're with. In fact, not doing so is frowned upon socially - for example, you might use truly foul language with your friends and family, but wouldn't dream of dropping the f-bomb during a performance review with your boss. Sounds normal right? And it is, but the mechanism that makes this possible is nothing short of extraordinary and deserves some exploration.

You see, beyond the mechanism that composes the brain (which neuroscientists call wetware, a reference to hardware in the traditional sense), we also possess sentience, cognition. We are self-aware and we see ourselves as seperate from others and seperate from the environment. We have two realities, essentially. One we all experience, and another completely closed off reality that exists in our minds. Now, as fascinating as the workings of this mind are, there's no room here to discuss them. What matters is that your brain (as far as we can tell) is responsible for causing this sensation. Molecules from the bread you are baking reach your nose and activate several receptors in your nose, a pattern of neurons is activated and - here's the really cool bit - you SENSE freshly baked bread. You can picture the bread in your mind. You EXPERIENCE the smell. All because a bunch of cells in your head got excited. Why does this translate to experience? Who knows? It's a good time to be a neuroscientist.

No robot has experienced anything ever. How could they? A robot is not alive. It does exactly what it's programmed to do. The difference lies in the fact that biological brains can adapt their 'programming'. They can, in fact, do so astoundingly

Figure 2: Where the magic happens.

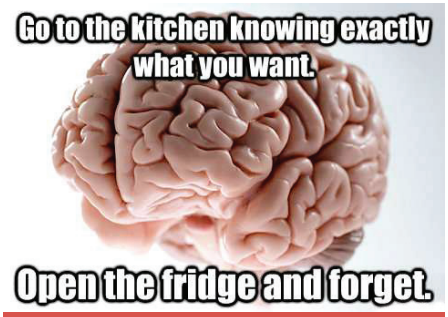


Figure 4: This happens to me all the time.

quickly. The most well-known example of this is called classical conditioning and was demonstrated by Ivan Pavlov. Pavlov conducted an experiment in which he fed dogs and simultaneously rang a bell. After enough repetition, the dogs learned to associate the bell with food, and ultimately would start to salivate when they heard the bell regardless of whether they were offered food or not. This is just one of many different types of learning, but it illustrates the point nicely.

"After enough repetition, the dogs learned to associate the bell with food"

That, and robots are (usually but not always, see the article about BEAM robots further on page XX) designed around microcontrollers that are programmed to behave in a certain, fixed way. They do not adapt, they cannot learn, and as such cannot exhibit intelligence in the traditional sense. We can, however, create a circuit that reproduces a neuron's behaviour, and this opens up some rather interesting questions. Could we build an electronic brain that works on the same principles as neurons?

"How do you teach an FPGA to be a sea slug?"

The answer is yes (see BEAM bots again), but there are some (read: a royal buttload of) practical difficulties. Our man-made electronic neurons are billions of times larger than their biological counterparts. They're also slower and require much more energy to operate. On average a human brain needs about 600 kcalories of energy per day. This boils down to 2510 kJ per day or 29 J/s. The entire human brain runs on under 30W. In contrast, my computer at home has a 450W power supply, and there's no reason in the world to assume that my computer is in any way intelligent.

Neglecting space and efficiency, you end up with a wiring problem. The roundworm (caenorhabditis elegans) has 302 neurons. This does lie in the realm of feasability as far as reconstructing its nervous system, but it's barely *conscious*. Roundworms are more like robots than people. Trying to link even a modest amount of electro-neurons (say 500 000) together results in a stupendous amount of wiring that is only really possible on an integrated circuit, and those turn out to be rather expensive.

What about an FPGA then? Perhaps given larger resources, but my Altera DE-1 board features a Cyclone II FPGA with 18,752 logic elements. Assuming I can use all of those to be neurons, I might be able to reproduce a sea slug brain, which has 18 000 neurons. Not exactly impressive. That, and it opens up a rather challenging problem: How do you teach an FPGA to be a sea slug?

All of this is both hypothetical and complicated, so why bother at all? I give you two reasons. Firstly, it touches on the subject of what consciousness is, what causes it, and if we can replicate it. It's pure science fiction. And it will stay that way until people start doing this kind of thing just to see if they can do it. And that's my second reason.

It's an awesome thing to do, and my curiosity (which is nothing more than my brain's desire to form new pathways) compells me to consider what would happen. If nothing else, it's worth spending 15 minutes thinking about.

Final Bachelor Project

Self-Deploying Sensor Swarms

Author: W.F. Heida BSc.

Last year 5 fellow students and I have been working on a Self-Deploying Sensor Swarm (SDSS) for our Final Bachelor Project. An SDSS is a network of autonomous Unmanned Aerial Vehicles (a.k.a. drones) that are capable of performing simple tasks which are combined in a swarm-based approach. By using this approach the network is able to perform complex tasks although the basic working mechanisms of the system are fairly simple.

A good example of these complex tasks are monitoring dynamic systems, like tracking of large groups of people or finding bottlenecks in road infrastructures. These tasks would normally require a large, fixed infrastructure which cannot be moved and need big investments. The SDSS gives much more flexibility than currently available systems, because it can react to changes in the system it is monitoring and adjust its network to the new situation. The network is also able to only deploy in those places where monitoring capacity is really needed, so less units are needed. By using relatively cheap drones alongside the fact that less units are needed the total costs of these systems are lower compared to traditional monitoring systems.

This all sounds very promising, but at the moment the SDSS is still in the concept phase and no full scale prototypes have been built yet. So a lot of research has to be done into the possibilities and also the feasibility of this concept. It is also unknown what kind of problems you would experience during the design of such systems. Therefore Chris Verhoeven, theme leader for Swarm Robots at the TU Delft Robotics Institute[1], asked us to build a demonstrator of this concept which can be used as a prove of concept. During this assignment we focused on some key components of the system that are essential for the SDSS to perform monitoring tasks as described before. These key components are:

- Basic controls of the drones
- Communication between the drones,
- Tracking of objects
- Swarm intelligence

Each pair of students designed one or two of these components which can eventually be put together to form the Self Deploying Sensor Swarm. In the next sections I will explain more about these components.

For this project we used the Parrot AR.Drone 2 which can be controlled by some basic software on a base station, in this case a laptop. The communication between the quadcopter and the base station is performed via Wi-Fi. Avoiding collisions with other quadcopters and objects in the space is a major issue. In an SDSS the collisions should be avoided by the swarm intelligence, but an additional mechanism was designed for safety reasons. This mechanism is implemented by using ZigBee modules that can be attached to the quadcopter. The ZigBee's send requests for other units to return their signal and based on the Received Signal Strength Indication (RSSI) the distance to other quadcopters can be estimated. If the distance becomes too short, the quadcopters both will perform a reflex to avoid the collision.

The Parrot AR.Drone 2

Basic controls

The quadcopter, an aerial vehicle with 4 horizontal blades, provides a good platform for the drones in the SDSS, because they are highly maneuverable and can land everywhere. These commercially available quadcopters ship with solutions for controlling the quadcopter, but the main drawback of these solutions is that they need user input. These drones are not capable of flying completely autonomous. Because autonomous flying of UAV's is a big research topic for which a comprehensive solution is still not available, we decided not to focus on this.

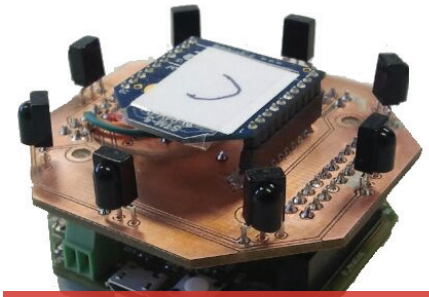
Communication

In real life situations a SDSS will generate large quantities of data that can be analyzed by the user. Because the drones can be spread around large areas you need some sort of mechanism to retrieve this data from the swarm. You can use a base station to which all drones can send data, but due to the weight limitations of drones there is not much power available for communication. Hence, the range of the communication modules of a drone will be limited and not always be enough to reach the base station. By using a communication protocol in which quadcopters can function as hops between the base station and other quadcopters all data can eventually reach the user for analysis.

In our demonstrator we implemented a simple self-designed protocol that uses the already present ZigBee module for the communication. This protocol uses a routing table in which information about other quadcopters that are in range is stored. With this protocol we managed to provide a network between all quadcopters and the base station that can deliver enough throughput so data can be delivered fast enough.

Tracking of objects

The main task of the demonstrator is to track objects on the ground, which we called crawlers, and follow them. The major difficulty in these kind of tracking problems is that you need a property that distinguishes a crawler from other objects. This property can already be present at the crawler, but you can also add it in the form of a beacon. For this demonstrator we did not have to cover a large area so we decided to work with a sensor node containing a ZigBee module and an IR-LED. The quadcopters use again a ZigBee module and 8 IR receivers for locating the crawlers. The ZigBee module is again used for measuring the distance between the quadcopter and the crawler and the IR receivers are placed in the form of a compass rose for angle detection. The distance and angle combined result in polar coordinates of the crawler in an axis system in which the quadcopter is at the origin.

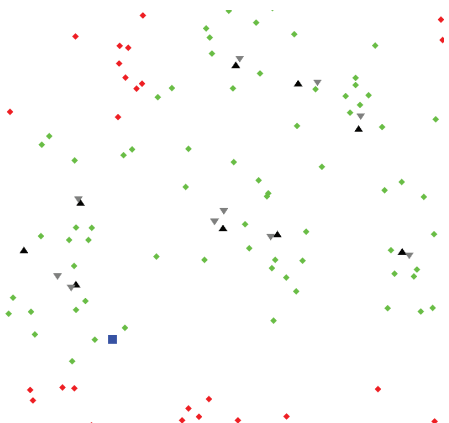


The sensor node

Swarm intelligence

The main goal of our project was to design a demonstrator of a swarm, so we needed to design a form of swarm intelligence. This swarm intelligence will be placed on each drone in the network and there will be no control unit available that controls all drones in the network. Because placing the intelligence directly on the drones and testing it in a real environment was not possible at the start of our project, we decided to build a simulator that we can use to develop and test the swarm intelligence. This simulator was written in C++, because this gave us maximum control over the behavior that we could simulate and how it is implemented. In order to make debugging and testing easier we also used the OpenGL library to create an animation of the simulation.

An important property of swarms is that drones are only allowed to send and receive information and are never allowed to make requests for information. In one way this simplifies communication between drones, but on the other hand this will complicate data accumulation. And we also have to take into account the limited range of communication of the drones. In order to solve these two problems we used a gossip protocol. Just like with human gossip the drone receives some information and then decides whether he should send on the information or not if he did not receive this information before. A probabilistic process is used in order to ensure some randomness in the resending of information. This randomness is actually quite important, because you don't want to resend all data, because that would create an enormous waste of bandwidth. But you still need to send enough information so most drones eventually receive the information. Figure 1 *(Printed on the next page)* contains a graph that shows about how much units in the system a particular quadcopter received information from over time. Because not all of these units were within communication range of the quadcopter, this shows that the gossip protocol works for this type of networks.



A screenshot from the simulation

The simulation

The black triangles represent the quadcopters and the grey triangles are the target positions of the quadcopters. The squares represent crawlers where green means that they are within detection range of a quadcopter and red that they are not. The blue square is the base station of the swarm that accumulates all data.

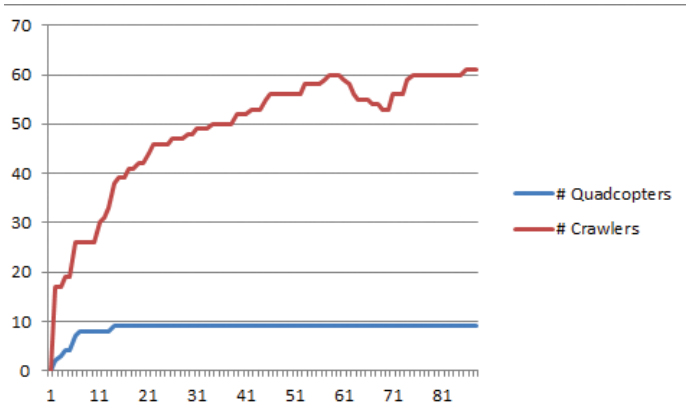


Figure 1: The 'gossip' protocol - Amount of entities about which a single quadcopter received information over time.

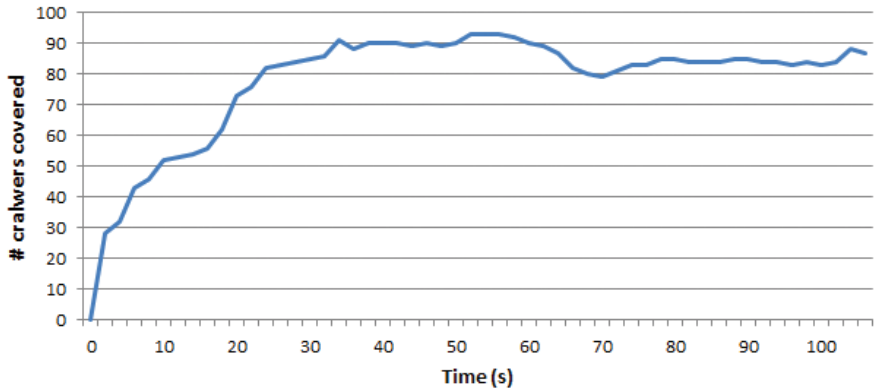
There are all sorts of artificial intelligence available these days so we had to decide what kind of approach we needed. Agent-based modelling turned out to be a good solution for this problem. In agent-based modelling you have agents that operate autonomously from each other and can only operate based on their surrounding area. The decisions of an individual agent are based on some simple rules, but the behavior of the entire system will eventually be much more complex.

During this project we developed two agents: the solo agent and the swarm agent. The solo agent is meant for situations that involve a small numbers of drones and crawlers. Every drone will follow a single crawler if he knows where that crawler is and otherwise it will explore the space in a random way. The movements of the quadcopter are limited once they are following their target in order to save energy. In a real life situation the drone will land somewhere suitable to save energy. A simple form of collision detection has been implemented, because this agent does not avoid collisions by itself.

The swarm agent is designed for situations where large numbers of crawlers need to be followed by a small number of quadcopters. This agent has two states: one in which the space is explored in a random fashion and the other in which it will stay at the center of all the crawlers the drone can detect. The state transitions are partly random in order to ensure that all crawlers are covered by the swarm. The collision avoidance for this agent is realized by a "swarm like collision avoidance" algorithm that is based on the attraction and repulsion by positive and negative charged particles. Figure 2 contains a graph that shows how much of the 100 crawlers in the simulation are within detection range of a quadcopter during a particular test. Because the agent uses some random processes a 100% coverage will be difficult to achieve, but these results are already quite good.

Future work

The goal of this project was to build a demonstrator of a Self Deploying Sensor Swarm, but due to a lack of time we did not integrate all components into one working system. We also used some pretty simple techniques to demonstrate that the main concepts of the SDSS work, but these techniques are not suitable for real-life applications. But we did show that the concept works and that is has a good potential for providing solutions for all kinds of problems. Based on our project the Robotics Institute is now looking into new directions for additional assignments and research projects for both Bachelor and Master students. So if you are interested in this concept and want to help improve it, please contact Chris Verhoeven. He will be happy to tell you more about the possibilities. More information on our project can be found in our theses listed below.



Firuge 2: The covered amount of crawlers by the system over time

References

[1] http://www.robotics.tudelft.nl/

[2] J. van den Bor and J. P. G. van Dijk, "Aandrijving quadcopters, communicatie, collision avoidance," Bachelor Thesis, Technische Universiteit Delft, Juni 2013

[3] K. Meun and N. Radeljic-Jakic, "Uav ir & zigbee object tracking," Bachelor Thesis, Technische Universiteit Delft, Juni 2013

[4] W.F. Heida and D.H.P. Kraak, "Zwermintelligentie voor een self-deploying sensor swarm," Bachelor Thesis, Technische Universiteit Delft, Juni 2013.

Dye-sensitized Solar Cells

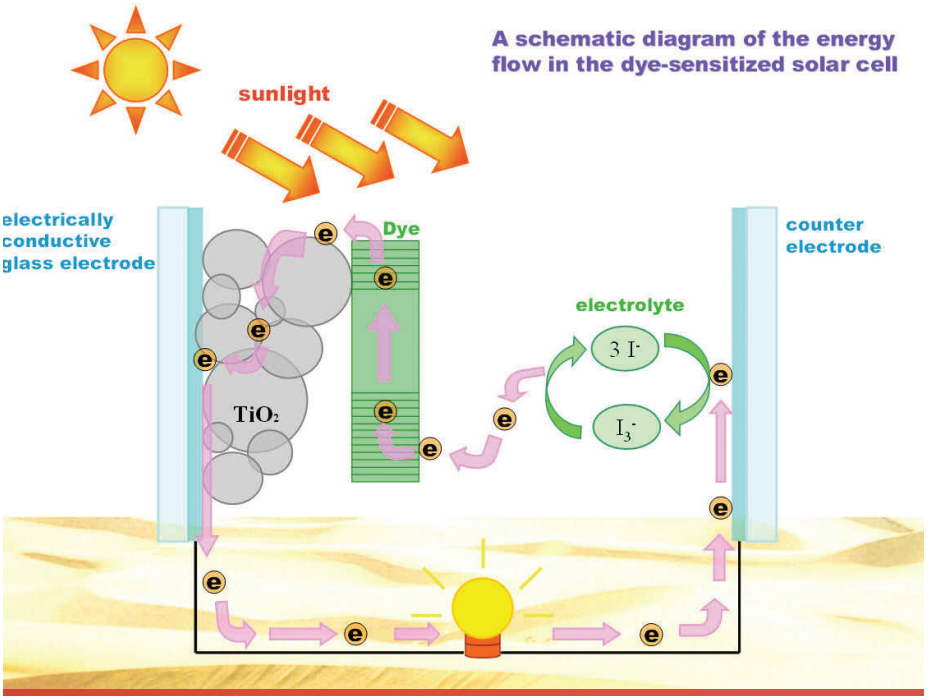
Cheap Solar Cells

Author: Jurr Andriesen

Dye-sensitized Solar cells are relatively cheap solar cells, which unlike 'normal' silicon based solar cells mimic the first steps of photosynthesis in plants. These first steps involve capturing photons released from the sun by a method of absorption using a special dye, which can be extracted from certain fruits, and then using the energy of the photons to create a flow of electrons. From there photosynthesis involves using that electrical energy to create chemical energy, from which ultimately the product of photosynthesis, sugar, is created, whereas in a DSC (Dye-sensitized cell) our purpose is to create electric current, or electricity.

The dye used to absorb electrons is basically an analog to chlorophyll in plants and just like the thylakoid membranes inside leaves, solar cells have a high-surface-area to maximize efficiency.

DSCs are often called wet cells because they contain an electrolyte solution that replaces lost electrons back into the absorbent dye. This is what makes them so different from the 'dry' silicon based cells. The liquid electrolyte has temperature stability problems. Too cold? The electrolyte freezes causing end of power production and potential damage to the cells. Too hot? The liquid expands, making sealing the panels a serious problem. Unfortunately the sun tends to heat up stuff. Another drawback of the DSC is its relatively poor durability, caused by the degradation of the liquid electrolyte. Replacing the liquid electrolyte with a solid has been a major ongoing field of research. Recent experiments using solidified melted salts have shown some promise, but currently suffer from even higher degradation during continued operation.



Dye-sensitized solar cells

The production of DSCs is quite easy. The main ingredient TiO2, which is used for toothpaste and lots of other stuff, does not have to be very pure. It can be used without serious filtering. The other main parts from the DCSs, the dye and the electrolyte are also easy and cheap to obtain. This makes the DCSs much cheaper and easier to produce compared to silicon solar cells.

Although silicon based solar cells currently demonstrate higher efficiencies than DSCs (12-15% in commercially available silicon cells, compared to 11% in DSCs),

DSCs have a couple major advantages over silicon cells: they can operate way better in low light conditions, such as on cloudy days and in indirect sunlight, they are much less expensive to produce (so that more surface area can be covered by them for an equivalent cost) and DSCs, in contrast to silicon cells, can radiate away heat quite easily because they are produced with only a thin layer of conductive plastic on the front instead of the typical glass encasing and metal backing silicon cells need. This leads to higher efficiency at higher temperatures and the possibility to make DSCs flexible! And the best part, given you have some conductive plastic or glass, the right fruits and a (lead) pencil, you can even build one at home!

Silicon based panels

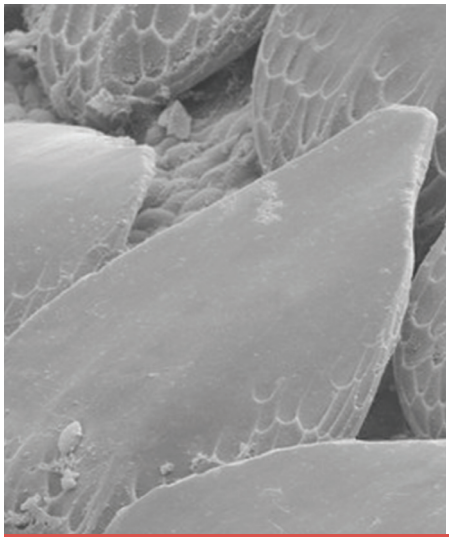
Fotopagina

Biomimicry

Author: Jurr Andriessen

The highly developed properties of butterfly wings reflect light so that specific wavelengths interfere with each other to create bright colors. This same principle was applied to cutting-edge display technology.

The Namibian Beetle raises its back into the air as fog rolls into its desert habitat. Bumps on its shell catch water droplets, which then run down chutes toward its mouth. Inventors and designers have taken note. A "Dew Bank Bottle imitates the beetle's water-collection system. Morning dew condenses on it and conveys it to a bottle, which has a drinking spout.

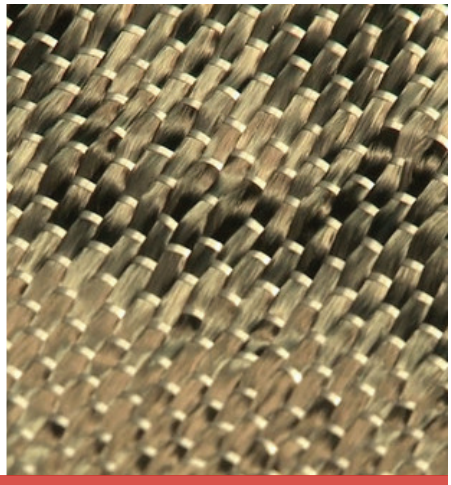


Sharks stay remarkably clear of algae and other fellow travelers. That's largely thanks to their unique skin, covered with microscopic patterns called dentricles, which help reduce drag and keep micro-organisms from hitching free rides. NASA scientists copied the patterns to create drag-reducing patterns they call riblets. They adapted this into a thin film used to coat the hull of the sailboat Stars & Stripes, which won an Olympic medal. Other applications can help planes, boats and windmills reduce drag and conserve energy.

The Calla Lily's centripetal spirals assist with the ideal flow of liquid, which allows this water mixer design to mix more liquid with a fraction of the horse power usually required.

Mercedes-Benz found inspiration for a car body in the boxfish, a tropical species shaped sort of like, well, a two-door compact car. The fish's body turned out to be aerodynamically superb, and the resulting concept car has a 65% lower drag coefficient than other compact cars out at the time (2005).

The goal was to cut out the extremely loud claps that occurred when Japan's bullet train emerged from tunnels. Engineers looked toward the kingfisher, a fish-eating fowl that creates barely a ripple when it darts into water in search of a meal. The train's redesigned nose — a 50-foot-long steel kingfisher beak — didn't just solve the noise problem; it reduced power use and enabled faster speeds!



For years, the secrets behind the extraordinary climbing prowess of the gecko baffled scientists. Eventually they discovered millions of tiny keratin hairs, called setae, on their feet. The hairs work at an intermolecular level, providing incredible grip and allowing the gecko to support its own weight using just a single toe. Gecko Tape has been made using the same principles.

Circuit Bodging

Biology Electronics Aesthetics Mechanics

Author: Ben Allen

In the Food for Thought section, I explored the idea of using electronics to emulate neurons and the philosophical consequences that had. Luckily we're a long way from having the technology to create anything that can actually think. However, with just a handful of electronic neurons we can make networks that do exhibit interesting behaviours. Today in Circuit Bodging, we tread in the footsteps of analogue robot maverick Mark Tilden and play with some unusual robot designs.

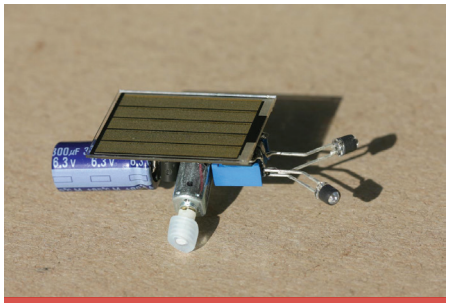


Figure 1: A light-seeking roller bot.

We all love robots. When you want to show off your electronic tinkering skills to non-geek friends and relatives, robots will never fail to impress. But robots these days are designed around FPGA's or microcontrollers. This makes sense if you want your robot to perform a specific task, but this is not the kind of robot we're talking about today. What I'm getting at is a simple robot that exists only to perpetuate its own functioning. We want a project that we can complete over a weekend. We want to build a robot that emulates nature. In short, we want to build a BEAM bot.

BEAM?

As the astute reader may have gleaned from the subtitle, BEAM stands for *Biology*, *Electronics*, *Aesthetics*, and *Mechanics*. The BEAM acronym represents a design philosphy for robots which revolves around making electronic systems that exhibit natural behaviours thought up by Mark Tilden in the early 1990s. You might know Asimov's Three Laws of Robotics; Tilden came up with his own three laws:

- A robot must protect its existence at all costs.
- A robot must obtain and maintain access to a power source.
- A robot must continually search for better power sources.

These three laws describe the basic functioning of a BEAM robot. They also appear to have been taken straight from nature, as these laws are pretty good advice for any creature attempting to stay alive. Surprisingly, with BEAM bots the first Law is harder to implement than the other two. In an abstract framework, Laws two and three are the basic function of the robot, while the first Law is at its core a case of exception handling.

We can achieve this by having a continuous 'process' that serves to have the bot seek out energy and recharge, with sensors that can detect impending doom and interrupt the energy-seeking process.

BEAM species

BEAM bots come in many shapes and sizes. There are several different types, usually classified by their method of locomotion (if any). To name a few:

- *The Sitter*.
  These bots don't move, but perform some function. A BEAM bot that collects solar energy and releases it by blinking an LED (for instance as a beacon for other bots) is an example of a sitter.
- *The Squirmer*.
  Robots that don't move around, but can perform an interesting action like moving limbs. A solar panel that tracks a light source is an example of a squirmer known as a *Head*.
- *The Roller*.
  Robots that move by rotating all or part of their 'body'. Any robot that uses wheels is a roller. See figure 1.
- *The Walker*.
  Robots that propel themselves (predictably) with leg mechanisms. These bots tend to look like insects and can be made with as little as two neurons. See figure 2.

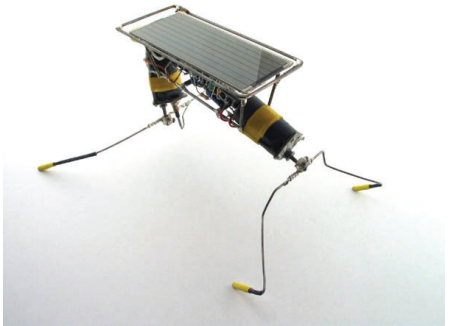


Figure 2: A solar-powered walker.

Energy is everything

The most important part of any electronic system is power. Without power, our robot would do nothing - a state biological beings call 'dead'. Clearly our robot's primary goal must be to replenish its energy supply. Because of the simplicity of implementation the most commonly used renewable power source for BEAM bots is light. A small solar cell is inexpensive and given enough light and time can collect enough energy to operate a small bot.

The BEAM neuron

Most BEAM bots operate around a construct called an NvNet (nervous network). This consists of multiple neurons, called Nervous Neurons or Nv's in BEAM nomenclature, linked together in such a way that the circuit operates continuously. However, to understand a network we must first understand its components. A single neuron is shown in figure 3.

As you can see in the diagram, an Nv consists of a resistor, capacitor, and a single schmitt-trigger inverter. Schmitt triggers are essential in this situation, as a normal inverter lacks stability and would continually cause erroneous glitches. The use of schmitt triggers smooths this noise out and stabilises the system.

For now we'll assume that the inital state of the Nv is with the output high. When a positive 5V signal is applied to the input, the capacitor is charged and we measure a high signal at the inverter's input, causing the output to switch low. If the input is held high, the capacitor charges and the voltage over the resistor (and thus presented to the inverter) drops. This eventually causes the inverter to switch its output once again to a high signal. In short, a rising edge at the input will produce a negative pulse (the length of which depends on the RC time of the filter) at the output. As you may have noted, Nv nets are active-low, meaning the 'on' state of a neuron is defined as when its output is low.

However we also have to contend with the falling edge at the Nv input. Normally this would cause a negative voltage to appear at the inverter's input, but we're going to use a little bit of electronic wizardry to deal with this. CMOS components have input protection diodes build in to the package, and in this case they come in very handy. When the input voltage drops, the left side of the capacitor sees a voltage change of -5v, and the voltage accross the resistor drops accordingly. However, if that voltage is already at 0V, it will want to fall to -5V. The input protection diode in the CMOS IC clamps this voltage at around -0.6V, bringing the voltage across the capacitor to almost 0v, resetting the neuron. A 74HC14 is a good choice for this application, as it costs next to nothing and provides you with 6 schmitt-trigger inverters in a single DIP package.

Connecting the dots

Alright, we have a working neuron at our disposal. It's great, but so far all it does is make a pulse whenever we apply a positive signal to its input. It can't really do much yet, let alone sustain a process to drive a robot. We need to link several neurons together in an Nv net. For the purposes of this example, I'm going to use this network to describe the functionality of a light-seeking *Head* robot. It consists of a motor that can rotate the bot left and right, and two photodiodes on each side to detect light levels.

The reason we want the Headbot to face directly at a light source is because it is powered by a solar cell. I don't have enough space to explain how to implement this, but for now, bear with me in assuming the bot has enough power to move and that the power circuitry is sophisticated enough to avoid glitches.

In figure 4 we see a two-neuron Nv-net known as a bicore. For simplicity's sake, I'm also going to assume the initialisation circuitry is in place and works correctly. In the initial state, the circuit looks like this:

in_1	out_1	in_2	out_2
1	0	0	1

Then the left capacitor discharges through its resistor, flipping the left inverter and pulling out_1 and in_2 high, which forces out_2 low. Now the input of inverter 1 is high and inverter two has switched off.

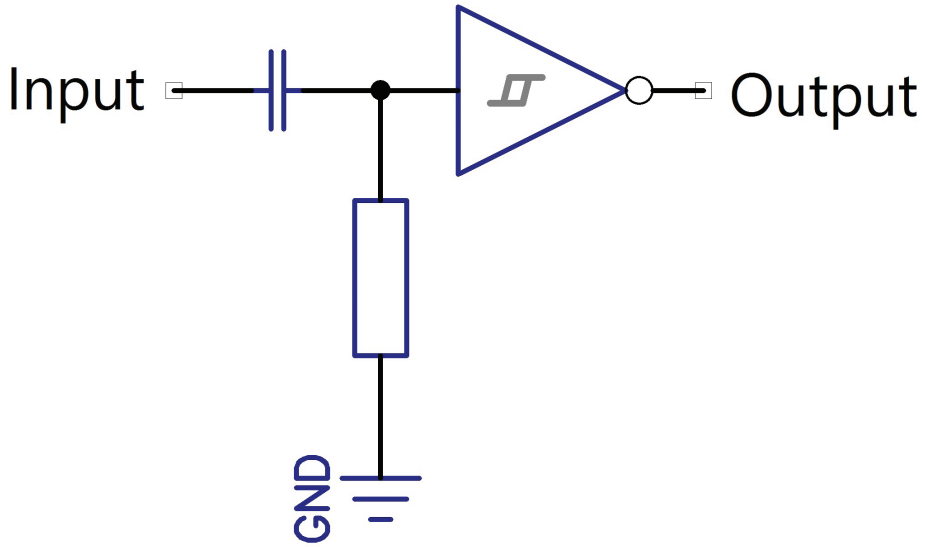


Figure 3: A single BEAM neuron.

in_1	out_1	in_2	out_2
0	1	1	0

From this state, the rightmost capacitor discharges through the resistor, eventually bringing in_2 below the schmitt trigger's threshold voltage, switching out_2 high, resulting in the following condition:

in_1	out_1	in_2	out_2
1	0	0	1

We're back where we started. We have built an oscillator. It's a little tricky to explain on paper but essentially what you get is a pulse that propagates through the network, the timing of which is dependent on the values of R and C.

This pulse can then be used to control robot functions. In the case of a light-seeking bot, the outputs here can be sent to a motor driver circuit and make the robot look left or right. If the light source is brighter on the right of the bot, we need to suppress the leftward motion and exaggerate the rightward motion. We do this by manipulating the flow of the pulse through the network.

This is where building BEAM bots becomes creative, because there are a lot of ways in which you can modify the oscillator's behaviour. The rule of thumb is "if it works, it works." Playing with circuits like this is a great way to learn.

Pulse manipulation

First off, we must establish what state means "turn right" and what state means "turn left". It's fully arbitrary and depends on how you connect your motor driver. Let's say that out_1 low means "turn left", and out_2 low means "turn right".

If we want the bot to turn left, this means we want the turn left state (out_1 low) to last longer than the turn right state. Preferably, we would disable the "turn right" part of the process completely.

So how do we reduce the time the "turn right" process is active and turn the bot left? One way is to modify the parameters of the RC filter, causing the capacitor to discharge faster or slower, thereby changing the length of time the Nv-net stays in that state. Specifically, we want out_2 to remain high for as long as the robot needs to turn left, so we need to discharge the capacitor connected to out_1 faster, and the cap connected to out_2 slower.

What I've come up with is a basic idea - chances pretty good are it won't work 'out of the box' and will require some tweaking. You have been warned!

Suggested control method

See figure 4. This replaces the resistor to ground in the original bicore diagram in both cases and features an enhancement MOSFET.

The photodiode-resistor network outputs a voltage depending on how much light falls on the photodiode. The more light falls on the diode, the lower the voltage across the gate and source and thus, the lower the current flowing through the MOSFET. This means that darkness on the sensor means a higher discharge rate.

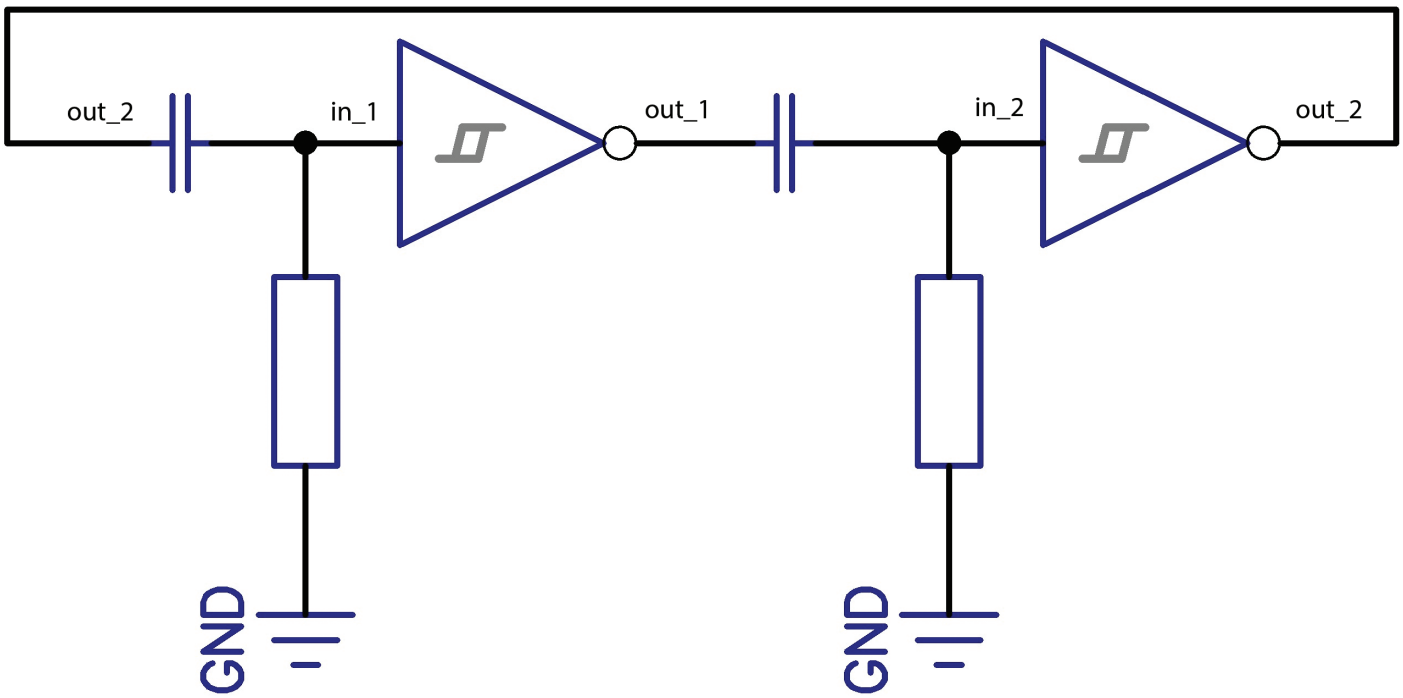


Figure 4: An Nv-net consisting of two neurons. Also known as a bicore.

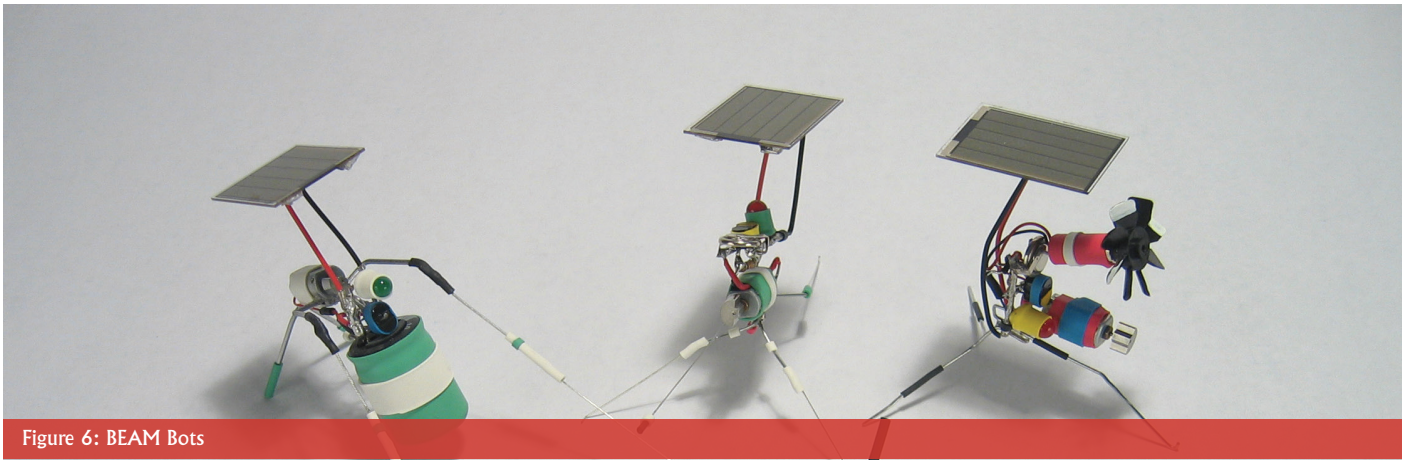


Figure 6: BEAM Bots

Ideally, you would have an amplifier between the photodiode and the MOSFET, allowing you more control over the voltage presented to the MOSFET gate.

By replacing the two resistors in the original bicore by two copies of this circuit, we can influence the discharge rate of the capacitors based on detected light levels. Remember that out_1 low means 'turn left', and out_2 low means 'turn right'.

For the detector connected to in_1, low light means a faster discharge rate, pulling in_1 low, forcing out_1 high thus spending less time in the 'turn left' state. This means that this detector must be on the *left* side of the robot.

Subsequently, the detector connected to in_2 must be on the *right* side of the robot. Darkness on the right side of the robot means we want to turn the other way, and we must reduce the amount of time spent turning right, which is done by discharging the capacitor between out_1 and in_2 more rapidly.

All BEAM sensors operate in this fashion, influencing the propogation of the neural pulses through the core.

In conclusion

This is just the tip of the iceberg as far as BEAM robots are concerned. If this grabs your attention, a quick Google search will yield tons of information to get you started on building these cute little robots for yourself.

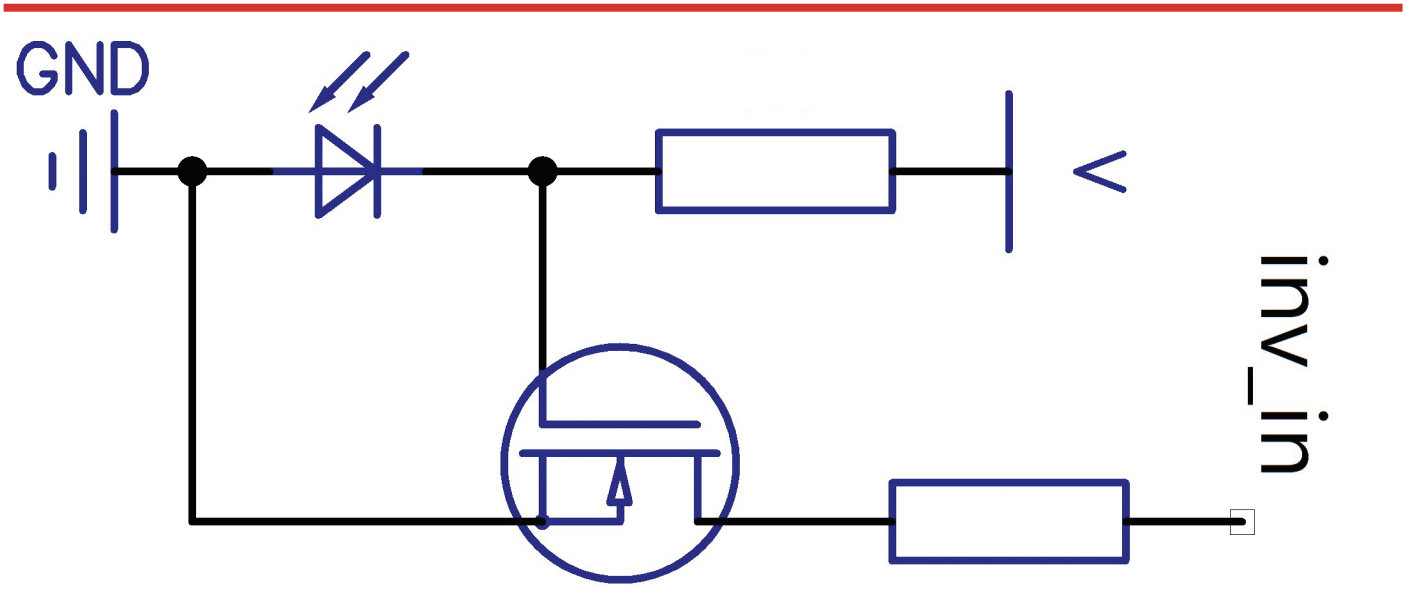


Figure 5: Simplified control network.

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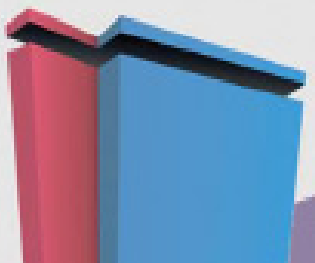

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EEMCS Recruitment Days

Recruitment days 2013

Author: Joost Geelhoed

In the second year of my master I was convinced by fellow students to apply for the recruitment days. Since the end of my career as a student was slowly approaching I had to think about the future, so this event came at a good time. I was hoping it would contribute to my search for an interesting company and a kind of job that fits me. I was not just looking for a full-time job for after graduation, but also for a graduation project. The opportunity to work on my master thesis at some company seemed useful to me, because I had never done an internship and I did not have much relevant work experience. Applying for the recruitment days was a good choice. A couple of departments of TNO saw my resume and were interested, so the recruiter of TNO gave me the opportunity to get in contact with those departments. One department gave me a lot of freedom in choosing and composing my own graduation project, which resulted in a project that fits very well to my interests. So at this point the Recruitment Days was already very successful, since it has led to a very cool graduation project.

Besides the graduation project the Recruitment Days had led to, it was also very useful to meet a number of very different companies. The Recruitment Days' organisation tries to gather a range of companies that will address all kind of students. I spoke to a selection of big and small companies that operate in very different fields, some not even technical. It is surprising to see that such a lot of companies outside the field, such as consulting and assurance companies, are looking for you. Besides that the small interviews helped me discover some companies I had never heard of, it also gives a lot to think about. Recruiters tend to ask a lot of questions that make you think about what you want in a job. This helps very much in finding out what you want to do after graduation. This year I have the last opportunity to apply for the Recruitment Days and I certainly will do so. Hopefully it will be as successful as last year and that it will lead to an interesting job!

Digital camouflage
So you want to be a chameleon?

Author: Yvo Mulder

Invisibility(-cloaks). One of the many gadgets which we have all seen or heard about in lots of different movies, books and so on. And, if you think about it, how cool would it be to be invisible?!

Do you remember those trips to the zoo when you were a child and looked from behind the glass only to find a room without any animals? Strange wasn't it? But, if you looked very closely, you were able to see some of those little bastards in there. However, at first sight, they were invisible. These animals are of course not really invisible. They, for example, change their skin to the same color as their surroundings to create the perception of being invisible. This exact method, and many more, are used in today's technologies to establish "invisibility" in some kind of way. Many scientists and entrepreneurs are very successful and they all use different approaches. One surrounds an object by an electromagnetic field and the other manipulates light or an object's heat signature.

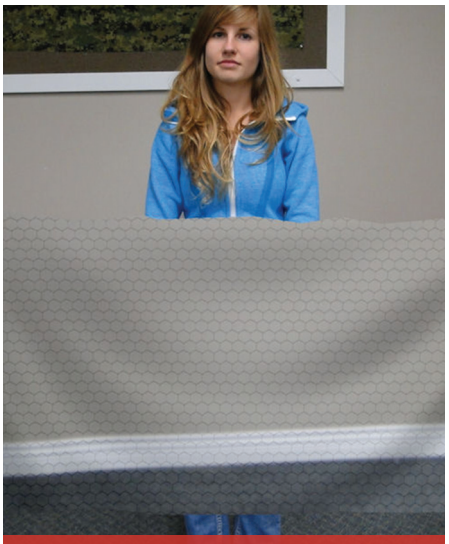
It should be clear that, even though it would be pretty cool to be invisible and sneak up on people, the different technologies are, at the moment, way too expensive to be commercially aviable. That is also the reason why only scientists and government contractors are experimenting with it.

Take for example HyperStealth Biotechnology Corp. They claim to have a blanket, see figure, that can make the user invisible. The specifications are classified and the only thing the public knows about these blankets is that they bend the light that falls on them to create the perception of invisibility.

BAE modules placed on a tank

Another company working on invisibility is BAE Systems, but they work on camouflage for vehicles. Their camouflage system uses honeycomb like modules which can be individually cooled down or heated up very quickly and in this manner can create heat patterns. The vehicle scans the temperature of its surroundings and adapts its heat signature to it, making it invisible to infra-red cameras. The beauty of this system is that it can also mimic the heat signature of other objects such as cars or trucks or display images on the modules from a detailed image bank. This way you can, for example, disguise your tank as a family car or basically anything. See *goo.gl/nzjkp* for a video.

Scientists are of course also working on invisibility. For example, Professor George Eleftheriades and PhD student Michael Selvanayagam from the Edward S. Rogers Sr. Department of Electrical & Computer Engineering have recently been able to create a very thin, scalable and adaptive cloak to make objects invisible to radar. They use a set of small antennas to cancel out the bounced back signals by the object. The antennas could be printed on a blanket and there you have your invisibility cloak. It works much like noise canceling headphones. This technology can also be used to make an object bigger, smaller, or shift it in space. For now, the technology works with radio waves, but the antennas evolve and tuning it to work with Terahertz or light waves could be possible.



The Quantum Stealth by Biotechnology corp.

The possible applications of invisibility cloaking in the examples mentioned are astonishing, but at the moment these invisibility cloaks have no real practical value for the everyday user. However, most people would probably find the idea of being invisible at will appealing. However, think about the debate that would arise if people would have access to these cloaks. You could theoretically rob a bank and no one would ever notice. Whatever your opinion, the evolution of these technologies will continue nontheless.

Cyberzoo
Elektronische dieren in de vlieghal bij LR

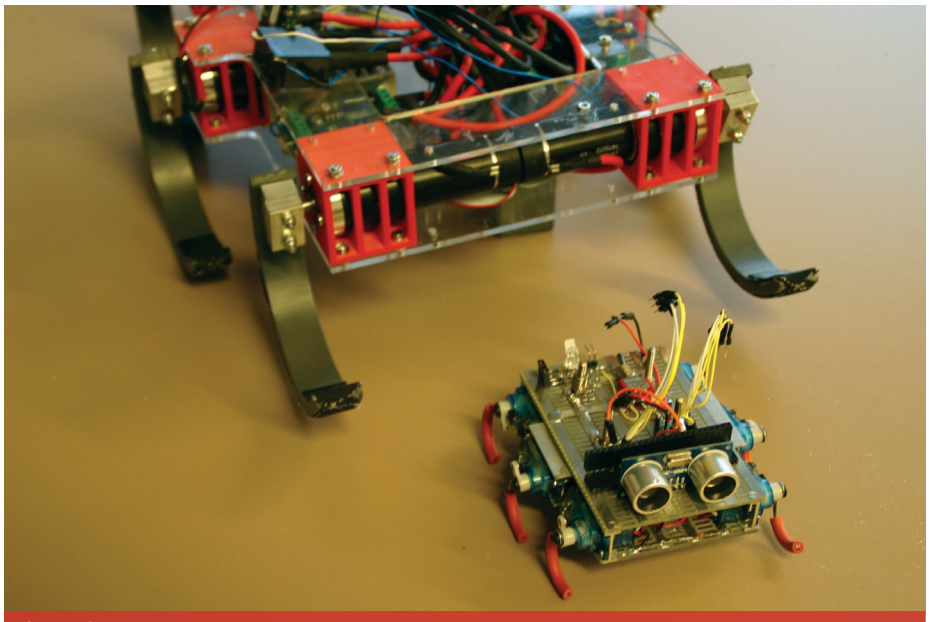
Auteur: Chris Verhoeven

Begin vorig jaar is het TU-Delft Robotics Institute opgericht waarin de krachten van de TU Delft op het gebied van het ontwerpen, bouwen en testen van robots gebundeld wordt. Het is voor het instituut heel belangrijk dat er echte hardware gerealiseerd wordt omdat veel onderzoeksvragen eigenlijk pas ontstaan wanneer je het functioneren en het gedrag van de werkende systemen in interactie met hun omgeving kun bestuderen.

Modellen zijn nooit beter dan de werkelijkheid waaruit de modelparameters gehaald zijn en ook beperkter in het beschrijven van het gedrag. Ze geven dan ook minder kans op een onverwachte ontdekking en zijn veel minder inspirerend voor onderzoekers in aangrenzende vakgebieden zodat het minder vaak tot spontane "grensoverschrijdende" innovaties komt. Het bouwen van echte hardware dwingt multidisciplinariteit af en maakt het bovendien leuk. Persoonlijk geeft het werken in een omgeving waar je tot echte hardware komt mij het gevoel een echte ingenieur te zijn. Erover vertellen hoe je dat doet tijdens colleges ook.

Swarm Robots

Een van de thema's in het Robotics Institute is het "Swarm Robots" thema. De moderne bulkmarkt technologie die gebruikt wordt in de automotive en de smartphone industrie heeft gezorgd voor een overvloed aan krachtige processoren die weinig energie gebruiken en MEMS sensoren zoals gyroscopen en versnellingssensors die enorm betrouwbaar zijn en erg nauwkeurig zijn terwijl de kosten daarvan extreem laag zijn. Het is ineens heel erg goedkoop geworden om ontzettend betrouwbare extreem geminiaturiseerde mechatronische systemen te bouwen. Dat betekent dat het heel goed mogelijk is geworden om de miniaturisatie van satellieten, onbemande vliegtuigjes en rovers tot in het extreme door te drijven. En dat je er door de lage kosten heel erg veel van kunt bouwen. De afgelopen jaren zijn er veel van deze sterk geminiaturiseerde systemen gebouwd. Er zijn inmiddels twee nanosatellieten van de TU-Delft in een baan om de aarde gebracht. Delfi-C3 in 2008 en Delfi-n3Xt in 2013. Ze werken allebei uitstekend. Er zijn steeds kleiner wordende Delfly vliegtuigjes gebouwd. De Delfy is een vliegtuigje dat vliegt met flapperende vleugeltjes. De nieuwste daarvan heeft stereo vision en kan daarvoor volledig zelfstandig rondvliegen zonder ergens tegenaan te botsen. En er wordt gewerkt aan steeds kleiner wordende versies van de Zebro rovers. Dat zijn rovers die met zes poten in staat zijn zich door de meest extreme omgevingen heen te worstelen. Dat kan op aarde zijn, maar er wordt ook gekeken naar het gebruik op de maan en op mars.



Swarm Robots

Kunst insecten

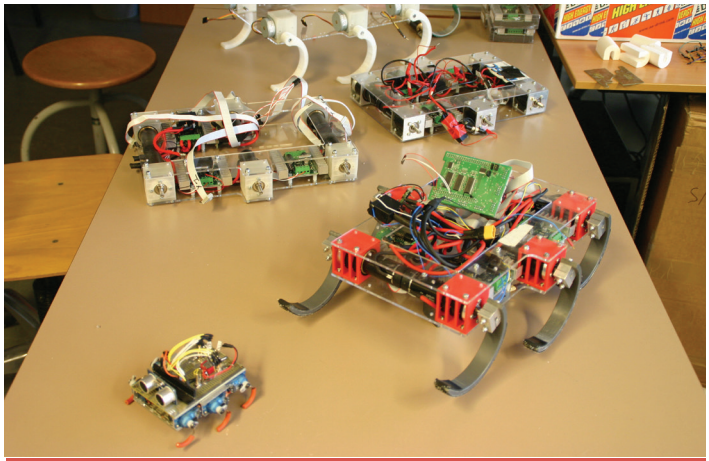
Veel mensen hebben naar het functioneren van deze drie systemen gekeken en geprobeerd te bedenken waar je ze voor zou kunnen gebruiken. Na de eerste teleurstellende conclusie dat ze door de extreme miniaturisatie en ook de beperkingen in rekenkracht en energie eigenlijk geen enkele bestaande taak beter

De kooi van de cyberzoo in aanbouw.

zouden kunnen uitvoeren dan bestaande grotere systemen sloeg de inspiratie toe. Zeker wanneer je een Delfly door de kamer ziet fladderen is de overeenkomst met een insect dat de kamer in is gevlogen opvallend. Maar ook voor de nanosatellieten en de rovers was al snel de conclusie dat ze het meeste op insecten leken. En de meeste insecten halen hun kracht uit samenwerken in een zwerm. De bouwers van deze zwermen hebben elkaar nu gevonden in het Robotics Insititute. Een belangrijke taak van het instituut is zorgen dat echte hardware gerealiseerd en getest kan worden. Daarom wordt op dit moment in de vlieghal bij de faculteit Lucht en Ruimtevaart een CyberZoo gebouwd, waar zwermen van Delflies en Zebros uiteindelijk 24/7 autonoom aan het werk zullen zijn. Een kunstmatige "dierentuin" waar het gedrag van de zwermen bestudeerd kan worden en ook de interactie tussen de vliegende en lopende "kunst insecten". Natuurlijk zal ook de reactie van de zwerm op andere objecten en op personen bestudeerd worden.

De CyberZoo

De CyberZoo bestaat uit een kooi van 10 bij 10 meter met een hoogte van 7 meter. Netten voorkomen "ontsnappingen". In de kooi zijn 12 camera's opgehangen die nauwkeurig de 3D positie kunnen bepalen van alle objecten die zich in de kooi bevinden. Deze informatie wordt via een flinke PC als stream beschikbaar gemaakt die weer in bijvoorbeeld MatLab gebruikt kan worden om het gedrag te analyseren of te kunnen experimenteren met de besturing van een of meerdere robots. Er worden ook gewone video-opnamen gemaakt zodat na afloop van een experiment er veel data beschikbaar is.



Enkele swarm robots

Op dit moment zijn studenten van de faculteiten EWI, 3ME en LR actief met de swarm robots. Dat geeft in de CyberZoo in vlieghal bij LR een mooie multidisciplinaire enclave waar studenten met eenzelfde drive maar met verschillende expertises tot iets wonderlijk nieuws kunnen gaan komen. Een "levend" ecosysteem van insectachtige robotjes die in een zwerm 24-7 autonoom rondlopen en rondvliegen zonder opdracht van buiten eenvoudige taken uitvoeren en "in leven" te kunnen blijven. Zij moeten autonoom hun aan hun energiebehoeften voldoen zoals laadpunten vinden, doorgeven aan elkaar waar de energie te halen is maar ook op hun beurt wachten om op te laden zonder in energie problemen te komen. Verder zullen er eenvoudige taken te doen zijn, zoals het vinden van objecten. Een van de eerste toepassingen die naar boven kwam is het vinden van rijp fruit. Er zijn in Nederland grote pakhuizen vol met fruit en het is erg belangrijk te weten waar in dat pakhuis het fruit rijp wordt en zo geschikt om te verkopen. Een kunstmatige "fruitvlieg" zou daar van grote waarde zijn. Een van de taken in de CyberZoo voor de zwermen zal dan

ook best het vinden van een rijpe peer kunnen zijn. Maar er kan natuurlijk ook gezocht worden naar geld, drug, explosieven, gaslekken of bijvoorbeeld de ingang van een gebouw of een grot. Dat laatste is trouwens een taak die een Zebro zwerm uitstekend zou kunnen uitvoeren op Mars. Het vinden van grotten op Mars waar mensen in zouden kunnen gaan wonen is belangrijk om daar te kunnen overleven.

De kooi van de cyberzoo in de vlieghal bij LR

We verwachten dat wanneer de CyberZoo eenmaal in vol bedrijf is, het een hele leuke plaats zal zijn om projecten te doen en ook een hele inspirerende plaats zal zijn voor mensen die de techniek zelf niet beheersen, maar die wel de echte toepassingen kunnen bedenken, de "killer application". Gebruikers en bouwers zullen hier samenkomen. Een kleine kooi met daarin de wereld van morgen wordt gebouwd in de vlieghal van LR door studenten en onderzoekers van drie faculteiten. En als het daarbinnen eenmaal goed blijft leven, dan zetten we de deur open en zien we wat ervan komt….

Wil je meer weten of de CyberZoo of een van de andere labs zien of er een project doen, neem dan contact op met Chris Verhoeven, leider van het Swarm Robots thema. Er is heel veel mogelijk.

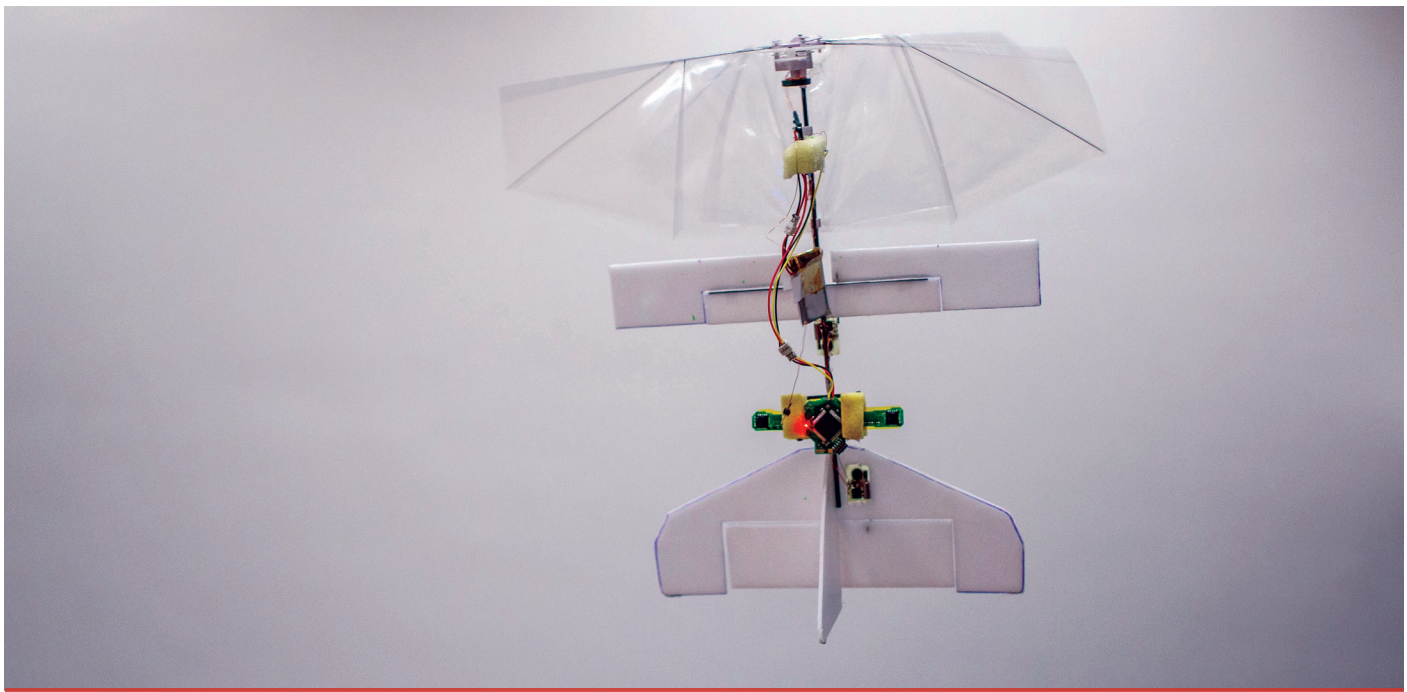
Interessante links:

http://www.delfly.nl/

http://www.delfispace.nl/

http://www.robotics.tudelft.nl/

http://www.robot161.nl/2012/02/het-zebro-project/


De DelFly explorer, die volledig autonoom kan vliegen.

ETVIP
What is happening at the ETV?

This edition of the Maxwell brings something new. We decided to bundle all the pages about the different ETV activities into one section. Here, you will find pictures and reports of past events and previews of upcoming activities. So here they are: The ETVery Important Pages!

The ETVery Important Pages

Lunchlecture Tebodin
Author: Conchita Martin

Tuesday the 3rd of December Electrical Engineering students gathered for another lunch lecture. This time it was a presentation by a representative of Tebodin; a multidisciplinary consulting and engineering company.

The lunchlecture was visited by a lot of students.

The presentation existed of two parts. The first part was about Tebodin as a company. Tebodin helps firms (mostly those which produce and not those which solely provide services) build infrastructures, such as factories. This part of the presentation emphasized how close Tebodin is to her clients. Everywhere the company's location is chosen with care.

The second part of this lecture treated ATEX (ATmosphères EXplosives), which has to be dealt with by companies when working in 'explosive' environments. This part was illustrated with some (explosive) videos when ATEX guidelines weren't met and the guidelines were explained. An informative presentation!

Activity: "Disney Borrel"
Author: Bart Kölling

Once upon a time there were seven first year EE-students. These students form the Winter Activities Committee 2013-2014. In the week before christmas they organised the "Disney Borrel" in the /Pub. Students dressed up as various Disney characters, there was a Disney quiz and also a karaoke featuring Disney songs.

This was a perfect opportunity for some people to let their inner Disney character out. There were princesses, fairies, cowboys and even Star Wars-costumes *(Yes, Star Wars is also Disney)*. It was quite entertaining, especially later in the evening when the less talented singers also had a go at the karaoke.


Especially the karaoke at the " Disney Borrel" was a lot of fun!

Activity: "Rally"

Auteur: Ludo van den Buijs

Na het success van edities van afgelopen jaar werd ook dit jaar opnieuw de ETV Rally georganiseerd dit jaar getiteld "Silicon Rally". Vol enthousiasme vertrokken de zeven deelnemende teams op de vroege ochtend van woensdag 11 december richting de eerste post. Bij elke post kregen de teams instructies hoe bij de volgende post terecht te komen. Deze instructies waren natuurlijk in een bijzonder jasje gestopt en de teams hebben dan ook telkens weer flink moeten puzzelen om de juiste plek te eindigen.

De instructies varieerde van het in elkaar puzzelen van een verknipte kaart tot het gebruik maken van de zogenaamde "strippenkaart" waarbij er nauw in de gaten gehouden diende te worden hoeveel afslagen er aan beide zijden van de weg gepasseerd werden. Hoewel de meeste teams het er redelijk vanaf bracht bleek een niet nader te benoemen team de grootste moeite te hebben met de opdrachten. Hoewel ze uiteindelijk wat posten hebben moeten overslaan zijn ook zij uiteindelijk veilig thuis gekomen met een dag vol met vermaak achter de rug.

Hoewel de instructies natuurlijk de leidraad vormden van de rally, zat een groot deel van de energie van de deelnemende teams in het uitvoeren van de bonusopdrachten. Elk team ontving aan het begin van de dag een boekje met niet alleen de regels van de dag maar ook een lijst met bonus opdrachten waarmee zij kilometer aftrek konden verdienen. Deze opdrachten varrieerde van simpele opdrachten zoals "finish met meer mensen in de auto dan waar je mee gestart bent" en "verzin een groepslid" tot lastigere opdrachten als "rijd zijwaarts een post binnen". Deze opdrachten werden vervolgens geheel op eigen wijze geïnterpreteerd en uitgevoerd. Wat soms tot hilarische taferelen leidde.

Al met al was het een zeer geslaagde dag die voor een heleboel mooie verhalen gezorgd heeft. De commissie is inmiddels in beraad om de ingestuurde foto's van de uitgevoerde opdracht te keuren en tot een winnend team te komen. Dit winnende team zal spoedig hun prijs in ontvangst nemen tijdens een borrel waar opnieuw met zijn allen alle mooie avonturen van deze dag kunnen delen.

Activity: "Whisky Experience"

Auteur: Ralph van Schelven

Studenten drinken alleen maar bier. Deze stelling hebben de aanwezigen van de Whisky experience op donderdag 12 december met een geslaagde avond ontkracht. Naast studenten waren er ook faculteitsmedewerkers en afgestudeerden aanwezig.

Om 19:00 uur liep de /Pub vol met liefhebbers en nieuwsgierigen om deel te nemen aan een onvergetelijke avond. De avond werd geleid door de eigenaar van een lokale slijterij die een gevarieerde verzameling whisky had meegebracht. De experience stond in het teken van het onderscheiden van kwaliteit van verschillende whisky's van hetzelfde merk of uit dezelfde regio. Zo werd er een whisky van 3 jaar oud vergeleken met een van 12 jaar. Ook kwam het verschil tussen een goedkope en een dure fles uit hetzelfde gebied ter sprake. Om de whisky's te presenteren vertelde de presentator prachtige verhalen over de verschillende whisky's, waarop gelet moest worden bij het proeven en legde hij uit hoe er geproefd diende te worden. Om zijn verhaal krachtiger te maken was er een PowerPointpresentatie aanwezig en hadden alle deelnemers een boekje om aantekeningen te maken. In dit boekje stonden alle whisky's op een rijtje en kon je aangeven wat je van de kleur, geur, smaak en nasmaak vond. Achterin stond de mening van de professionele whiskykenners.

Om de experience compleet te maken had de organisatie hapjes verzorgd die bij een avond als deze horen. Zo waren er blokjes kaas gesneden en broodjes ossenworst en zalm klaargemaakt. Na afloop werden de geproefde flessen te koop aangeboden aan de deelnemers met een flinke korting. Veel deelnemers maakten goed gebruik van deze aanbieding en kochten een fles van hun favoriete whisky van de avond.

Ben je benieuwd welke whisky's er geproefd zijn of wil je graag de foto's van de avond terugkijken? Ga dan snel naar de website en scroll door de foto pagina.

Pauze tijdens de Silicon Rally

Uitnodiging Dies Taart

Op 26 maart 1906 werd de Electrotechnische Vereeniging opgericht. Nu, bijna 108 jaar later bestaat zij nog steeds en dat mag gevierd worden. Om dat te doen nodigen we je van harte uit om een stukje taart te eten in de hal van de faculteit

Invitation Dies Cake

On the 26th of March 1906 the "Electrotechnische Vereeniging" was founded, almost 108 years later we still exist and keep on growing. In order to celebrate this with you, you are cordially invited to have a piece of cake.

The christmas lunch was very busy, a lot of people showed up to enjoy some Glühwein and a story with their lunch!

Last quarter, there was the annual parents day. For one day, EWI was filled with parents who came to see what their children do here.

Real whisky connaisseurs were made at the whisky experience, where a wide variety of whisky's was tasted.

The "sinterklaas lunch" was like a big party. People would get gifts in their shoes and have a nice lunch! What more could you ask for?

ETV-Rally participents think of creative ways to complete challenges to earn extra points as a reward.

ETV Agenda Kwartaal 3

Een overzicht van aangekondigde ETV activiteiten

Wil je meer weten over onderstaande activiteiten of ben je benieuwd naar wat de ETV nog meer organiseert het komende kwartaal? Kom dan langs de bestuurskamer en vraag het aan het bestuur!

- Motivatieborrel
  11 februari
- Lunchlezing Deerns
  11 februari
- Lan-party
  22 & 23 februari
- Lunchlezing Pinewood
  25 februari
- Algemene Ledenvergadering
  5 maart
- Solicitatietraining Recruitment Days
  5 maart
- Excursie ASML
  13 maart
- Excurise Bakker Sliedrecht
  24 maart
- Diestaart
  26 maart
- WeeCo Weekend
  28, 29 & 30 maart
- EEMCS Recruitment Days
  1,2 & 3 april

Electrip 2014

Net als vorig jaar komt er ook dit jaar een Electrip aan! De Electrip is een studietrip van ongeveer 4 dagen over ons eigen continent. Waar precies naartoe, blijft nog even een verrassing. Onderweg zullen we uiteraard studiegerelateerde bedrijven bezoeken en ook veel plezier maken. Het is een mooie kans om kennis te maken met elektrotechniek in de praktijk, op verschillende manieren en in verschillende landen.

De Electrip richt zich voornamelijk op tweedejaars, maar ook als ouderejaars maak je zeker een kans om mee te gaan.

Dus ben je nu eindelijk tweedejaars en heb je de trip vorig jaar gemist of wil je gewoon nog een keer mee? Laat dan weten dat je interesse hebt om mee te gaan met de Electrip door de bijbehorende flyer in te leveren bij het bestuur en dan maak ook jij kans om mee te gaan met de Electrip.

Heb jij interesse om deel te nemen aan de Electrip van dit jaar? Knip dit pamflet dan uit je Maxwell en lever het in bij het ETV Bestuur in de Bestuurskamer of aan de ETV-balie.

Naam: _____

E-mail: _____

Leeftijd: _____ Studienr: _____

Studiejaar: _____ Rijbewijs: Ja / Nee
(Aantal jaar) _____

Mocht je nog niet helemaal overtuigd zijn, spreek dan vooral mensen aan die eerder mee zijn geweest of vraag de Electripcommissie! Zij kunnen je meer vertellen over de gaafheid van deze trip.

Wil je je exemplaar van de Maxwell liever heel houden? Je kan natuurlijk ook een e-mailtje met deze informatie sturen naar:
Electrip-ETV@tudelft.nl
Ook berijkbaar voor vragen.

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