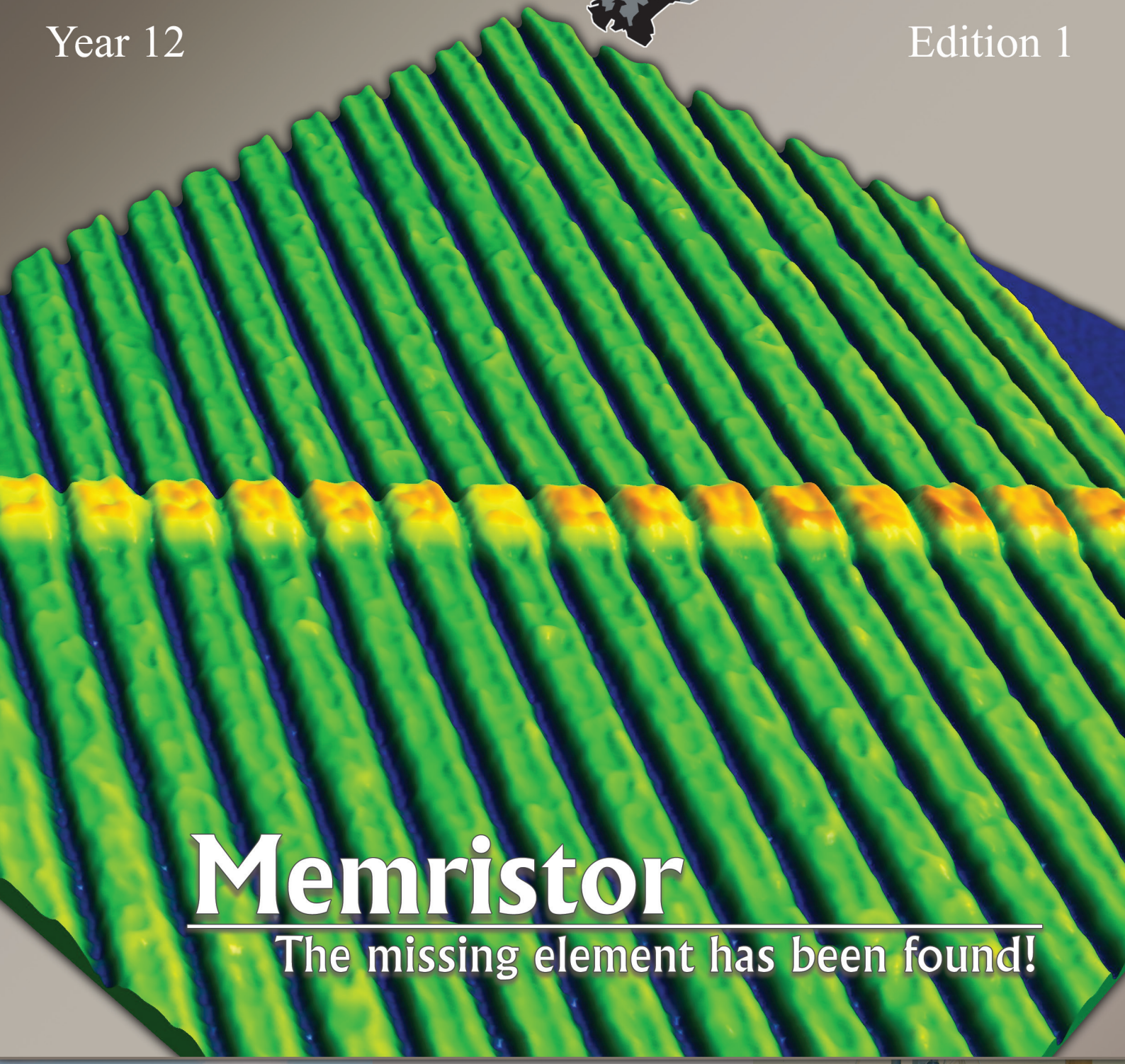
Periodiek der Electrotechnische Vereeniging

Maxwell

Year 12

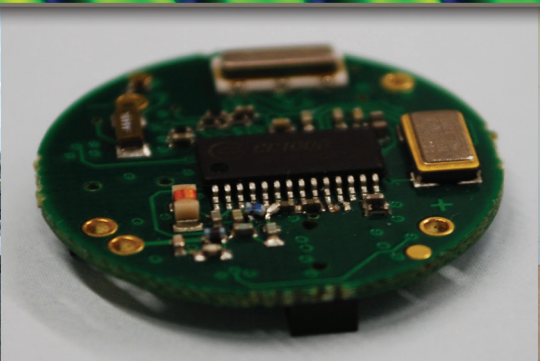
Edition 1



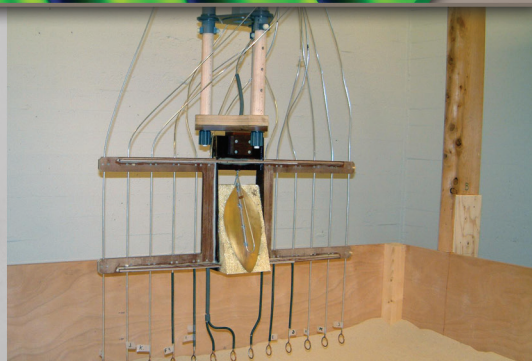
Memristor

The missing element has been found!

EOW 2008



Interview SOWNet



Detecting landmines

INVOEGEN:
Movares_A4_Jelte.pdf

From the board

We're already more than a quarter on the way in the academic year. A quarter full of lectures; the first exams have already passed and the first credits (hopefully) gathered. As fresh ETV-board it means a quarter full of ETV-activities, full of constitution drinks of other Delft boards and all of that while you're getting used to being a fulltime board-member. In short a quarter in which happened a lot, both on ETV- and EEMCS area.

By the time you read this, the Re{is} is just back in Holland. For two weeks 24 members of the ETV have visited Israel. A country which is mostly in the news due to politics, so why would you choose such a county for a study tour. Admitted, Israel can't name itself the world's safest country. But in return you get a big amount of technical and cultural highlights which are worth the danger. Many sacred places for each of the three monotheistic faiths (Judaism, Christianity and Islam) lie in present Israel. Jerusalem, for example; to Jewish people this is the city of Abraham's sacrifice. To the Christians it is where the crucifixion and the resurrection of Jesus took place. To the Muslims it is where the prophet Muhammad ascended to heaven.

But most people forget that beside all the cultural highlights Israel is the epicentre of high-tech start-ups in the Middle East. Near Haifa lays the largest and oldest business park of Israel. This business park accommodates development centres for big international companies such as Intel. The Centrino and Core Duo technology has its origins in this Intel development centre. The possibility to combine culture and technology makes Israel the perfect place for an ETV study tour. Ask a participant for his experiences and I'm sure he can tell you the most amazing stories.

Back in Holland, the time didn't stand still either. A quarter filled with an excursion to the AWACS-base in Geilenkirchen, lunch lectures from Movares and Corus; you can read all about it further on in this Maxwell.

As ETV-board, this quarter was our first, making it an exhausting one. You experience the ETV on a whole other level then being an ETV-member. Like every big change in your life, getting used to it costs a lot of energy. Especially when there's no time for getting used to, with an agenda that is filled with appointments and an endless list of to-do's.

Looking back on this first quarter I can conclude that besides being busy, it also was a very instructive quarter. With three quarters in prospect the whole board is eager to freshen up lots things and supply you with many more activities, so drop by at the ETV and enjoy a cup of fresh coffee.

I wish you lots of pleasure reading this first Maxwell of the 137th board, and lots of success in the upcoming exam-period.

On behalf of the refreshing Board,

Thijs van Leeuwen, President

Editorial

While the few remaining Maxwell-committeemembers are still hard at work to complete this edition, the 24 participants of the Is real study tour have, on the moment of writing, just arrived three days ago in Tel Aviv, Israel.

The Re{is}-committee has succeeded to set up a two-week tour, in which they will visit, among others, lots of high-tech startups. Naturally, the reports of the tour will provide more than enough writing material for the next edition of the Maxwell.

The past trimester, the furthest trip the ETV organised led to Geilenkirchen, where a group of members could admire one of the impressive AWACS-aeroplanes. Other activities, such as the lunch-lecture about 'ERTMS', a new train safety system, and the symposium by NERG and Kivi Niria on the role of the engineer in the social debate, can be found in the activities section as well.

Apart from all the ETV-activities you will also find articles on 'the fourth basic circuit element', a column by recently inaugurated professor Dekker and an article by a gratuated Electrical Engineering-student about landmine detection.

All that's left to say is to wish you lots of reading pleasure with the very first Maxwell of this acedemic year.

Jeroen Ouweneel, editor

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The ETV organised several activities in the first trimester. In this edition of the Maxwell you will find reports of the Movares lunch-lecture, the AWACS-excursion and the NERG/Kivi Niria symposium about the role of the engineer in the social debate.

Electro Ontvangst Weekend 2008 11
Zoals elk jaar werd ook in 2008 wederom het 'Elektro Ontvangst Weekend' georganiseerd, om de aankomend eerstejaars met elkaar en met de ETV kennis te laten maken. In dit uitgebreide artikel is precies te lezen wat er zich dit weekend allemaal heeft afgespeeld.

Interview SOWNet Technologies 15
Imagine a foul proof sensor network with multiple nodes, which you can extend and reduce to your own needs. Usable from agricultural to security applications. With SOWNet's new distributed network of nodes this became possible. Winelis Kavelaars, the director of SOWNet Technologies, tells us about this network.

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Het geheim achter de gemoedstoestand van KITT.

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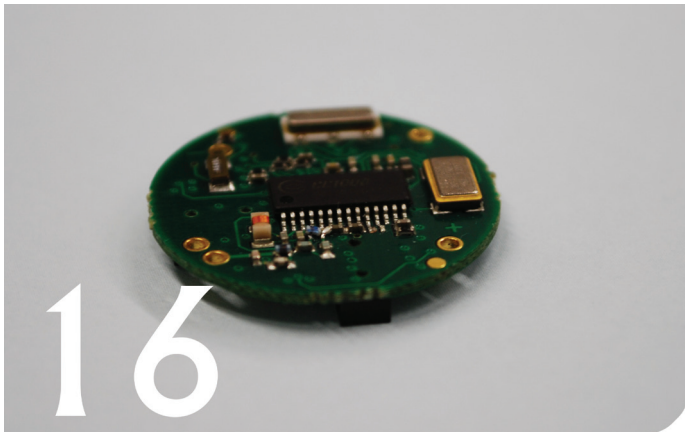
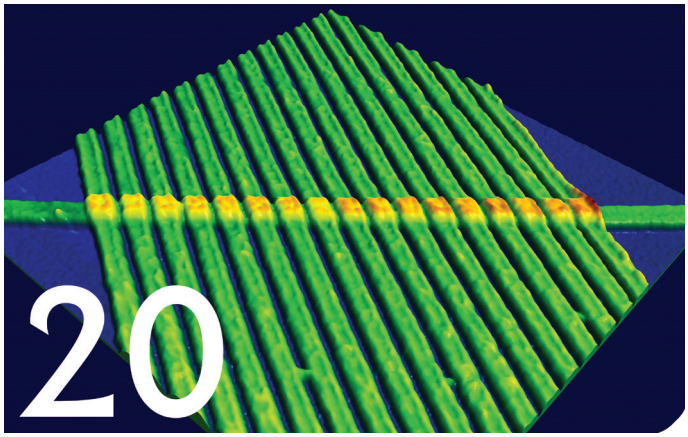
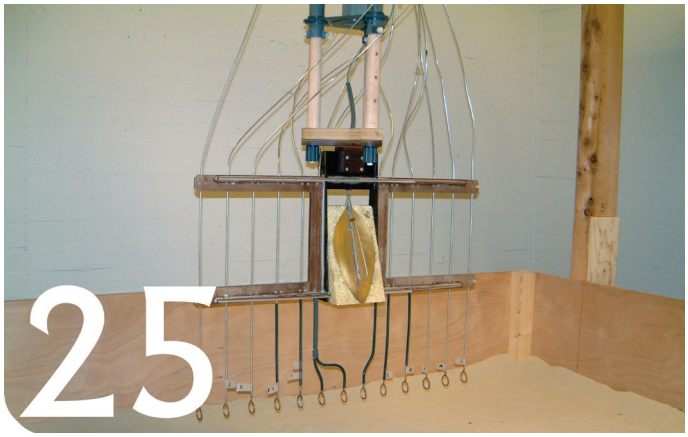
Niels van Tol describes his Master-thesis about detecting landmines.

Column: Professor Dekker 30
Professor Dekker tells about the role of the Dutch engineer in the international Integrated Circuit-industry.

ETV MAGAZINE "MAXWELL" Year 12 – edition 1 – November 2008 **PRINTING** Thieme Media Services, Delft **NUMBER OF COPIES** 1.000 **EDITORS** Thijs van Leeuwen, René van der Meij, Jeroen Ouweneel, Johan Splinter, Erwin Stout, Imke Zimmerling, Joost van Zwieten **CONTACT** Maxwell, p/a Electrotechnische Vereeniging, Mekelweg 4, 2628 CD Delft, phone: 015-2786189 or 015-2781989, fax: 015-27 81002, e-mail: maxwell@etv.tudelft.nl, website: www.etv.tudelft.nl **CHANGE OF ADDRESS** Please send your changes to the address above, or use the website. Alumni can change their address via the Alumni Office website: www.alumni.tudelft.nl. **ADVERTISEMENTS** Movares (p.2), Siemens (p.24), Technolution (p.5 & back cover), Vanderlande (p.31) **SUBSCRIPTIONS** Non-members can receive the Maxwell four times a year, against a contribution of € 10,- per year. For more information, please contact the Maxwell Committee.







Technolution

AUTOMATION TECHNOLOGY

Newsflash

Electric field boosts fuel economy

Fuel economy could be boosted by as much as 20 percent by adding a small device that applies an electric field to fuel before it enters internal combustion engines.

Researchers at Temple University (Philadelphia), who invented the device, recently completed six months of road testing with a diesel-powered Mercedes-Benz. The tests increased fuel efficiency from 32 to 38 MPG on highways (a 20 percent boost) and a 12 to 15 percent gain in city-driving mileage. The researchers claim the device could also be adapted to gasoline, biodiesel and kerosene.

The device draws power from vehicle batteries to electrically charge a tube used for fuel injection, thereby reducing fuel viscosity and increasing MPG. Since the electrically charged fuel is thinner, the researchers said engine injectors create smaller droplets, enabling cleaner, more efficient combustion.

Save The World Air, (Morgan Hill, California) a green design and development company seeking to reduce auto emissions, has been licensed by Temple University to commercialize the technology. The company is retrofitting the device onto diesel trucks for testing. It estimates the device could save the embattled U.S. trucking industry as much as 12 percent in fuel costs.

Source: R. Colin Johnson, EE Times

Stroomstoring zorgt voor geboortegolf

De vliegers van de Apache die vorig jaar december bij de gemeente Maasdriel een hoogspanningskabel kapot vlogen, hadden het niet kunnen vermoeden: in de gemeente zijn de afgelopen maand veel meer baby's geboren dan gebruikelijk. Dat meldde de gemeente Maasdriel dinsdag.

Door het incident zaten meer dan 50.000 huishoudens in de Tieler- en Bommelerwaard in de donkere dagen voor kerst twee dagen zonder elektriciteit. Dat leidde in september in de gemeente Maasdriel tot de geboorte van 26 baby's.

Dat is 44 procent meer dan het maandelijkse gemiddelde van achttien baby's, aldus een gemeentewoordvoerster.

In Haaksbergen deed zich in augustus 2006 ook een geboortegolf voor. Oorzaak was de stroomstoring die de boel daar in november 2005 in het duister zette.

Bron: www.nu.nl

Intel dumps ultra-wideband development

Intel has dropped its internal development of ultra-wideband (UWB), the company has revealed. The semiconductor firm decided to end the five-year-old project a month ago in a low-key move that is only now coming to light. The call doesn't mark the end of UWB at Intel but was made as the company decided it would be less expensive to source components from outside when necessary than to develop its own.

"It was a typical make-versus-buy decision," says Intel technology strategist Stephen Wood.

However, the move comes as key third-party UWB booster WiQuest was forced to shut down on Friday and reduced Intel's options for third-party equipment.

Intel's shift away from UWB casts doubts on the future of wireless peripheral standards such as Wireless USB, which depend on UWB to provide performance closer to wired USB at distances as far as 30 feet. To date, the short-range standard has had relatively little support in the industry that has chiefly been limited to notebooks from a few manufacturers, such as Dell and Lenovo, as well as Wireless USB adapters and hubs from accessory makers like Belkin.

Source: www.electronista.com

SanDisk cranks up solid-state drive speed

Technology introduced at the Windows Hardware Engineering Conference by SanDisk could boost solid-state drive performance in Windows Vista by 100 times.

The largest supplier of flash memory cards unveiled an advanced flash file system for solid-state drives that "has the potential" to accelerate random write speeds by up to 100 times over existing systems.

Despite being generally faster than hard-disk drives (particularly at reading data), solid-state drives fall short of hard disks when they randomly write data. Random writes are generally considered to be the Achilles heel of solid-state drives.

To maximize random write performance, SanDisk developed the ExtremeFFS flash file management system that uses a "page-based algorithm" so when "a sector of data is written, the SSD puts it where it is most convenient and efficient," SanDisk said.

The result is an improvement in random write performance as well as in overall endurance.

"For SSDs to perform optimally in Windows Vista, and thus replicate or surpass the functionality of hard disk drives, a new flash management technology is needed to accelerate SSD write speed and endurance," said Rich Heye, senior vice president and general manager for SanDisk's solid-state drive business unit.

SanDisk will present this technology here at WinHEC 2008 on Wednesday. ExtremeFFS will ship in SanDisk products in 2009.

Heye also introduced two metrics that can help users evaluate solid-state drives.

One metric, vRPM, enables comparisons in performance between a solid-state drive and a hard-disk drive or another SSD. The other metric, LDE, calculates the lifespan of a solid-state drive.

Source: news.cnet.com

Groene technologie wordt winnaar van kredietcrisis

De VS staan voor een nieuwe golf van investeringen in zonne- en windenergie, energiebesparende maatregelen en andere schone technologieën. In het reddingsplan voor de Amerikaanse financiële wereld is daarvoor minstens 18 miljard dollar opzij gezet, en de veelbelovende industrietakken zouden ook wel eens minder last kunnen ondervinden dan andere sectoren om schaarse investeringsmiddelen aan te trekken.

De voorbije jaren zijn er in de VS al miljarden dollars geïnvesteerd in groene technologieën. Zowat alle gespecialiseerde investeringsmakelaars en instellingen willen het komende jaar nieuwe investeringskansen bekend maken. Dat blijkt uit een nieuw onderzoek van het Social Investment Forum (SIF), een vereniging van ongeveer 500 investeringsmakelaars met oog voor het milieu en voor sociale problemen.

"Het financiële reddingsplan is een echte opsteker voor de groene economie", zegt Jack Robinson, de voorzitter van de Winslow Management Company in Boston en een expert in groene investeringen.

Om het Amerikaanse parlement over te halen het licht op groen te zetten voor de massale reddingsactie voor de banken, werden er voor 150 miljard dollar belastingvoordelen voor consumenten aan verbonden. Van dat bedrag gaat minstens 18 miljard dollar naar belastingaftrek en langetermijnfinanciering voor investeringen in hernieuwbare energie.

"Vroeger kon je er nooit zeker van zijn hoe lang de overheid hernieuwbare energie zou blijven steunen. Nu ligt die steun voor acht jaar vast." Robinson geeft toe dat ook bedrijven in de sector van groene technologie het nu moeilijk hebben om aan krediet te komen. Maar vroeger hadden ze het moeilijker dan andere bedrijven, en dat lijkt nu voorbij.

Groene bedrijven zullen bijvoorbeeld zo goed als zeker profiteren van de afkondiging van uitstootnormen voor broeikasgassen en de lancering van een emissiehandelssysteem in de VS. Dat wordt ten laatste tegen 2010 verwacht.

"De kost van fossiele brandstoffen zal eindelijk de milieukost beginnen te weerspiegelen", zegt Adam Seitchik van Green Century Balanced Fund en Trillium Asset Management in Boston. "Ondanks de kredietcrisis is het concept schone energie zo sterk dat bedrijven er wel financiering voor zullen vinden."

Bron: PD (IPS)

Activities of the Electrotechnische Vereeniging

The Thalys, the high speed train from Amsterdam to South-France, equipped with ERTMS.

Lunch Lecture Movares: ERTMS

15 oktober - Stephan Groot

Wednesday, October 15th. Lunch break. While enjoying an again tasteful lunch, a mixed company is excitedly waiting for the start of the lunch lecture of Movares in lecture room C. The employees of Movares, a firm of consulting engineers, Jorgen Heinrich and Jari Klomp are preparing themselves to tell us all about the developments in railway security.

Currently the trains in the Netherlands are equipped with a security system called ATB. ATB is short for the Dutch term *automatische treinbeïnvloeding*, which means something like *automatic train control system*. This system can intervene with the driver of the train, if he ignored the signal, which commands him to reduce his speed. This system interacts with the trains trough beacons or loops in the rails.

With the rapidly increasing international rail connections, a couple of problems to connect this routes arose. First, the difference in the overhead wire voltage was a problem, that had to be solved. Another problem was the different systems for railway security in the different countries. The disadvantage of different systems is clear: the drivers of the international trains has to have knowledge of a lot of different systems. An example of this is the Thalys, which contains no less than seven different security systems. To improve the interoperability between the different European countries, a standardized system for Europe was developed: ERTMS.

ERTMS is an abbreviation of European Railway Traffic Management System. It is the collective term for a train control system ETCS (European Train Control System) and a communication system GSM-R(ail). ERTMS consists of five different levels. During the lecture Level 1 and Level 2 were discussed. Level 1 is equivalent with the Dutch ATB. The information about the allowed speed is communicated with the train trough beacons in the rails. Level 2 is an advanced version. In stead of beacons to pass the information to the train GSM-R is used, to continually provide the train of the necessary information. The GSM-R system is a standard for the mobile communication specialised for train functionality. GSM-R is based on GSM, but uses another frequency range and has a couple of extra functions, specially for the use in the railway sector.

Currently the transition from ATB to ERTMS is started in the Netherlands. The so-called *Betuweroute* is the first route that is equipped with ERTMS Level 2. The new high speed route to Belgium and

ERTMS test setting on the railway.

further, the *HSL-Zuid*, is also equipped with ERTMS. Currently there has to be waited for new trains, that are compatible with ERTMS, for the HSL-Zuid to become operational. The only Thalys that was already ready for ERTMS, unfortunately got crashed in the small city of Gouda.

The interesting lecture of Movares gave a great insight in the current developments of railway security. Besides that, the lecture proved that also in the railway business there is a great need for Electrical Engineers.

Gezellig met zijn allen op de foto voor één van de 17 AWACS-vliegtuigen van de NATO.

Excursie naar AWACS

8 oktober - Patrick Fuchs

Woensdagochtend 8 Oktober om 6 uur 's ochtends, veel te vroeg, stond er een groepje Elektrotechniek studenten op het parkeerterrein achter faculteit EWI te wachten op een bus van de luchtmacht. Deze stond echter op het parkeerterrein van de Universiteitsbibliotheek. Na dit probleem te hebben opgelost, zijn we een half uur later dan gepland uit Delft vertrokken naar Geilenkirchen in Duitsland. De reis verliep verder heel voorspoedig en rustig, waardoor we goed op tijd aankwamen.

Van tevoren had iedereen een paspoortnummer of ID-kaartnummer op moeten geven, dus we verwachtten eigenlijk bij het betreden van de basis nog een keer gecontroleerd te worden of we deze wel bij ons hadden en niet op de "most wanted" lijst van de VS staan. Hiervan was echter geen sprake, we moesten alleen overstappen op een andere bus van de luchtmachtbasis.

Hierna hebben we eerst een rondje gereden over de basis, als een soort rondleiding over het toch groter dan verwachtte terrein waar zelfs een school en een tax-free winkel waren. Na het rondje kregen we een presentatie over de structuur van het NATO opperbevel, en hoe de politiek en militaire leiders allemaal hun eigen zegje doen in het gebruik van de AWACS. Voor- en vooral nadelen van dit systeem werden uitgelegd. Hierna kregen we nog een kleine presentatie over geluidshinder van de luchtmachtbasis Geilenkirchen dat vooral wordt ondervonden door de mensen die over de grens met Nederland wonen, in Limburg. Tijdens deze presentatie werd heel mooi duidelijk gemaakt wat er allemaal gedaan wordt om geluidshinder tegen te gaan, maar ook hoe weinig het uiteindelijk helpt tegen de klachten die ze krijgen.


Een AWACS-vliegtuig op zo'n 10.000 ft. hoogte met een prachtig uitzicht op de wolken.

Na deze presentatie gingen we verder naar de AWACS-vliegtuigen zelf, waar we door een groep bemanningsleden werden rondgeleid door de vliegtuigen. Opvallend was hierbij vooral hoe ruim de bemanning het achterin heeft ten opzicht van een commercieel vliegtuig. Het is natuurlijk wel belangrijk dat de bemanning comfortabel zit omdat ze vaak meer dan 6 uur lang (tot wel 16 uur) vliegt en hierbij de hele tijd lang naar hun schermen moeten kijken, dus heel intensief bezig zijn.

Er is ook een kleine keuken aanwezig, zoals deze in normale vliegtuigen is, zodat de bemanning eten kan maken (al is daar niet altijd tijd voor tijdens een missie).

Nadat we de vliegtuigen van top tot teen hadden uitgekamd zijn we doorgegaan naar het IT-gebouw van de luchtmachtbasis. Daar staat bijvoorbeeld een simulator die de binnenkant van een AWACS weerspiegeld om hiermee missies te oefenen. Hier hebben we een presentatie over de "IT - Wing" gekregen waar werd uitgelegd hoe de informatiestructuur van de basis werkt en welk belangrijk deel deze groep bij het onderhouden en vernieuwen van deze structuur heeft. We mochten natuurlijk ook een kijkje nemen in de Simulator, waar op dat moment twee militairen met docenten bezig waren met een missie. Waarbij het opvallend was hoeveel verschillende vliegtuigen er zijn waar je rekening mee moet houden (waarvan het overgrote deel wel commerciële vluchten waren).

Tot slot hadden we nog een borrel als afsluiting van deze geslaagde excursie in de "Double Dutch" bar op de basis, waar de Nederlandse militairen bij elkaar komen om de dag af te sluiten. Hierna zijn we teruggegaan naar Delft met de bus.

Re{is} Symposium

17 oktober - René van der Meij

Op 17 oktober was er een symposium georganiseerd door de NERG en de KIVI NIRIA met als onderwerp: 'De ingenieur terug in het maatschappelijke debat'. De hele dag stond onder leiding van de dagvoorzitter Kees Mijnten. Professor Baken heeft het symposium geopend met een kort introductieverhaal van de dag. Kees Mijnten nam daarna meteen het stokje over door vragen te gaan stellen in het publiek. Op deze manier werd iedereen meteen bij het symposium betrokken en stond iedereen op scherp.

De eerste gast was Diederik Samson. Hij is lid van de Tweede Kamerfractie van de PvdA en heeft kernfysica aan de TU Delft gestudeerd. Hij hield een verhaal over wat de rol van een ingenieur in de politiek moest zijn en kwam tot de conclusie dat we de politiek over moeten laten aan Den Haag omdat de ingenieurs hard nodig zijn op hun eigen plek. Ingenieurs moeten uiteraard wel informatie verstrekken aan de politiek als dat nodig is.

Als tweede spreker was Gerlof Bosveld aan de beurt. Hij heeft technische natuurkunde aan de TU Delft gestudeerd en is nu werkzaam bij TNO. Na eerst de termen ingenieur, terug en maatschappelijk debat te hebben uitgelegd ging hij verder met zijn eigenlijke presentatie. Ook hij kwam tot de conclusie dat de ingenieur zich beter niet met de politiek kan bemoeien en zich met zijn eigen zaken bezig moet blijven houden.

De derde spreker was Albert Smit. Hij heeft technische bedrijfskunde gestudeerd aan de TU Eindhoven. Hij is nu directeur van zijn eigen bedrijf Milestone Marketing. Zijn verhaal was vooral gericht op hoe de ingenieur zijn boodschap beter kon verkopen, een probleem waar veel ingenieurs tegen aan lopen. Als laatste was de Reiscommissie van de ETV gevraagd om een bijdrage van studenten aan het symposium te leveren. Twee studenten hebben toen kort hun stellingen ingeleid en gepresenteerd. De stellingen die aanbod kwamen waren:

- Feiten zijn niet relevant in de grote discussies.
- De ingenieur blijft teveel binnen zijn eigen specialiteit en kijkt niet naar andere vakgebieden.
- Er is geen ruimte voor voortschrijdend inzicht.

Na elk van deze stellingen was er een discussie met de gastsprekers en het publiek onder leiding van Kees Mijnten. De middag werd afgesloten met een gezellige borrel.

Elektro Ontvangst Weekend 2008

“Chip My Life!”

“Nous sommes Hollandais!” klonk er op zaterdagavond 2 augustus over de idyllische boulevard van het Normandische badplaatsje Courseulles-sur-mêr. Willem Zwetsloot, president van de 26e EOW-commissie der ETV, was na het nuttigen van 26 Franse Koningsbiertjes zo vrolijk geworden dat het hem nuttig leek om de plaatselijke bevolking te laten horen waar deze studenten in prachtige donkerblauwe polo’s vandaan kwamen.

Zelfs voor een eerstejaars ETV’er die mee is geweest op het 26e Elektro Ontvangst Weekend zal deze anekdote misschien onbekend in de oren klinken. Daarom een kleine toelichting op deze gebeurtenis van afgelopen zomer, ergens ver van Delft. Als voorbereiding op het 26e Elektro Ontvangst Weekend en onder het motto “één commissie, één vakantie” had de EOW-commissie besloten af te reizen naar een plaats waar zij in alle rust kon nadenken over hét perfecte EOW. Dat dit zijn vruchten heeft afgeworpen is te lezen in dit verslag van het 26e EOW.

Auteur: Seth van Roemburg

Beter te vroeg dan te laat

Op vrijdagochtend 15 augustus was het dan zo ver, het 26e EOW met het thema "Chip My Life!" zou om 9 uur van start gaan op de faculteit EWI. Sommige enthousiaste nullen kwamen echter al enkele minuten na de commissie - die natuurlijk al vroeg aanwezig was - de faculteit binnen stappen. Om dit enthousiasme niet te temperen, werden meteen de overalls, pullen, programmaboekjes en pakken koffie tevoorschijn getoverd, zodat de nullen alvast hun pul met koffie konden vullen en aan het integreren konden beginnen, wat natuurlijk het belangrijkste doel van het EOW blijft.

Het weer was prima, dus het dak werd ook bezocht bij de rondleidingen

Om de pullen makkelijk uit elkaar te houden, stond 'Chip my pul' op het programma

Fascinatie

Onder het genot van een heerlijk stukje muziek van Alphabeat, stroomden de nullen langzaam binnen. Om te zorgen dat iedereen zijn eigen pul kon herkennen gedurende het EOW, had de EOW-commissie gezorgd voor materialen om de pullen te chippen. Veel nullen grepen deze kans om hun IO-kant te showen. Hierna was het tijd voor de officiële opening in collegezaal B door de presidenten van de EOW-commissie en de ETV en met een praatje over de geschiedenis van de chip door prof. Beenakker. Na deze interessante presentatie vertrokken de nullen naar buiten om daar onder leiding van het 136e Bestuur en met hulp van de mentoren een Delftsche zangsessie te beginnen. Ook werden natuurlijk de altyd zo geweescht foto's vanaf het dak gemaakt, waarna er geluncht kon worden.

Van dak tot bestuurskamer

Na de overheerlijke lunch, natuurlijk klaargezet door het Potentieel Bestuur, was het tijd voor de rondleiding door de faculteit. Van het invullen van een enquête op de Drebbelweg tot het dak van het EWI en van DIMES tot het ETV-domein, de nullen hebben het allemaal gezien. Gelukkig was er na de rondleiding nog tijd voor het spelen van de zwakste schakeling en natuurlijk weer een zangsessie. Vervolgens zijn de nullen naar Proteus-Eretes gefietst om daar te gaan eten.

Beursspel en meer

Het beursspel stond al klaar toen de nullen terugkeerden van Proteus-Eretes, maar er moest natuurlijk eerst nog even bak geduwd worden. Hierna stortten de nullen zich vol enthousiasme op het jaarlijks terugkerende beursspel waarbij ze de gekste dingen deden om aan ETValuta te komen en natuurlijk de schakelingen bouwden. Na het uitroepen van een winnaar van het beursspel, was het tijd voor het liftenspel, een voorbereiding op het bezoekje aan het Bestuur en de daarop volgende intensieve integratie activiteit. Terwijl de nullen groepje voor groepje terugkeerden van deze activiteit, stond de tap niet stil en werd er flink geklemd om daarna te gaan slapen in de /Pub.

Voordat de nullen kunnen slapen, moet de tent nog opgezet worden

Het Bestuur leert de nullen hoe je een Elektrolytje zingt

Het beursspel was wederom een groot succes

Drie van de PB-ers begeven zich naar het strand

Tussendoor is er even tijd voor het Bestuur om uit te blazen

Zondagmiddag komen de nullen voor de laatste keer bij elkaar in de /Pub

De nullen leren wat teamwork is tijdens de welbekende kratjesrace

GPS is wel een beetje laf

De volgende ochtend werd na het ontbijt de EOWegwijzer uitgedeeld, zodat de nullen naar het kampterrein konden gaan fietsen met, natuurlijk, een kleine omweg langs de Beestenmarkt. Ondanks het feit dat er twee groepen het deel 'speur' uit speurtocht niet hadden begrepen en met de GPS het kampterrein opzochten, kwamen alle groepen ongeveer tegelijk binnen voor de lunch. Na de lunch werden chipjes uitgedeeld om te ruilen voor grotere jetsers en units in het nabijgelegen supermooie dorpje Monster. Na dit spel verzamelden de nullen, EOW-commissie, PB en het Bestuur zich op het strand van Monster om de verzamelde apparaten te bekijken en in het geval van het PB, te claimen. De rood-witte ETV-strandballen bleken een groot succes, maar er moest begonnen worden aan het bouwen van faculteit EWI als zandkasteel. Toen tegen het eind van de middag alle geregelde spullen weer terug de strandovergang over moesten, bleken sommige nullen al bekend te zijn met het traditionele monitor slepen.

Lekkere cadeaus

Bij terugkomst op het kampterrein stond de barbecue, met daarachter natuurlijk de barbecue-koningen, al klaar zodat iedereen een lekker kon eten en natuurlijk integreren met elkaar. In de warmte van een flink ETVuur kregen de nullen de mogelijkheid hun cadeaus te overhandigen aan EOW-commissie, die deze bedankjes natuurlijk erg kon waarderen. Zeker bepaalde alcoholische versnaperingen konden de president van de EOW-commissie erg bekoren. Als klap op de vuurpijl werd er ook nog tweemaal een verjaardagslied aangeheven. Van zingen kregen de nullen dorst, dus was het tijd voor een bierestafette met natuurlijk de opening door de EOW-commissie tegen het Bestuur, die natuurlijk gewonnen werd door, jullie raden het al, de EOW-commissie. Na dit laatste spelletje van de dag, werd er nog volop geïntegreerd en geslapen naast sloten om vervolgens echt allemaal ons bed in te kruipen.

Boterham smeren of de grasmaaier

De volgende ochtend begon het Bestuur, onder het genot van een goudgele rakker, de nullen wakker te maken om ochtendgymnastiek te gaan doen. Natuurlijk werden de alom geroemde elektro-moves aangeleerd, waar de nullen nog heel de OWee profijt van hebben gehad. Het eerste verdiende biertje werd in ontvangst genomen door de nul die de heer Velzeboer met slaapzak en al durfde te vloeren.

Bij het ochtendgymnastiek kunnen de ETV-dansmoves natuurlijk niet ontbreken

Dit jaar begon het ruilspel met chips, die wederom meer dan genoeg bouwmateriaal opleverden

Na de ochtendgymnastiek volgde een welverdiend ontbijt, zodat alle nullen die hun vriendjes van de vorige avond waren vergeten, weer lekker verder konden integreren. Als laatste spelletje zonder mentorgroepje werd het aardespel gespeeld.

ETVriendjes

Nu moest het toch echt gaan gebeuren, het vormen van de mentorgroepjes. Toen iedereen zijn vriendjes had gevonden en een naam voor het mentorgroepje had bedacht, kon er geluncht worden. De mentorgroepjes gingen na de lunch de strijd met elkaar aan in spelletjes als kratjesrace - waarbij de EOW-commissie natuurlijk het goede voorbeeld gaf – en het altijd hilarische ETVoetbal. Toen het PB terugkeerde van het doorgeven van de mentorgroepjes aan het OWee-bestuur, werden zij vakkundig omgebouwd tot een smakeloos broodje shoarma. Als laatste spelletje was er natuurlijk de altyd zo geweescht pindakaaspottenrace met dit jaar maar liefst 3 badjes. Onder leiding van Yves Prévoo als presentator en een of andere malloot op een opblaaskrokodil als starter konden de nullen hun adtjes trekken en natuurlijk zo diep mogelijk in de pindakaaspot gaan.

Afsluiting

Voordat iedereen terug naar Delft kon vertrekken, moest nog even het kampterrein opgeruimd worden. De nullen gingen met de mentoren bij Virgiel eten om daarna terug te fietsen naar EWI. Op EWI aangekomen sloten de presidenten van de ETV en de EOW-commissie het Elektro Ontvangst Weekend passend af en konden de nullen aan de OWee beginnen met hun nieuwe ETVriendjes!

Namens de gehele 26e EOW-commissie der Electrotechnische Vereeniging wil ik graag via deze weg iedereen bedanken die direct of indirect hebben geholpen het Elektro Ontvangst Weekend tot een succes te maken.

SOWNet Technologies BV

Wireless security sensor-networking

Imagine a foul proof sensor-network with multiple nodes, which you can extend and reduce to your own needs. Usable from agricultural to security applications. With SOWNet's new distributed network of nodes this has become possible. Winelis Kavelaars, the director of SOWNet Technologies, tells us about this network.

Interview and text by Johan Splinter and Joost van Zwieten

The beginning

TNO developed a Compound Security Demonstrator for the Dutch Ministry of Defense. The idea of the Compound Security Demonstrator is to know on an early basis when and from where intruders are coming. Small tubes with infrared sensors and wireless communication are spread around the compound. The tubes or nodes form a wireless sensor network where each node can forward data from another node and therefore every node can communicate with any other node in the network. In theory such a network can span an infinite area provided that there are enough nodes to forward the data.

The nodes sleep until the infrared sensor 'sees' something moving. Adjacent nodes are contacted to confirm the movement and then an alarm is spread across the network. The alarm reaches the compound via several nodes and the military staff can take further action. When nodes are located at a large distance from the compound intruders can be sensed early, without them knowing they are being "watched".

What happened to the system afterwards is confidential information, but Winelis Kavelaars, project manager at that time, decided to bring this technology to the market. In 2006 he decided to start his own company around wireless sensor-networks: SOWNet Technologies BV, an acronym for Self Organising Wireless Network. Actually, TNO encourages people to start such a commercial spin-off and has a department called TNO Bedrijven that supports these companies.

CV WINELIS KAVELAARS

- director SOWNet Technologies (as of August 2006)
- project manager TNO Defense Security and Safety (from January 2001 to December 2006)
- project manager KPN Development and Engineering (from July 1999 to December 2000)
- Electrical Engineering at Hogeschool Utrecht (from 1996 to 1999)

Former projects

SOWNet uses the basis of the Compound Security Demonstrator in several other products. In cooperation with the Wageningen UR SOWNet developed a wireless sensor network which is able to monitor cows. The sensors are attached to the cows and record location and pose. Every minute the data is sent to a base station through the wireless network of cows.

The GreenNode was another project in cooperation with the Wageningen UR. The temperature and humidity inside a greenhouse are actively controlled. These two factors are tightly coupled and are of extreme importance for the growth of the plants. GreenNodes spread across the greenhouse can measure the temperature and humidity in their immediate surroundings. All nodes together form a wireless sensor network which generates data every two minutes and sends it to the climate controller.

Museum surveillance

Nowadays, SOWNet is focussing on a totally different product: museum surveillance. Let's say a thief has feelings for a certain painting. He picks it up and tries to escape the building, thereby traversing several rooms. The museum guards are supposed to catch the thief before he leaves the building. They would very much like to know which painting is taken and

NETWORK TYPES

There are three types of wireless sensor networks: centralised, decentralised and distributed.

CENTRALISED

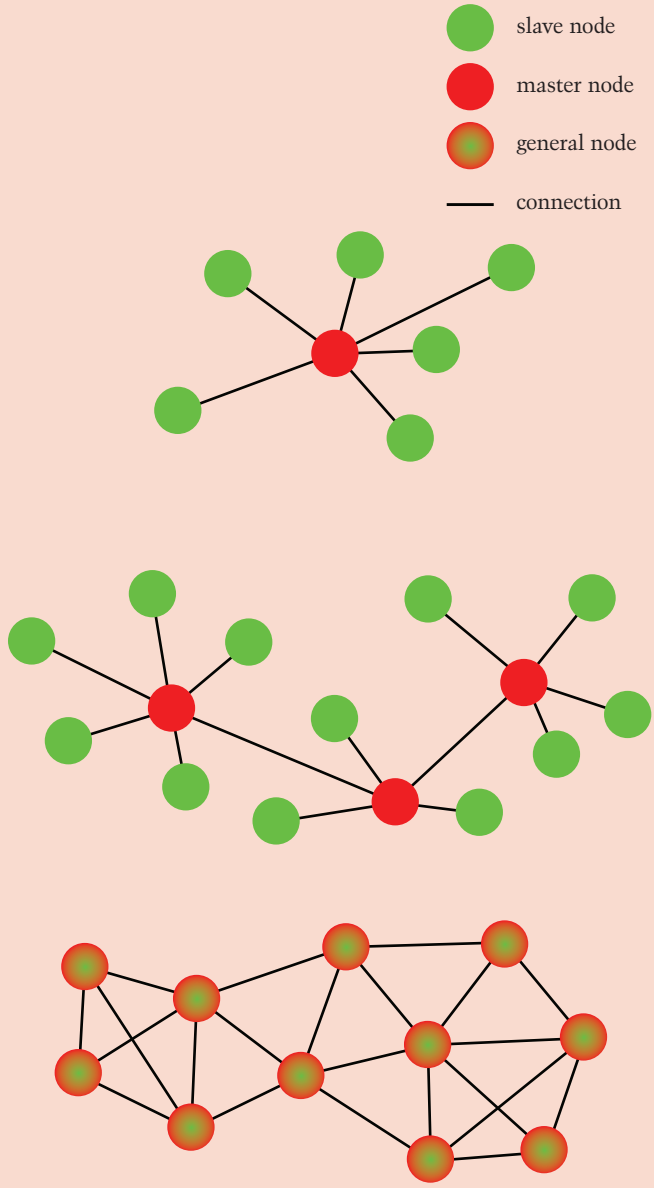
A centralised network consists of several slave nodes and one master node. The slave nodes are equipped with sensors and communicate bidirectionally with the master node. The slave nodes do not have to forward data from other nodes and therefore consume a small amount of energy. A slave node can operate on just two AA bateries for more then ten years. The master node is more complex than a slave node and consumes more power.

DECENTRALISED

A decentralised network consists of several centralised networks, where the master nodes can communicate with each other. Data from slave nodes can be transmitted throughout the network via the master nodes. The advantage above a centralised network is that the network can span a larger area by adding a sufficient amount of master nodes. Slave nodes consume the same amount of energy as in the centralised network.

DISTRIBUTED

This type of network uses one general nodes which can communicate bidirectionally with adjecent nodes. All nodes together form a network in which data can be send from every node to every other node. The nodes consume more power than the slave nodes in a (de)centralized network. On the other hand, a distributed network is in general more reliable because there are multiple routes from one node to another.



what its location is throughout the robbery.

The system invented by SOWNet is based on a decentralised sensor network (see aside about network types). The paintings in the museum are equipped with a slave node and a very sensitive vibration sensor. When a painting is touched the sensor awakens and sends an alarm signal to a master node located in every room of the museum. The master nodes form a connected network and forward the alarm signal to the control room in the museum. The painting keeps communicating with master nodes so that the guards know exactly at which room, corresponding to a master node, the painting currently is.

What is the sense of creating a wireless network inside a building with paintings that have a tendency to stay fixed at one position? Musea are often situated in historic buildings where it is not allowed to drill holes in walls or conceal cables in walls. In such places it is almost impossible to place a large amount of cables, say for every painting.

The system is currently being installed in a Dutch museum. More musea inside Europe will probably follow. In the future the nodes may be extended with temperature and humidity sensors to monitor the condition in which the paintings reside. Another plan is to make it possible to read out sensors directly via a PDA, without contact with the control room. Another application might be to supply information about a certain painting to visitors, when they stand in front of it.

Security of the sensor network

The security of a security network is of course very important: it must not be possible to mislead or penetrate the network. Therefore, the wireless communi- »

The museum sensor. Inside are a.o. an L-Node, a vibration sensor, and two AA batteries.

cation between nodes is encrypted. This makes it almost impossible to read data from the network, or even worse, send data over the network. This rules out the possibility of so-called bogus nodes which replicate the behavior of real (authorised) nodes. A bogus node can be viewed as a fake painting, but then in network space.

There is another way to mess with the network. Someone could deliberately jam the used frequency band with a source that is powerful enough. This creates a blackout for at least part of the sensor network. Since no signal can be transmitted to the control room the paintings can be touched and taken away without being detected. Such a jam, however, is simply detected by not receiving an "I'm alive signal" of each node in time. When this happens, the museum guards are immediately alerted.

Technology

The basis of the wireless sensor network is formed by T-Nodes or the more recently developed L-Nodes. These nodes contain a radio for transmitting and receiving data at 868 MHz. A microcontroller takes care of the read out of the sensors connected to the node and the wireless communication with other nodes.

For many applications it is very useful if the node and sensor can operate for a long time without replacing batteries. In case of the Compound Security Demonstrator, the batteries are not intended to be replaced at all. Therefore the nodes are designed for low power consumption. The L-Node is an improved version of the T-Node: smaller in size, lower power consumption and able to handle a larger communication distance.

There are several protocols for wireless communication such as ZigBee and Bluetooth. These are designed for higher data rates than needed and introduce some overhead, therefore consuming more power than needed. Furthermore, SOWNet wants a protocol that is flexible and can be tuned for a specific application. Thus with low data rates, low power consumption and flexibility in mind they created the protocol called SOWNet.

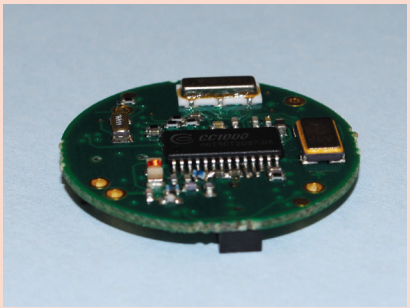
About the company

SOWNet is a small company consisting of only four employees. Winelis Kavelaars is the (technical) director and the only one with a degree in Electrical Engineering. Furthermore, there is a commercial director and two engineers with a degree in Computer Science.

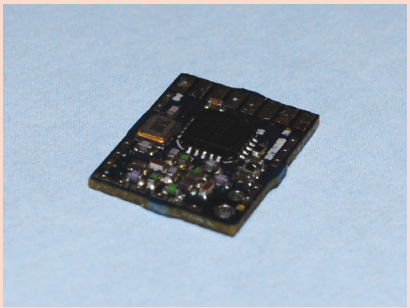
website: www.sownet.nl
e-mail: info@sownet.nl
address: Delftechpark 26, 2628 XH Delft

T-NODE AND L-NODE SPECIFICATIONS

	T-Node	L-Node
range indoor	40 m	50 m
range outdoor	120 m	500 m
power consumption in sleep mode	20 uA	2 uA
centre frequency	868 MHz	868 MHz



T-Node



L-Node

The Knight Rider

De intelligentste auto

Wie kent hem niet, KITT, oftewel 'Knight Industries Two Thousand', misschien wel de meest intelligente auto die men zich kan voorstellen. Met het, voor die tijd grote, geheugen van 1000 MB is KITT zeer vooruitstrevend. Een klein detail van KITT zullen we nader toelichten en bouwen.

Auteur: Matthijs Weskin

Op 26 september 1982 was voor het eerst de serie 'The Knight Rider' te zien op televisie. In deze serie strijdt Micheal Knight tegen het kwade samen met zijn 'intelligente' auto, KITT. Een zeer geavanceerde auto, die er ook mooi uitziet. Om een beetje van deze concept-car, of eigenlijk een fictieve concept-car, te realiseren hebben we een schakeling gezocht met betrekking tot KITT.

De LED's

De LED's aan de voorkant van KITT, zie figuur 1, zijn niet alleen voor de versiering, zoals men vaak denkt. De LED's van KITT geven aan wat hij doet en wat hij 'voelt'. Gaan bijvoorbeeld de LED's uit, staat hij in stand-by modus of verstopt hij zich. Als de LED's daarentegen snel knipperen is KITT boos en wil hij actie ondernemen. Vaak moet Micheal Knight hem dan tegenhouden.

Schema

Het circuit dat we gaan bouwen is een circuit waarmee we de LED's van KITT kunnen nabootsen. Met dit circuit kunnen we zelf de intensiteit en de snelheid regelen. Het circuit staat weergegeven in figuur 2.

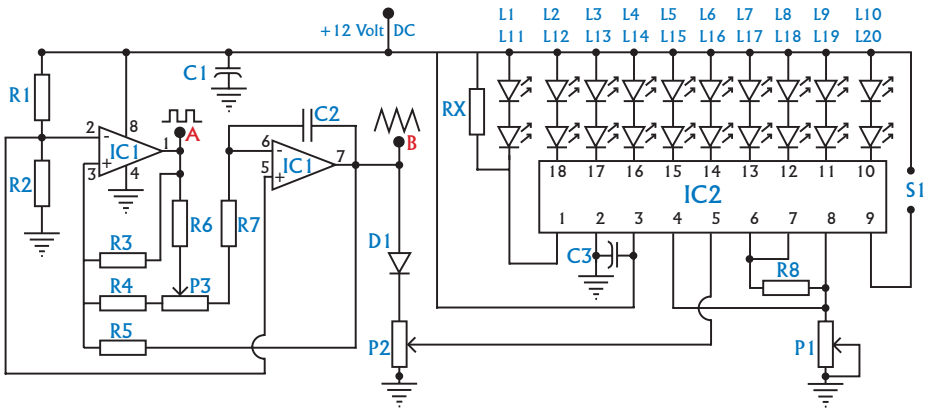
IC1 genereert een zaagtandgolf (B) en een blokgolf (A), waarvan we alleen de eerste gebruiken.

Potmeter P1 regelt de ingangsspanning van IC2 en daarmee de minimum lengte van de array van LED's.

Om de spanning van de zaagtand te regelen, hebben we potmeter P2. Hiermee wordt het andere uiteinde van de LED-array bepaald. Stel deze twee zelf in om de array naar je eigen zin te krijgen.

De potmeter P3 regelt de frequentie van de zaagtand, hiermee kun je dus de snelheid van de LED-array instellen.

Voor IC2 kun je ook een LM3915 of een LM3916 gebruiken. Dan is echter de array niet meer lineair.



Figuur 2: Het schema van de Knight Rider LED's.

Figuur 1: De superintelligente auto KITT

Verder kun je met de schakelaar S1 instellen of je dot- of barmodus wil gebruiken. Dat wil zeggen dat je of één LED tegelijk wil laten branden, of de LED's voor bepaalde tijd laten branden als de volgende aangaat.

Als er problemen zijn met het laten branden van de twee middelste LED's kun je een weerstand RX plaatsen. De waarde ligt in de buurt van 20kΩ.

Opbouw

Het schema is van dusdanige kleine omvang dat het mogelijk is deze schakeling op een simpele test-printplaat te bouwen. Wat voor het effect beter is, is als de LED's via draadbruggen op een apart plaatje komen, waardoor je alleen de LED's inclusief effect hebt, zonder dat de schakeling zichtbaar is.

ONDERDELENLIJST

Weerstanden:
R1, R2 = 10k
R3 = 100k
R4, R7 = 82k
R5, R6 = 47k
R8 = 1k2

Potmeters:
P1 = 1k
P2 = 5k
P3 = 250k

Condensatoren:
C1, C3 = 1µF
C2 = 1µF

IC's:
IC1 = TL082
IC2 = LM3914

diodes:
D1 = 1N4148

LED's
Alle LED's (L1...L20) zijn standaard rode 5mm LED's.

The Memristor Inside Out

The missing element has been found!

Earlier this year HP Lab engineers announced their physical realization of the 'missing' fourth basic circuit element in electronics: the memristor. Not often a technological discovery attracted so much attention from the media. Apart from the wildest possible speculations on future applications in new non-volatile memory devices with human brain synthesizing properties and suggestions to rewrite the existing textbooks on circuit theory, the discovery met with much scepticism as well. What exactly is this memristor? Where does it come from? What will it bring us? Why didn't we miss it before?

Author: Dimitri Jeltsema

The four element quadrangle

Since electronics was developed, engineers designed, analyzed, and synthesized circuits using combinations of three basic two-terminal elements: resistors, inductors, and capacitors. From a mathematical perspective, the behavior of each of these elements, whether linear or nonlinear, is described by relationships between two of the four electrical variables: voltage, current, charge, and flux(-linkage). A resistor is described by the relationship of current and voltage, a capacitor by that of voltage and charge, and an inductor by that of current and flux. But what about the relationship between charge and flux? As Professor Leon O. Chua (the inventor of the well-known chaotic Chua circuit) from the University of California, Berkeley, pointed out in his 1971 paper, a fourth element should be added to complete the symmetry. He coined this 'missing' element the *memristor*. More specifically, if q denotes the charge and ϕ denotes the flux, then a two-terminal *charge-controlled* memristor is defined by the constitutive relationship.

$$\phi = \hat{\phi}(q). \quad (1)$$

Since flux is the time integral of voltage u (like in Faraday's law), and charge is the time integral of current i, or equivalently, $u = d\phi/dt$ and $i = dq/dt$, we obtain, after differentiating (1) with respect to time, the more familiar expression

$$u = M(q)i, \quad (2)$$

where $M(q) := d\hat{\phi}(q)/dq$ is called the incremental or small-signal memristance. At first glance (2) shows that a two-terminal charge-controlled memristor behaves like a linear resistor described by Ohm's law. The difference, however, is that its resistance $M(q)$ is not a constant, but va-

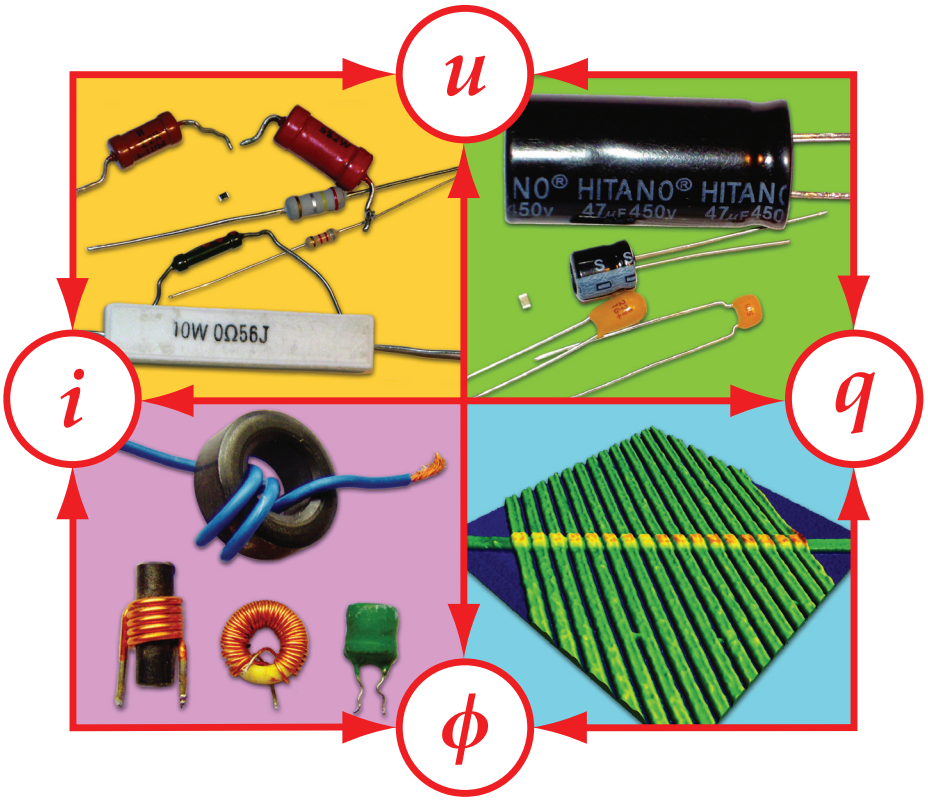


Figure 1: The four element quadrangle. An inductor corresponds to a static relationship between current i and flux ϕ, a capacitor corresponds to a static relationship between voltage u and charge q, and a resistive element corresponds to a static relationship between current and voltage. There are two dynamical relationships, one between current and charge, and the other between voltage and flux. The remaining relationship, namely between flux and charge, defines a memristor.

ries with the instantaneous value of the charge. Recalling that charge follows from the time integral of current, it thus records the past values of the current and hence motivates the name memory resistor, or memristor for short. It follows from (2) that the SI unit of memristance is the ohm [Ω], the same as that of resistance.

Similarly, a two-terminal *flux-controlled* memristor (memductor) is defined by

$$q = \hat{q}(\phi), \quad (3)$$

Differentiation with respect to time yields

$$i = W(\phi)u, \quad (4)$$

where $W(\phi) := d\hat{q}\ q(\phi)/d\phi$ is called the incremental *memductance*. Clearly, the corresponding SI unit of memductance is the mho [℧] or Siemens [S], the same as that of conductance.

The relationships between the variables and the four basic electrical elements are summarized in the so-called four element quadrangle shown in Figure 1.

Linear versus nonlinear

In the special case that the constitutive relationship of a memristor is linear, or in other words, when the constitutive relationship defines a straight line through the origin in the flux-charge plane, a memristor becomes an ordinary linear resistor. Indeed, in such case (1) reduces to $\phi = Mq$, with constant memristance M (the slope of the line). Differentiation of both sides of the latter with respect to time yields $u = Mi$, which precisely takes the form of Ohm's law. Hence it is not possible to distinguish a two-terminal linear memristor from a two-terminal linear resistor. This perhaps explains why its existence could not be predicted from classical linear circuit theory.

A curious kind of pipe

In order to gain some intuition for what distinguishes a memristor from a resistor, as well as from an inductor or a capacitor, let us briefly consider the common analogy of an electrical resistor and a pipe that carries a fluid. The fluid can be considered analogous to charge, the pressure at the inlet of the pipe is similar to voltage, and the rate of flow of the fluid through the pipe is like current. As is the case with a resistor, the flow of fluid through the pipe is faster if the pipe is shorter or if it has a larger diameter and vice-versa.

Now, an analogy for a memristor is an peculiar kind of pipe that expands or shrinks when fluid flows through it. For example, if fluid flows through the pipe in one direction, the diameter of the pipe increases, thus enabling the fluid to flow faster. If fluid flows through the pipe in the opposite direction, the diameter of the pipe decreases, thus slowing down the flow of fluid. If the fluid pressure is turned off, the pipe retains its most recent diameter until the fluid pressure is turned back on. Unlike a bucket, which can be considered as a hydraulic capacitor, a memristive pipe does not store the fluid, but 'remembers' the amount of fluid that flowed through it. In the electrical domain this means that, like a capacitor, a memristor has a memory, but unlike a capacitor it does not store charge but just 'remembers' the last charge that passed through it. It is precisely this persisting memory feature of the memristor that could be used advantageously to create a new type of non-volatile RAM. More about that later

Quasi-static field perspective

It is well known that the circuit-theoretic definitions of resistance, inductance, and capacitance can be associated with electromagnetic systems operating in their quasi-static limit. From this point of view, a resistor or conductor corresponds to an electromagnetic system for which the first-order fields are negligible compared to its zero-order fields. Its low frequency behavior is then characterized by an instantaneous (memoryless) relationship between the zero-order electric and magnetic field intensities. Similarly, an inductor corresponds to an electromagnetic system for which both the zero-order electric field and the first-order magnetic field can be ignored. The behavior of an electromagnetic system for which both the zeroorder magnetic field and the first-order electric field can be ignored corresponds to a capacitor.

The fourth combination, in which both zero-order fields are negligible while the first-order fields are both relevant, naturally implies to correspond to a memristor type of device. Indeed, the latter situation gives rise to an instantaneous relationship between the first-order electric and magnetic field densities, which in turn correspond to charge and flux. It should be noted that this interpretation also implies that a memristor or memductor is essentially an AC device since under DC operating conditions the resistive behavior (zero-order fields) can not be ignored.

Brother or distant cousin?

So a memristor is essentially a nonlinear element described by the same fundamental set of circuit variables as the passive two-terminal resistor, inductor, and capacitor. But does that give it the right to be just as fundamental as the latter familiar three circuit elements? This, of course, depends on how we (prefer to) look at it. From a linear perspective it is senseless to complement the linear circuit elements with a linear memristor as it precisely coincides with an ordinary resistor. In the realm of impedances it is clear that linear electronics is already complete in itself; linear resistors are purely real Q impedances, linear inductors and capacitors are merely the positive and negative purely imaginary impedances »

Impedance is not passive if its real part is negative. There is simply no room to complement that.

One the other hand, apart from the fact that linear elements can be considered as a special case (small-signal or local approximation) of nonlinear elements, a few arguments in favor of the memristor as the fourth fundamental passive circuit element can be given as follows. A fundamental property of a resistor, inductor, and capacitor, whether linear or nonlinear, is that the values of their associated incremental or small-signal resistance, inductance, and capacitance, respectively, do not change with the frequency of an infinitesimally small sinusoidal variation about any fixed point of operation. The same property holds true for a memristor. Furthermore, there does not exist a combination of two-terminal passive resistors, inductors, and/or capacitors that duplicates the properties of a memristor (although including active elements like op-amps can do so). These features make the memristor just as fundamental as the existing three elements.

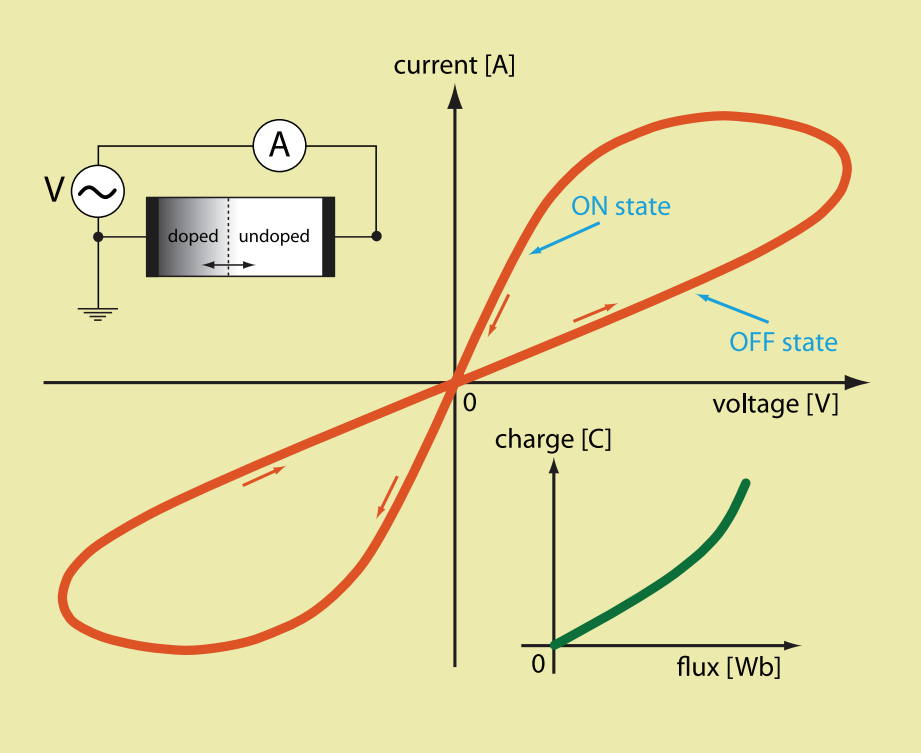


Figure 2: Current-voltage plot demonstrating hysteretic phenomena of HP Lab's memristor. The application of a sinusoidal voltage (V) across the device will move the boundary between the doped and undoped regions causing the charged dopants to drift. The distribution of the dopants, and thus the resistance of the device, is proportional to the charge that passes through. Note the corresponding charge-flux plot shows a much simpler non-hysteretic relationships.

About HP Lab's device

Now that we know some ins and outs about the theoretical background of the memristor, let us briefly look at what the engineers at HP Lab have actually created. HP Lab's memristor is a two-terminal, two-layer semiconductor constructed from layers of titanium oxide (a substance we also find in toothpaste and suncream) sandwiched between two metal electrodes in a crossbar architecture. One layer of titanium oxide is doped with oxygen vacancies and the adjacent layer is undoped, leaving it in its natural state as an insulator. Under the influence of a bias voltage, oxygen vacancies move from the doped layer of titanium dioxide to the undoped layer. A high concentration of dopants results in a relatively low resistance. Likewise, if the polarity of the voltage is reversed, oxygen vacancies migrate back into the doped layer, thus turning to the region with relatively high resistance. The most typical feature of HP's device is that, after reversing the polarity of bias voltage, the current does not take the same reverse path, an effect we know as hystereses.

An example of a typical current-voltage characteristic observed by the HP engineers is shown by the so-called Lissajous plot of Figure 2. In relation to the features highlighted above, the two approximately straight lines segments within the curve correspond to the two distinct resistance states. The connecting end parts are the transition regions between these two states. Obviously, a memristor can be used as a switching device, where the low resistance or conduction state can be associated with its 'ON' state and the high resistance state as the 'OFF' state. As already emphasized before, the main advantage of the memristor is that its resistance changes are non-volatile, and remain until a reversed bias voltage is applied.

Criticism

The main criticism received by HP Lab's discovery is that memristors, or the memristance phenomenon in particular, already existed. Indeed, a variety of physical devices, including thermistors, discharge tubes, Josephson junctions, and even ionic systems like the Hodgkin-Huxley model of a neuron, were shown to exhibit memristive effects. Apart from the fact that these devices belong to a broader class of systems that generalize the memristor, called memristive systems, there remains a lack between the mathematics and the physical properties. Furthermore,

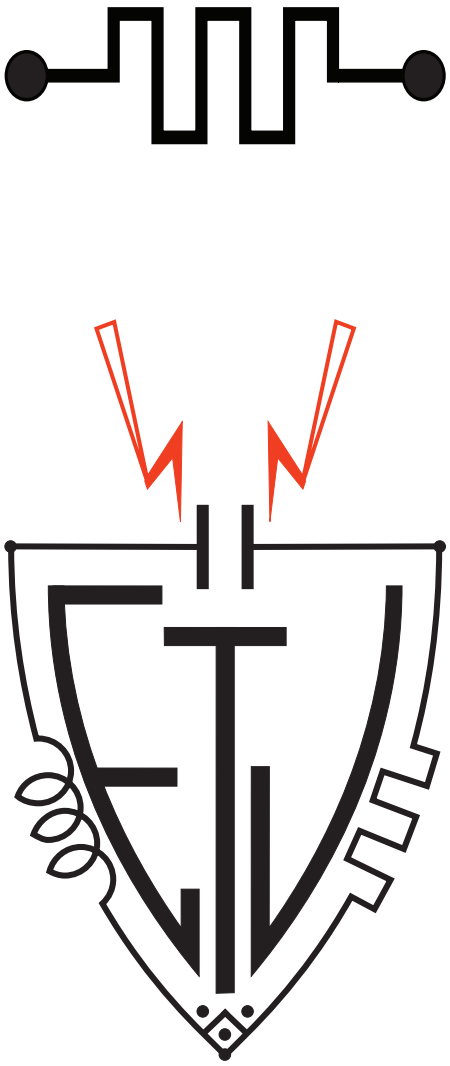


Figure 3: Memristor symbol (upper) and the logo of the ETV (lower).

it is also known that there have been many researchers before who observed similar peculiar hysteretic current-voltage characteristics in various materials. However, most of these observations were reported as anomalous or interpreted as difficult time-varying conductances, often leading to paradoxes and confusion.

Admittedly, the actual order of events at HP Lab was alike. The HP Lab engineers were also puzzled by their creation and it took them years to realize that their device satisfied the equations of Chua's memristor. For that reason, the main contribution of HP Lab is that they provide a physical passive two-terminal model that allows a better understanding of the mechanism behind memristance and the hysteretic current-voltage characteristics observed in many nanoscale electronic devices. This understanding might gain the possibility to create new and useful devices.

Concluding remarks

The question why we did not really miss the memristor before can most likely find its answer in the fact that so far the majority of practical devices are still reasonably well modeled by some (though often artificial) combination of standard circuit building blocks such as the resistor, inductor, capacitor, and their nonlinear and multiport versions. As nanoscale electronic devices become more and more important and complex, it might be beneficial, and on the longer term maybe even necessary, to enlarge our repertoire of modeling building blocks that establishes a closer connection between the mathematics and the observed physics. This of course does not mean that we have to abandon our classical and familiar tools, or that we have to rewrite the existing textbooks on linear circuit theory. We should, however, avoid to confine ourselves too much to the things we ought to think of as safe, sound and complete.

In conclusion, it would be interesting to see what future applications arise from the concept of memristance. As remarked by Stan Williams from HP: "the most valuable applications of memristors will most likely come from some young student who learns about these devices and has an inspiration for something totally new." There seems to be a fairly big chance that this will be somebody from our faculty as the existence of the memristor was already apparent from the logo (see Figure 3) of the Electrotechnische Vereeniging (ETV), even 65 years before it was postulated as the fourth element.

Selected references

This text is largely based on a variety of resources which are too many to cite here. Some key references that are recommended to the interested reader are listed below. An article nuancing some of the overblown media statements can be found in the 10th issue of Bits & Chips magazine of 2008 (in Dutch).

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Detecting Landmines

Subsurface imaging by space-time deconvolution for a GPR array.

The UN states that around 80-110 million landmines are laid throughout the world. Landmines can remain active for decades, so they continue to be a threat even after the conflict has long been resolved. Since mines can not distinguish between soldier and civilians, they cause a high number of civilian casualties. Annually thousands of people are killed or maimed by landmines, so the reason for the need for clearing them is quite obvious. Various methods exist to detect the landmines; each having his own advantages and drawbacks.

Author: Niels van Tol, MSc

Ground Penetrating Radar

My thesis work treats the signal processing part of data acquired by an ultra-wideband Ground Penetrating Radar as described in the previous edition of the Maxwell. I will briefly discuss the basics of the particular GPR that I've used.

The system is based on a time-domain radar that sends out a very short pulse emitted by the transmitter antenna located at the top. Because the pulse is in the order of nanoseconds the bandwidth is in the order of gigahertz, hence the term ultra-wide band. The high bandwidth leads to a resolution in the order of centimetres, making it suitable to detect the smaller landmines as well. The receiving array consists of 13 receiving loops all placed under the transmitter antenna at 7 cm intervals, totalling to a width of 84 cm. This means that the array can scan a 2D area by only having to move the array over one dimension. The set-up is shown in Figure 1.

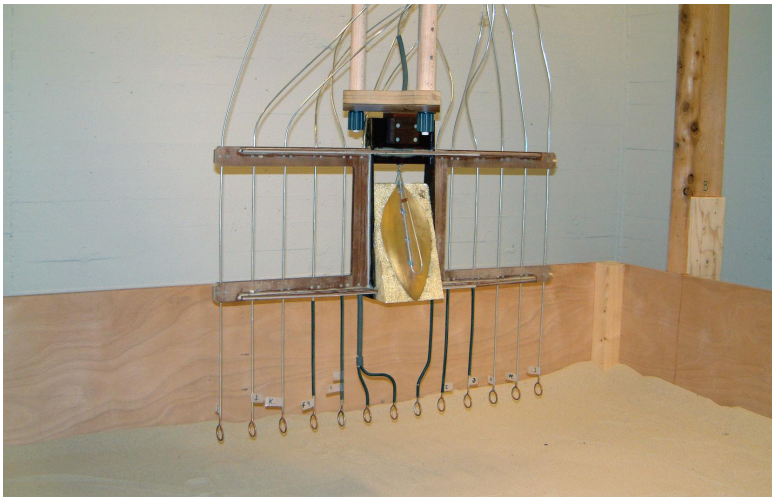

Figure 1: Array of 13 receiving antenna loops

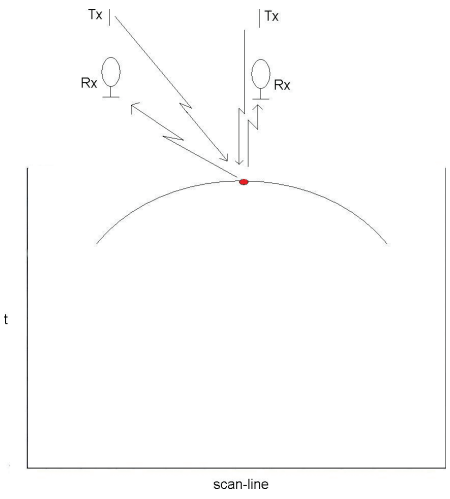

Figure 2: Need for migration

Need for sub-surface imaging

Unfortunately there's a fundamental problem with the data acquired by any time-based GPR. To simplify the situation a 2D scenario is used. In the case of our radar we could say that we would only take data from one loop. Now, let's take a look at Figure 2. The antenna is located at the top and there's an object located beneath it, which is denoted in red. It's important to realise that the unit of the y-axes is time, where increasing time is located lower on the axes. Imagine that the radar is moving from left to right over the scan line. At position 1 the radar sends out the pulse and the reflection made by the "red" object is recorded by the receiving loop. The reflection in this case is simplified as a dot which is detected after a certain amount of time. This time depends among others on the distance between the radar and the object. Now the radar moves to position 2 (directly above the object) and the pulse is sent out again. This time the distance between the radar and the object is smaller leading to a reflection which is earlier in time. When we extend this procedure to all over the scan-line this results in a hyperbola over the scan-line which has it's apex at the antenna position where the distance between antenna and object is the smallest. So basically, a very small object creates a large hyperbola in the data. A real example of this is shown in Figure 3. Here a small sphere was placed under the antenna and the antenna was scanned from left to right. The top two bars are the so-called antenna crosstalk; because the transmitter is above the »

receiving array the pulse first passes by the receiving loop before reaching the target. The hyperbola can be clearly seen in the image.

This distribution of energy does not give good localisation and resolution of the targets and therefore needs to be reversed. For that we use an imaging process called migration.

Problem description of my thesis

Several methods exist to do this migration, but they are very computationally intensive and use only a limited number of characteristics of the radar and soil. One of these methods is called the diffraction stack algorithm. This algorithm is based on the travel times from transmitter to object to receiver and basically searches for all possible hyperbolas in the data. It gives good migration results but is very computationally intensive.

A new method was introduced by [Scheers] that did not have these drawbacks. My job was to develop this method for our GPR and to extend it to a 3D array version. The diffraction stack algorithm was also implemented which served as a benchmark for the to be developed imaging process.

Basic concept of migration by deconvolution

Let's say that the reflection of any object can be modeled by the combined reflection of a set of point scatterers. So that objects in the ground are modeled by a certain number of point scatterers in a certain place.

If the combining of these reflections is linear this is a convolution in space and can be described by

$$b(y,t) = w(y,z_0,t) \otimes_{y,t} \Lambda_{z_0}(y,t)$$

where $b(y,t)$ is the recorded 2D-scan, $w(y,z_0,t)$ is the point-spread function (point-target response) and Λ_{z_0} is the scattering matrix (the objects). The recorded 2D-scan (for an example, look at Figure 3) is also called a B-scan.

Λ_{z_0} is of course what we're searching for. It's the collection of point scatterers that would result in a particular B-scan. Basically it's our processed dataset.

Now we'll discuss how the point-spread function $w(y,z_0,t)$ is determined. This is the 2D-result we would expect to get back from the radar if there was only a very small point target located beneath the radar array. The point-spread function is determined by using forward modelling; the synthetic B-scan is formed by interpreting the entire system as a cascade of linear responses. In this case the system is the combination of the influences of the radar, the air, the soil and the target itself. A schematic of this model is shown in Figure 4, where you can clearly see all the components that make up the reflection of a certain target. An example of a point-spread function (PSF) that has its scatterer at the center of the scan-line is shown in Figure 5.

TYPES OF SCANS

When the GPR's position is fixed and a reflection is recorded this has only time-information. This is a 1D-scan, also known as an A-scan. If we move an antenna pair over the scan-line with small intervals the recorded data can be combined to form a 2D-scan, also known as a B-scan. In our case, when we move the array over the scan-line, the scanned area is 2D; that together with the depth-information in the time-domain leads to a 3D-scan, also known as a C-scan.

Inverse Wiener filter and quality criteria

So we need to solve Λ_{z_0} out of Equation 1. A very straightforward way would be

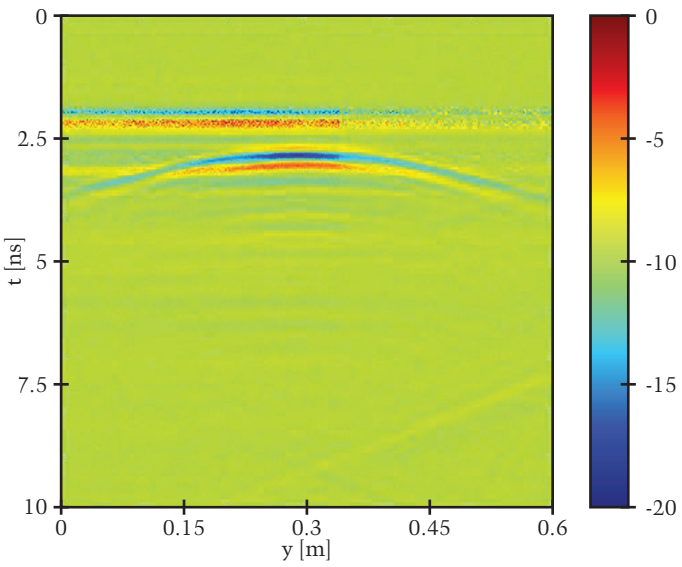

Figure 3: Original B-scan (signal level)

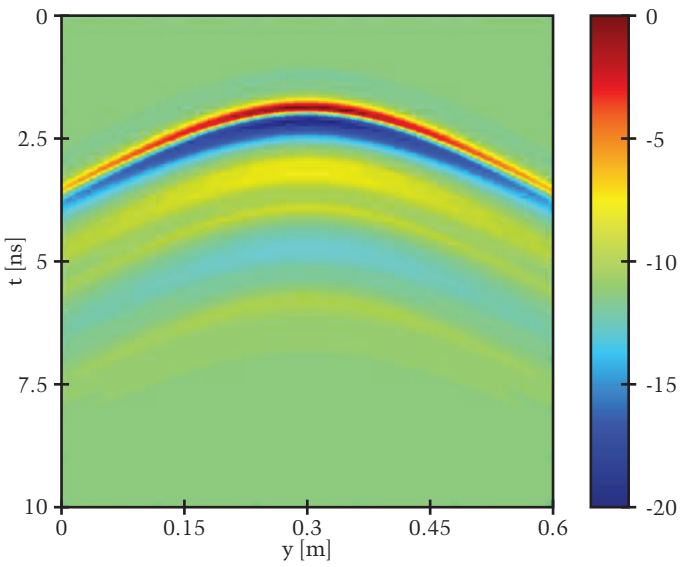

Figure 5: Point-spread function [signal level]

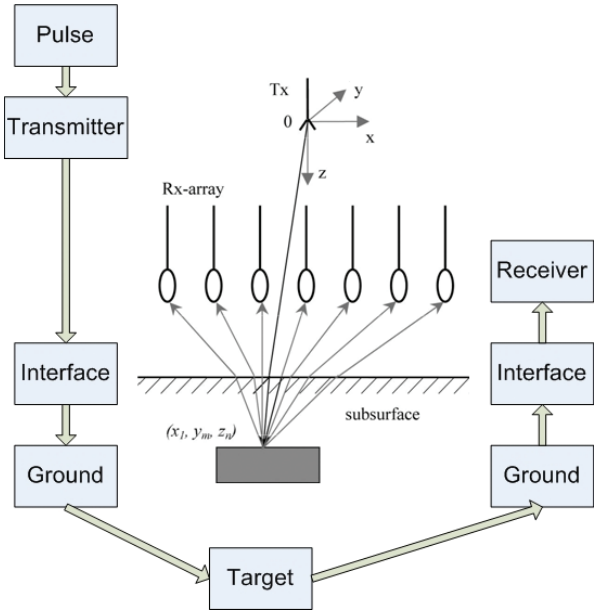

Figure 4: Scheme

to deconvolve the point-spread function $w(y, z_0, t)$ out of the B-scan, but doing this in the space-time-domain is very computationally intensive. So to perform this deconvolution we use an Inverse Wiener filter in the frequency-wavenumber domain which is described by

$$\hat{\Lambda}(k_y, \omega) = \frac{B(k_y, \omega) \cdot W^*(k_y, \omega)}{W(k_y, \omega) \cdot W(k_y, \omega)^* + \beta}$$

where $B(k_x, k_y, \omega)$ is the Fourier transformed acquired data-set, $W(k_x, k_y, \omega)$ the Fourier transformed point-spread function and β the regularisation parameter (1/SNR).

So after this filtering operation, all that remains is to transform the $\hat{\Lambda}$ back to the time-domain, right? Not quite. This filter needs the parameter β in order to function. Mathematically speaking, this parameter is the inverse of the Signal-to-Noise Ratio of the raw input data (the original B-scan). But since the signal is unknown, this is difficult to determine beforehand.

To overcome this issue two quality criteria were introduced by [Savelyev] to control the deconvolution result.

The first one is the Energy ratio between the processed result and the original B-scan and can be described by

$$\gamma = \frac{\left\|\hat{\Lambda}(y,t)\right\|}{\|b(y,t)\|}$$

The second one, the Error, is the measure of difference between the original signal and deconvolution result convolved with the point-spread function. Theoretically this convolution should result in exactly the recorded B-scan. The error can be described by

$$\epsilon = \frac{\left\|b(y,t) - \hat{\Lambda}(y,t) \otimes w(y,t)\right\|}{\|b(y,t)\| + \left\|\hat{\Lambda}(y,t) \otimes w(y,t)\right\|}$$

Ideally the error would be zero, so the natural approach is to vary the regularisation parameter to minimise the error. The maximum Energy Ratio functions as a constraint for the parameter, since not only the Error matters but the quality of the resulting image as well. This maximum Energy Ratio depends on the scenario (2D- or 3D-data), but should always be lower than 100% since that would mean that the processed result contains more energy than the original dataset.

The regularisation parameter is varied iteratively until the actual Energy Ratio is close to the maximum Energy Ratio »

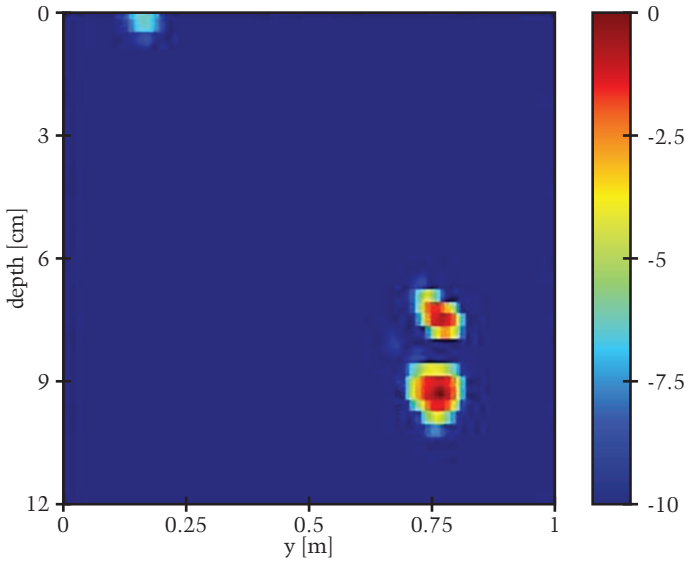

Figure 6: Diffraction stack result of sub-surface landmine [dB]

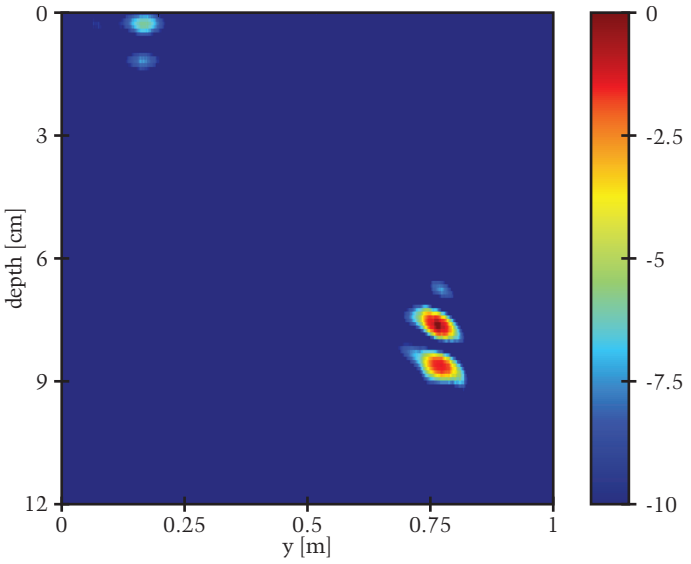

Figure 7: Deconvolution result of sub-surface landmine [dB]

constraint. The Error is calculated afterwards to give an indication on the quality of the result.

Results

The B-scan that's shown in Figure 3 is the result of a single sphere with a 2 cm diameter sphere placed at 41 cm from the transmitting antenna. In Figure 6 you can see the migrated result using the diffraction stack algorithm. Figure 7 shows the result of the new algorithm. It's clear that the deconvolution algorithm gives a more condensed image at a higher resolution. The diffraction stack needs 55 seconds to process while the deconvolution operation needs less than 5 seconds!

Extending to a 3D array method

To determine the performance of the algorithm a 3D dataset is used that contained two identical targets at around 80 cm on the scan-line at the centre and the side of the array. All figures are now 2D-projections of 3D datasets. So now the y-axes represents the scan-line and the x-axes represents the dimension over the width of the array (aperture dimension) and the time/depth-information is omitted.

To extend this algorithm to a 3D version is relatively straightforward. The raw dataset is now 3D, e.g. C-scan. So the PSF and the filter need to be extended to 3D as well. The challenge of making a 3D array version is two-fold. First there is the course resolution over the width of the array (remember that there are only 13 loops to cover 84 cm). Second the finite width of the radar all together (you can make the scan-line as long as you want, but the size of the radar is fixed).

To "increase" the resolution linear interpolation was applied to the PSFs and raw C-scans over the array dimension.

The result when taking these steps is shown in Figure 8 and the diffraction stack result in Figure 9. Only the centre target is visible in the deconvolution result, you can still see a little image at the right side but it is much weaker than the centre target. Both targets are clearly visible in the diffraction stack result, but still the side target is weaker. This is because the finite width of the array: a target located at the side will have a part of its hyperbola cut off because the array just doesn't detect it. On the other hand, when a target is located precisely at the centre of the array a much larger part of the hyperbola will be detected; resulting in a higher total energy for that particular target. This explains why the right target is a bit weaker in the diffraction stack result, but not why it almost disappears with the deconvolution result!

The use of multiple PSFs

Well remember that the PSF was formed with one scatterer in the middle in the 2D-case. The same was done in the 3D-case. One scatterer was placed at the centre of the scan-line and the centre of the array. This means that the filter is basically looking for hyperbolae that are located in the centre, so centre targets are biased and will have stronger results than targets at the side.

To resolve this a method was developed that used multiple PSF's; each having their scatterer at a different location. Using more PSF's also results in more processed datasets, which have to be combined in order to receive one imaged result. With the help of some trial and error I found that the optimal method consisted of 13 PSF's, where each PSF had their scatterer located under a different loop. The result is shown in Figure 10. Both targets can now clearly be seen, but naturally (as with the diffraction stack result) the side target is still perceived weaker due to the fact that there's less hyperbola energy of a side target in the original C-scan.

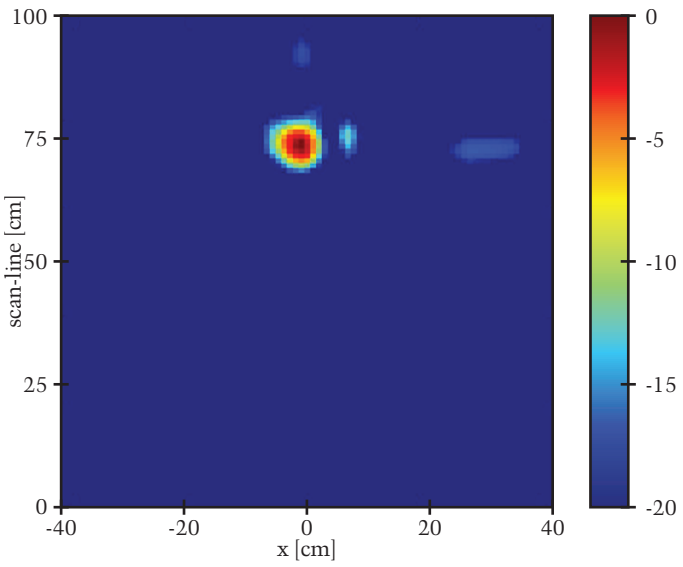

Figure 8: ASWEP deconvolution result [dB]

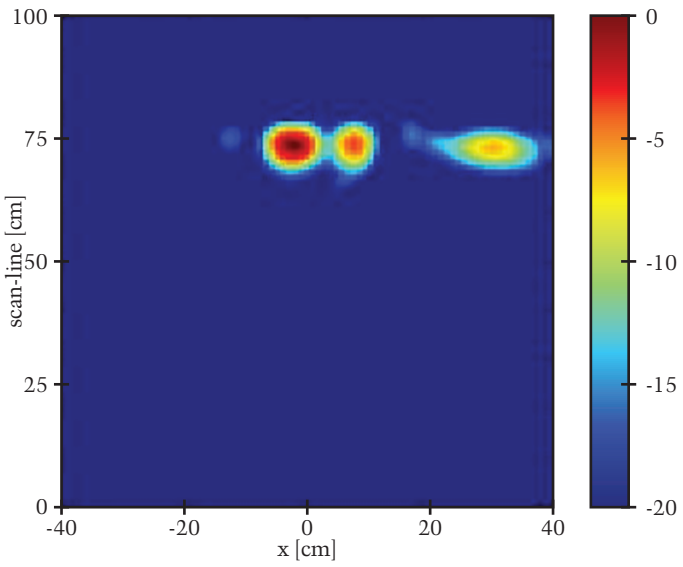

Figure 9: ASWEP diffraction stack result [dB]

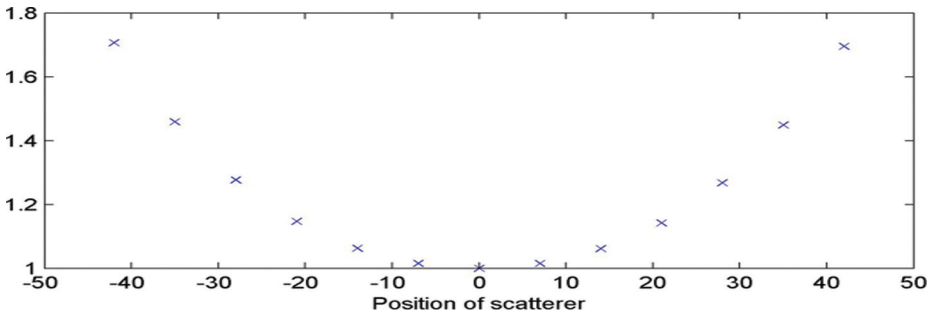

Figure 11: Weights for each deconvolution result related to position of scatterer

But just because we have this same problem with another algorithm, doesn't make it right. Fact of the matter is that two identical targets should give two identical responses.

Weighting the result

To counter this a weighting scheme was developed that multiplied the signal levels of the deconvolution results from each separate PSF with a linear weighting factor before combining the results. This weighting is of course relative and the deconvolution result obtained with the one PSF that has its scatterer at the centre will have a weighting factor of 1. But how do we determine with which factor to multiply?

It is necessary to normalise the PSF's before filtering; a.o. in order to make sure that the quality criteria make sense, but this does remove the energy information. You can imagine that a PSF with its scatterer at the side has less total energy than the PSF with its scatterer at the centre. So the normalisation factors of the 13 different PSF's are used to come up with a weighting factor for each deconvolution result. The factors are relative, which makes the lowest factor 1. The distribution is shown in Figure 11. The 13 weighting factors each correspond to a PSF which has their scatterer at a different position over the width of the array.

Combining the 13 results after weighting leads to the final result shown in Figure 12.

Conclusions

The complete deconvolution algorithm needed less than 8 minutes to do the same as the diffraction stack algorithm did in over 22 hours. The shapes of the targets in the diffraction stack result are nicer and the deconvolution result also has more artefacts. But the new algorithm does show both targets at comparable strengths. The good image quality together with the very big cut in computational effort make the newly developed method very interesting.

Interested?

You want to do a challenging thesis work with good guidance? You do not want to create a report that disappears in a cabinet? You want to work with a GPR that is designed to detect landmines? Anywhere from antenna design to signal processing? Contact Dr. Alexander Yarovoy

a.yarovoy@irctr.tudelft.nl

or T.G. Savelyev

t.g.savelyev@irctr.tudelft.nl

at IRCTR.

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[Scheers] B. Scheers and M. Acheroy. *Ground Penetrating Radar*, 2nd edition, chapter "Migration technique based on deconvolution", pages 283–293. D. J. Daniels ed., IEE Radar, Sonar, Navigation and Avionics Series 15, 2004.

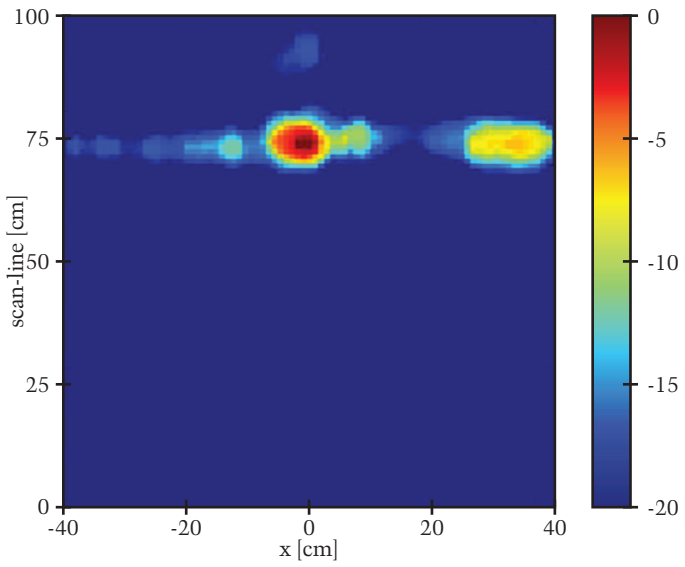

Figure 10: ASWEP result with median filtering [dB]

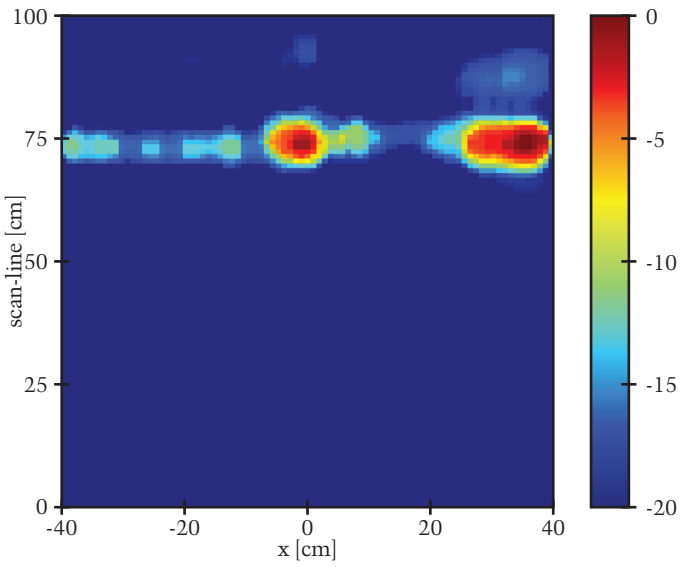

Figure 12: ASWEP combined deconvolution result [dB]

Column

Prof.dr.ir. Ronald Dekker
Hoogleraar Flexible Electronics
Principal Scientist Philips Research

Deze column is een uitsnede van de inaugurele rede die prof.dr.ir. Ronald Dekker heeft gehouden op 15 oktober 2008. Naast een uiteenzetting over de nieuwe ontwikkelingen en uitdagingen op zijn vakgebied Flexible Electronics gaf hij in zijn rede zijn visie op de toekomst van de microfabricage in Nederland.

We bevinden ons wat betreft microfabricage op een keerpunt! Nederland heeft moeten afhaken in de ontwikkeling van de mainstream microelectronica-technologieën. Door de moordende concurrentie met het Verre Oosten, de benodigde astronomische investeringen en de minimale marges in de halfgeleiderindustrie moeten we er bovendien van uitgaan dat zowel NXP als Philips op dit vlak niet meer het voortouw in innovatie zullen, of kunnen nemen. Ondanks de intensieve relaties tussen de universiteiten en industrie, heb ik vaak het idee dat de ernst van deze situatie niet goed op de universiteiten is doorgedrongen. Zo realiseren velen zich bijvoorbeeld niet dat Philips na de verzelfstandiging van zijn halfgeleiderdivisie nog maar één cleanroom heeft, namelijk de research-cleanroom van MiPlaza in Eindhoven. Het is bovendien niet onwaarschijnlijk dat binnen vijf tot tien jaar de gehele IC-fabricage in Nijmegen wordt gestopt, óf naar het Verre Oosten wordt verplaatst, waarna de research-cleanrooms in Nederland nog de enige plaatsen zouden zijn waar aan microfabricage wordt gedaan. Persoonlijk is het voor mij ondenkbaar en onverteerbaar dat Nederland op het gebied van de microfabricage - de technologie die samen met de biotechnologie zozeer het boegbeeld is van technische innovatie, en die cruciaal is voor innovatie in vele andere disciplines - wat betreft productie in de toekomst vrijwel geen enkele rol van betekenis meer zal spelen.

De enige oplossing die ik zie is dat wij als onderzoekers niet langer naar de grote bedrijven blijven staren, maar ons zelf verantwoordelijk gaan voelen voor de commercialisatie van onze ideeën. Dat is natuurlijk geen nieuwe boodschap. Er wordt over innovatie veel gezegd en geschreven, maar op microfabricage gebied gebeurt er daadwerkelijk maar heel weinig. De enorme dominantie van Philips en NXP op micro-elektronica gebied in ons land, heeft er wellicht voor gezorgd dat we misschien een beetje gezapig zijn geworden. Maar al te vaak wordt aan de TU's iets heel moois bedacht, waarna we verwachtingsvol naar Philips of NXP kijken, "of die er iets mee willen doen". Als dat dan niet gebeurt, wat meestal het geval is, dan heerst er onbegrip en irritatie. Het eind van het liedje is dat het resultaat van het onderzoek in de vorm van een proefschrift in de kast verdwijnt.

Het vervelende is natuurlijk dat het ondernemen ons als techneuten niet in het bloed zit. Weliswaar kijken we met fascinatie naar het Amerikaanse model waar het uitspinnen van start-ups aan de orde van de dag is, maar tegelijkertijd staat deze wereld mijlenver van ons af. Toch zullen we op een of andere manier wel moeten, wil op termijn ons onderzoek voor ons land niet betekenisloos worden. We zullen onszelf van de noodzaak tot ondernemen moeten doordringen.

Toch denk ik dat er mogelijkheden te over zijn voor een - voor Nederland economisch relevante - micro-fabricage industrie. Het is het "More than Moore"-domein waar zich de komende jaren de echte micro-electronische revolutie zal voltrekken. Dit is de zeer innovatieve industrie die gebruik maakt van de technologieën uit de halfgeleiderindustrie om mechanische, chemische, biologische en medische systemen te miniaturiseren, zodat ze handzamer, beter en goedkoper worden. Het is bovendien minder kapitaalintensief, waardoor het ook voor kleine, startende bedrijven mogelijk wordt hierin een rol te spelen. Bovendien verkeren we in de gelukkige omstandigheid dat de Technische Universiteiten, met DIMES voorop, al in een vroeg stadium voor dit pad hebben gekozen en hierdoor nu op dit gebied een wereldreputatie hebben verworven. Een ideale uitgangspositie dus. We moeten het nu alleen ook nog daadwerkelijk doen en DIMES moet hierin een belangrijke rol spelen.

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