Smart lighting control:
First NFC configuration IC
with integrated CLO

NFC

eeNews

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Dear readers,

After a summer of record temperatures and lesser design activity, let September bring us back to full swing, with cooler days to read and ponder about the microelectronics' latest trends.

IoT security and AI are still battling for designers' attention, but energy harvesting and alternative power solutions are coming to the fore including in the aeronautical and automotive industries. This edition reports several such advances.

Other features covered in *eeNews Europe*'s September edition include progress made on the design of Microcontrollers and Microprocessors, now also enhanced with AI or by the use of exotic materials.

Enjoy this edition of *eeNews Europe* and don't hesitate to get in touch to tell us your stories, from starting up a company to developing your first prototypes, achieving your first product design-in, sharing your insight on this fast-paced industry or to contribute your expertise on some of the topics we'll be covering along the year.

Julien Happich
Editor in Chief

When refrigerators attack

By Alan Grau

Homes and businesses worldwide are vulnerable to attacks from cyber thieves and other bad actors – and not just through their computer networks. The embedded electronics inside appliances present an easy path of entry. It has already been happening. According to Business Insider and Proofpoint, one of the first refrigerator incidents occurred in late 2013 when a refrigerator-based botnet was used to attack businesses.

Some of these attacks, such as infecting appliances with botnet malware, don't really have much effect upon a family's security and safety. In fact, if a "smart" refrigerator gets infected by a bot, the homeowner might not even notice anything wrong.

However, connected-appliance based cyberattacks are not limited to just refrigerators – and they are rarely one-off incidents. Almost any type of appliance can be hacked and used to host a bo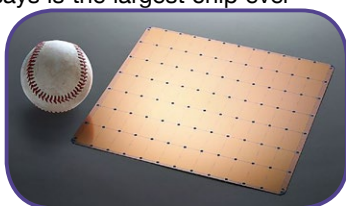tnet that could attack the web. According to Wired Magazine, a botnet of compromised water heaters, space heaters, air conditioners and other big power consuming home appliances, could suddenly turn on simultaneously, creating an immense power draw that could cripple the country's power grid.

A bot, quite simply, is an infected computer. Many cyberattacks, like the Mirai Malware and the Dyn attacks, infect a network of computers, including "smart" connected devices such as home appliances, security cameras, baby monitors, air conditioning/heating controls, televisions, etc., and turn them all into compromised servers. These compromised servers then act as nodes in an attack and together create a botnet. They can participate in a variety of coordinated attacks, infecting other devices and expanding the network of bots, or participating in Denial of Service attacks.

Without any apparent symptoms or notice, a criminally enhanced refrigerator could be generating and sending out thousands of attacks every minute. In addition to the homeowner or business manager never realizing what is going on, these attacks may be unstoppable unless the machine itself is disconnected from its web connection.

Additionally, the infected refrigerator could spread malware from the kitchen to the home's "smart" TVs, to the home's computer networks, to other smart devices in the home, and even to connected smart phones. Every target could be transformed into malicious bots that distribute millions of infected spam messages and cyber-attacks.

Alan Grau is VP of IoT, Embedded Solutions company Sectigo - www.sectigo.com

A bad actor or cyber criminal can send infected messages to a home or business network that targets various appliances or machines. Once infected, that machine is under the control of the bad actor and can be used to send out thousands of infected messages to new targets worldwide. The botnets can also send out millions of dummy messages to a single target – overwhelming it and putting it out of service.

Sectigo's IoT Manager locks down appliances and protects them against cyberattack.

So how do we combat this threat?

Unfortunately, end users really have no power to fix this problem. There is probably no way for a homeowner, office manager – or even an experienced refrigerator repair person – to talk to a refrigerator's electronics. No way to get into the appliance's software and middleware to identify and kill an infection. However, if the homeowner suspects an infection, they could disconnect the refrigerator from the its internet connection to make it "dumb" again.

It is up to device manufacturers to protect against these attacks

So how do manufacturers combat this type of attack? How can they ensure that appliances in homes and offices do not get infected to cause mayhem?

Security starts in the design process for the refrigerator itself, as well as for the appliances' various electronic components and control surfaces. Most appliance manufacturers get their control sub-assemblies from a wide network of smaller manufacturers, sometimes with a worldwide supply chain. These suppliers need to make sure that the chips and sub-assemblies they use are secure from hacks.

Two important security practices can be utilized by appliance makers:

Embedded firewall with blacklist and whitelist support – Protect appliances and edge devices from attacks by building firewall technology directly into the appliance. An embedded firewall can review incoming messages from the web or over the home network and, via a built in, and regularly updated blacklist, reject any that are not previously approved.

Secure remote updates and alerts – Validate that the firmware inside the device is authenticated and unmodified before permitting installation of any new firmware updates. Updates ensure the incoming software components have not been modified and are authenticated software downloads modules from the appliance manufacturer.

Most consumer and device manufacturers have heard about the potential for attacks on smart devices like door locks, baby monitors, and home thermostats, but this risk awareness needs to expand to types of connected systems – including appliances. An infected refrigerator sending out malware is not just a funny story. These systems have been attacked and used to spread malware. Ensuring the security of these devices is necessary to protect home network, slow the spread of malware and even protect credit card numbers or other personal data stored in smart home devices.

Shedding new light on NFC programming for LEDs
Using a PWM output to control analog LED-driver ICs directly

By Dr. Qi Zhu, Senior Business Development Manager, Infineon Technologies

In the LED market, more and more LED power suppliers to offer two novel functions: near-field communication (NFC) programming and constant lumen output (CLO). The NFC programming function is designed to replace the labor-intensive "plug-in resistor" current setting method to improve the flexibility across the value chain. Products with the CLO function can compensate for the luminous flux drop (aging effect) of the LED module by adjusting the LED current during the lifetime. Besides gaining customer satisfaction with improved lighting quality, this function is also beneficial for the environment since it reduces the total energy consumption by avoiding overcurrent for most of the lifetime.

However is there a cost-effective solution in NFC for lighting applications that can target the cost-sensitive middle- and low-end LED power supply markets? In this article, we expose a new concept from Infineon that offers full flexibility via NFC function to its customers' convenience.

The promise of NFC technology for lighting

NFC programming in LED luminaires is a relatively new concept. The term, NFC, refers to a set of communication protocols that enable devices to communicate wirelessly if they are in a near distance from each other. In the lighting world, it is used to set the operating characteristics of the LED luminaires wirelessly and mains-voltage freely. The transmitted parameters are pre-defined and configurable for a desired setting of the luminaire. It is faster and simpler than traditional LED programming ways and can enable more feature-rich and flexible LED driver products.

The system consists of an NFC reader (the hardware) and an NFC tag integrated into a driver. This NFC tag is responsible for data storage. The NFC reader is connected to a host PC. This PC instructs, and an application software controls the NFC reader to program the NFC tag wirelessly via NFC commands. The transmitted parameters are pre-defined and configurable in the application software based on the manufacturer's specifications for a desired setting of the luminaire.
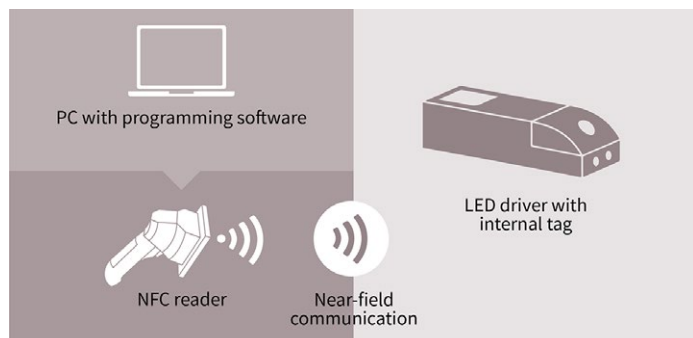
Figure 1 NFC programming of drivers – system overview

What makes NFC attractive for an LED-driver use case compared to other wireless communication technologies? Its unique characteristics, such as:
- The nature of the short-distance communication ensures that only objects at a defined physical position are con-

tacted and programmed. This feature is highly beneficial in the manufacturing environment, and can significantly reduce the complexity of the identification, and the authentication process.
- In a system that consists of an NFC reader and an NFC tag, the tag can operate passively (without an external power supply). The power is harvested from the RF field sent by the NFC reader. Thus, an object equipped with an NFC tag can be programmed in the assembly line without the need to connect to a power supply. It is a huge advantage that can improve operational efficiency.
- Operating in the globally available 13.56 MHz unlicensed radio frequency ISM band, and following well-defined standards allows for large-scale global rollouts.
- Its low data rate (106 to 424 kbit/s) and low frequency (13.56 MHz) reduce the complexity of the hardware design. A low-cost printed PCB antenna is sufficient for the application. Compared to other wireless communication technologies such as BLE, its hardware cost is relatively low.

Apart from technical advantages, there may be other benefits for all stakeholders across the LED-lighting value chain. For instance, a LED-driver vendor can set the product current level automatically in the manufacturing line to save labor cost, and even adjust it just before shipment to any warehouse worldwide. It provides supply chain flexibility and can save substantial logistic costs. The output tolerance level of an LED driver can also be significantly improved after taking in-production calibration. More important, your product gives more freedom and flexibility to your customers. Manufacturers can easily program the LED driver to match with the LED module. This makes it easier to change the vendor of the LED modules. Also, the light output can be more precisely controlled since the stepwise adjustment using plug-in resistor is replaced by a continuous adjustment using NFC programming. Logistic complexity – triggered by varying national standards - can also be reduced by doing shipment-destination-based NFC configuration.

At last but not at least, additional services are made possible at the installation stage. It is easy to set up any tailor-made lighting configuration that perfectly matches the user's specific needs. Now let's have a look at how NFC function is traditionally implemented in lighting systems.

The NFC-microcontroller concept

The existing implementation concept consists of a microcontroller and an NFC dynamic tag. Although this solution has its potential, it is expensive for the following reasons:
- The microcontroller itself and the additionally required passive components increase the overall component count
- A multi-layer PCB is needed (if the LED driver is using a single-layer or two-layer PCB, a separated daughter card is needed).
- In addition, to enable the microcontroller to operate, the user has to write firmware. It can be challenging for some manufacturers who lack the experience and knowledge in software writing or microcontroller firmware.
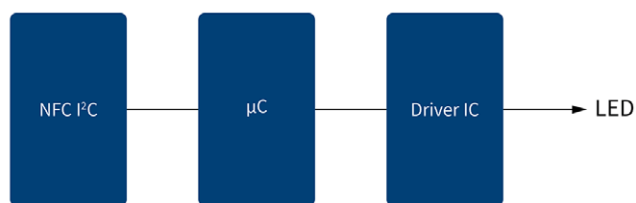
Figure 2 The NFC-microcontroller concept

So, is there a more compact solution that reduces component count, thus costs and still effective? This is where Infineon comes into place with its new NFC-PWM concept.

The new concept: the NFC-PWM series

This solution enables both NFC programming and CLO functions in analog systems using a featured NFC IC with PWM output to control the analog driver IC directly. Thus, the need for a microcontroller is eliminated.

Figure 3 Infineon's NFC-PWM concept

The system in a general setup consists of four parts: the antenna, the NFC IC, the RC filter, and the LED-driver IC.

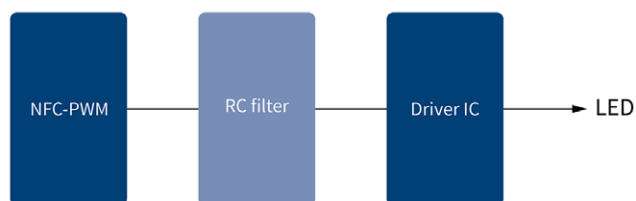How does this work? The working principle is simple. The configuration of the PWM parameters happens via a wireless NFC interface. While being powered, the chip generates a PWM output.
Then the PWM signal is converted (via the RC filter) to DC voltage to control the output current.
And finally, by adjusting the duty cycle of the PWM signal, it regulates the DC control voltage.
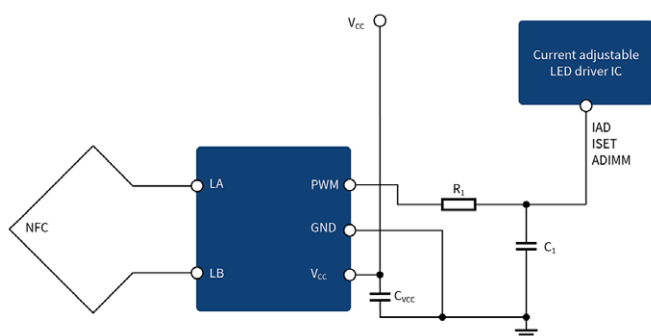
Figure 4 Application diagram

Being compatible with existing analog LED-driver designs and the NFC programming specification from the Module-Driver Interface Special Interest Group (MD-SIG), makes this new NFC-PWM concept a perfect fit for cost-sensitive segments.

The NFC-PWM method relies on dual-mode NFC configuration ICs (NLM0010 and NLM0011*) with PWM output primarily

designed for LED applications. In addition to the NFC programming advanced features like CLO, operating-time counting, and on/off counting are also integrated into the chips - without the need for any additional microcontroller or firmware development efforts.

The PWM parameters

The pulse width modulation (PWM) signal consists of three main components that define its behavior: an amplitude, a duty cycle, and a frequency. The duty cycle describes the amount of time the signal is in a high (on) state as a percentage of the total time it takes to complete one cycle. The frequency determines how fast the PWM completes a cycle. A simple RC filter can convert the PWM signal to a DC voltage. The level of the DC voltage is therefore adjustable by modifying the PWM amplitude or the PWM duty cycle and can be calculated as follows:

$$V_{target} = DC \times (V_{oh} - V_{ol}) + V_{ol}$$

Where DC is the duty cycle of the PWM, V_{oh} is the high voltage of the PWM output, and V_{ol} is the low voltage of PWM output.

Since the stability of the PWM signal has a direct influence on the tolerance level of the finished LED power supply, it is important to evaluate the tolerance requirement and the NFC IC capability at an early design stage. The critical NFC IC parameters are the duty cycle and the absolute PWM amplitude (Voh - Vol).

The products in the NFC-PWM series generate a PWM signal with a fixed amplitude at 2.8 V. Thanks to the integrated voltage regulator (LDO), the level and the stability of the external supply voltage does not influence the PWM amplitude. The duty cycle can be configured between 0% - 100% with an accuracy level better than 0.1 percent. The PWM resolution depends on the selected PWM frequency: 15 bit @ 1 kHz or 10 bit @ 30 kHz. Therefore, with Infineon's new NFC-PWM series, customers can achieve the required tolerance level without any significant design efforts. An extreme low tolerance level can be achieved by adding an in-production calibration step into the production test.

CLO implementation

The CLO is a quasi-control system (self-regulating system) that fights the natural degradation of the LEDs' light output trying to maintain the luminous flux constant by regulating the LED current.
The NLM0011 IC has an integrated 8-point CLO table to store the degradation curve of the LED module. Manufacturers can program this curve according to their needs. As soon as the CLO table is programmed, the duty cycle of the PWM signal is then automatically adjusted to compensate for the LED degradation. The actual duty cycle as a function of the actual runtime OTC is calculated by linear interpolation between two adjacent reference points. The IC is continuously counting the operation time (OTC function) and is continuously interpolating the duty-cycle correction factor, which is then multiplied with the nominal duty-cycle value to get actual duty-cycle value.
Being compatible with existing analog LED-driver designs and the NFC programming specification from the Module-Driver Interface Special Interest Group (MD-SIG) makes this new NFC-PWM concept a perfect fit for cost-sensitive segments.
An industry leader in power management, Infineon delivers solutions for next-generation LED lighting systems. For more information, please visit www.infineon.com/nfc-pwm.
* coming soon

1.2 trillion transistors on a wafer-scale chip

By Rich Pell

AI compute acceleration startup Cerebras Systems (Los Altos, CA) has unveiled what it says is the largest chip ever built, comprising more than 1.2 trillion transistors.

Measuring 46,225 mm^2 and optimized for AI work, the Cerebras Wafer Scale Engine (WSE) is 56.7 times larger than the largest graphics processing unit, which measures 815 mm^2 and hosts 21.1 billion transistors. The WSE contains 1.2 trillion transistors and 3,000 times more high speed, on-chip memory, and has 10,000 times more memory bandwidth.

"Designed from the ground up for AI work, the Cerebras WSE contains fundamental innovations that advance the state-of-the-art by solving decades-old technical challenges that limited chip size - such as cross-reticle connectivity, yield, power delivery, and packaging," says Andrew Feldman, founder and CEO of Cerebras Systems. "Every architectural decision was made to optimize performance for AI work. The result is that the Cerebras WSE delivers, depending on workload, hundreds or thousands of times the performance of existing solutions at a tiny fraction of the power draw and space."

In AI, says the company, chip size is profoundly important, with bigger chips being able to process information more quickly, producing answers in less time. Reducing the time-to-insight, or "training time" - a major bottleneck to industry-wide progress - allows researchers to test more ideas, use more data, and solve new problems.

The chip's performance gains are accomplished by accelerating all the elements of neural network training. A neural network is a multistage computational feedback loop. The faster inputs move through the loop, the faster the loop learns or "trains." The way to move inputs through the loop faster is to accelerate the calculation and communication within the loop.

With 56.7 times more silicon area than the largest graphics processing unit, the WSE provides more cores to do calculations and more memory closer to the cores so the cores can operate efficiently. Because this vast array of cores and memory are on a single chip, says the company, all communication is kept on-silicon providing breakthrough bandwidth so groups of cores can collaborate with maximum efficiency, and memory bandwidth is no longer a bottleneck.

The Cerebras WSE houses 400,000 AI-optimized, no-cache, no-overhead, compute cores and 18 gigabytes of local, distributed, superfast SRAM memory as the one and only level of the memory hierarchy. Memory bandwidth is 9 petabytes per second. The cores are linked together with a fine-grained, all-hardware, on-chip mesh-connected communication network that delivers an aggregate bandwidth of 100 petabits per second. More cores, more local memory, and a low latency high bandwidth fabric together create the optimal architecture for accelerating AI work, says the company. The WSE is manufactured by TSMC on its advanced 16-nm process technology.
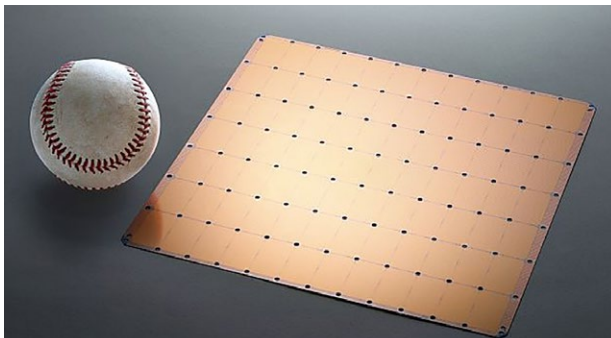
Sintered power electronics: Smaller yet more powerful

By Christoph Hammerschmidt

In addition to the electric motor and battery, a third component is crucial for the performance and range of electric vehicles: the power module. Continental has developed a new module that enables currents of up to 650 amps. A very coveted electric vehicle is already being equipped with it: The Jaguar Landrover I-Pace.

The current, third generation of the power electronics module delivers six times the power of the first generation in 2011, while the weight has been reduced from the original 12 kilograms to just 8 kilograms.

The technological highlight of power electronics is the special production process for the required semiconductors. In these, the conventional soldered wire connections have been replaced by sintering technology. Put simply, the contacts are baked together. The advantage: The double-sided sintered microchips in the power module offer significant advantages in terms of service life, reliability and thermal resilience. The Powertrain Division is using this technology for the first time in automotive electronics. As *eeNews Europe* learnt, Continental purchases the power transistors as bare dies from Infineon and refines them with its proprietary sintering process.

The robustness gained in this way is decisive, because the power module must provide the full current in fractions of a second. It also depends on this component whether the potential of the electric drive can be fully exploited. The electronic module not only supplies the electric machine with power, but also controls energy recovery (recuperation).

Jaguar Land Rover is a showcase customer for Continental's new power module: in the luxury car, this module provides vehement power delivery. Continental also cites the fact that the component has been adopted unchanged for the racing version of the vehicle, which will be launched in an international electric racing series, as proof of the exceptional performance of the power module. While such a technology transfer usually takes place from the racing cars to the production vehicles, in this case it is the other way around; high-performance production technology is used for racing purposes.

Bosch braces for massive job cuts, bets on fuel cell

By Christoph Hammerschmidt

The auto boom is over for the time being; suppliers are presenting bad figures in droves. Bosch, with more than 400,000 employees, is the world's largest automotive supplier. In an interview with daily paper Süddeutsche Zeitung, Bosch CEO Volkmar Denner explained which type of drive has the greatest future and what role AI plays for the company.

The current weakness of the global automotive market is by no means a short-term dent - for the next few years, the Bosch boss expects stagnation. "The development of diesel vehicles is hitting us particularly hard; the market share of diesel engines for passenger cars is declining sharply," Denner said in the interview. Bosch has a high market share in electrical and electronic equipment for diesel engines, both in passenger cars and trucks. But the recession is only affecting the passenger car sector, Denner said. Nevertheless, he expects significant job cuts. "It will have an impact on employees, especially in the diesel plants," said Denner.

Nevertheless, from Denner's perspective, the diesel engine is not a phase-out model. This engine type will continue to be superior to the gasoline engine in terms of fuel consumption and thus climate balance, he said. And what about the diesel scandal? "We have solved the nitrogen oxide problem of the diesel engine."

Even though the electric motor will come more to the fore in the future - the combustion engine will not die out so quickly, the Bosch boss was convinced. From market studies and discussions with major customers, he knew that 75% of all new cars in 2030 would still be equipped with a combustion engine - notwithstanding the statements of various OEMs that they would focus much more on electric drive in the future. This leads to the conclusion that many of the cars of the future will be equipped with a hybrid drive.

R&D focus on fuel cell

Nevertheless, Bosch is also working intensively on electric drives. After his disappointing experience with solid-state batteries and startup-company Seeo, which specializes in this technology, the electric giant's enthusiasm for battery-powered drives seems to have cooled somewhat. Denner spoke out in favour of open-ended and technology-neutral research in the field of electric drives and indicated a preference for fuel cell drives. "The electricity for the electric cars does not necessarily have to come from the battery, it can also be generated by a fuel cell," explained Denner. He also regards the fuel cell as an interesting alternative for air, ship and heavy goods traffic. The same applies to e-fuels (power-to-liquid).

Beyond the powertrain, Bosch is working intensively on AI and AI applications in vehicles and industry. At the forthcoming IAA motor show (September 12-22, Frankfurt, Germany), Bosch intends to present the first front camera that "understands what it sees". According to Denner, this camera will soon be installed in a series vehicle.

Russian physicist flies prototype hydrogen powertrain for electric aircraft

By Nick Flaherty

California-based startup ZeroAvia has emerged from stealth mode to test out a complete hydrogen powertrain for medium range electric aircraft.

The hydrogen power unit was tested in a six seat Piper aircraft. The company is developing the technology for 10 to 20 seat electric aircraft that will have a range of 500 miles to be in production by 2022, says Val Miftakhov, ZeroAvia Founder and CEO.

Russian physicist Miftakhov is a serial cleantech entrepreneur and pilot. He previously founded and was the CEO of eMotorWerks, and the team at ZeroAvia includes executives from Tesla, BMW, NVIDIA, Zee Aero, Air Liquide, and SystemIQ, as well as other founding members of eMotorWerks. The company is now raising $10m for the development, and suppliers of the fuel cell, electric motor, inverter and other parts of the hudrogen powertrain will be announced in the coming months.

"We are working with a supplier on this, not only sourcing the stack but working with the supplier to build on aviation variant for power profile," he said. "As you take these things to higher altitudes and colder temperatures there are more challenges in the oxygen supply so we are working with the stack manufacturer to make sure we can deliver the performance."

"Today our demonstrator Piper is at 260kW peak, delivered through two dual redundant sub units with – two inverters, two motors and two stacks with 150kW on each side. We will have at least dual redundancy in all our power units. Our commercial turbine will have 600 to 800kW power with dual redundancy which we will put into a 10 to 20 seat aircraft next year," he said.

The company plans to lease the drivetrain to customers and provide fuel and maintenance as part of its power-by-the-hour model, in which customers pay only for the hours that they use the drivetrain. This model emulates engine leasing options already popular in the aviation market.

"Using hydrogen produced from local renewable energy is the most practical way to enable zero-emission aircraft of commercially meaningful size on traditional 300 to 500-mile regional missions," he said. "It will also be more economical than conventional turbine engines, or even the battery-based systems, on the total cost basis. We calculate the total costs of operating a ZeroAvia aircraft to be close to half of what it costs to fly a conventional turbine aircraft, due to lower fuel input costs, higher powertrain efficiency, and reduced maintenance costs."

Porsche links VR infotainment and driving experience

By Christoph Hammerschmidt

Exploring the universe on the back seat of a car: As part of the Startup Autobahn Expo Day sports car manufacturer Porsche together with start-up company Holoride showcased what entertainment for passengers in the car could look like in the future. Above all, it shows how vehicle data and VR presentation can be linked with each other.

The aim of the joint project of Porsche and Holoride is to immerse the passengers of a car in virtual worlds of entertainment. To this end, VR glasses were

coupled with sensors in the vehicle, so that the audiovisual contents were adapted to the driving movements of the car in real time: If, for example, the car drives around a curve, the direction of the space shuttle in which one is located virtually in the presentation also changes. The result is a highly immersive experience that is even supposed to reduce the symptoms of travel sickness.

In the future, the system will also be able to evaluate navigation data and adapt the length of a VR game to the calculated driving time. The technology can also be used to integrate other entertainment offerings such as videos or virtual conferences for productivity in the passenger seat.

Nils Wollny, CEO of Holoride, founded the start-up in Munich at the end of 2018 together with Marcus Kühne and Daniel Profendiner. As part of the Startup Autobahn innovation platform, the company has now demonstrated that the Holoride software for motion-synchronous real-time generation of Virtual Reality (VR) and Cross Reality (XR) content works with manufacturers' vehicle data.

The holoride software makes it possible to offer "Elastic Content": a new form of media specially designed for use in vehicles. The content adapts to travel time, movement and context. The business model of the start-up follows an open platform approach, so that other car manufacturers and content producers can also benefit from this technology.

Over the next three years, Holoride plans to bring this new entertainment type to the markets using commercially available VR glasses for rear-seat passengers. With the further expansion of the Car-to-X infrastructure, traffic could also become part of the experience in the long term: Stops at traffic lights would then be visualized as unexpected obstacles in the action or would, for example, interrupt a learning program with a short intermediate quiz.

Car window panes double as digital interface

By Christoph Hammerschmidt

Today, around five square metres of glass are used in a modern car. But while many components, from interior mirrors with fatigue sensors to speedometer displays in 3D, already function as digitally networked high-tech components, the glass panes are large, digitally unused surfaces. Vehicle supplier Continental sees enormous potential here.

With a film technology developed by Continental, panoramic roofs can be darkened on command, part of the wind-shield can be tinted when the sun is low or the windows behind the B-pillar can be darkened in the rear seats for more privacy. The windows can even serve as displays:

"The window pane becomes an active, intelligent part of the vehicle," says Johann Hiebl, head of Continental's Body & Security and Infotainment & Connectivity business units. In addition to comfort and communication functions, the intelligent glass also opens up new energy-saving possibilities through darkening and heating functions – relevant for electromobiles in the first place.

The intelligent glass control works with special foils that are integrated into the glass and change their light transmission through electrical control signals. There are different technologies for this, but they have different advantages and disadvantages with regard to the optical quality or the speed at which the glass panes darken. Until now, such intelligent panes could mainly be used for panoramic roofs in the automotive environ-

ment. Continental chose Liquid Crystal (LC) technology in the first place, a technology that has long since established itself in the field of commercial displays.

The liquid crystals are aligned together with embedded colour particles by an alternating voltage in such a way that the screen darkens or brightens. This happens within milliseconds. According to Continental, in transparent mode the windows no longer show any visible residual turbidity. In addition, different colour schemes can be realized.

Controlled darkening of individual window panes offers more: More privacy protection and better air conditioning due to less heating of the interior. If the tinting function in the wind-shield is coupled with the vehicle electrical system and the cloud connection, areas of the wind-shield can be automatically darkened or brightened in good time depending on the weather conditions and the position of the sun. As a further example of application, the windows, networked with the locking system, could defrost immediately in winter when the driver approaches his car.

The intelligent glass could become even more important in a completely different function: Information from the driver assistance and infotainment systems could be displayed on a smart glass pane. The pane could also be turned into a smart display with touchscreen elements, according to the technology supplier's pioneers.

Re-imagining the electric vehicle with flat platforms

By Murray Slovick

The future looks bright for electric vehicles (EVs) despite the fact that each platform can cost manufacturers billions to design, test, and build. What's more, carmakers often struggle to recoup these costs through pricing alone, as EVs are still built in low numbers compared to ICE vehicles. Thus, cost amortization is higher per unit.

Nevertheless, carmakers plan to grow their portfolio of electrified vehicles and they have a tailwind: Stringent fuel-economy and emissions policies are a big stimuli for OEM EV investments.

But can the development costs inherent in designing and building an EV be reduced? Israeli startup REE thinks so—the company has unveiled a flat, modular reference platform aimed at decreasing both the design effort and cost of manufacturing EVs.

REE's approach strategically places the motor, steering, suspension, drivetrain, sensing, brakes, thermal systems, and electronics into the wheels, creating a truly flat platform.

This design provides a low center of gravity to maximize efficiency and supports the vehicle's agility and stability. REE's innovation reduces the vehicle's footprint and weight, and improves both energy efficiency and performance—aspects crucial to the electric- and autonomous-vehicle revolution. REE's

REE's flat, modular platform trims EV footprint and weight. (Source: REE)

EV platform also enables better packaging of interior cabin space, motors, and battery packs without compromising safety.

The system uses four motors, steer-by-wire, a quad gear box, and an integrated suspension that automatically senses and levels the height at each wheel. Having individual motors in each wheel also creates the possibility of employing advanced torque vectoring, a method of power transfer that would improve both safety and handling.

The adaptation of REE's universal framework will replace multiple platforms for OEMs, likely resulting in substantial savings. By enabling carmakers to utilize one platform for all of their electric vehicles, REE claims costs will be slashed while performance, safety, comfort, and energy efficiency will all improve.

The platform, REE says, offers automotive manufacturers multiple body configurations. It would provide the basis for vehicles ranging from high-performance cars to off-road SUVs with active suspension technology and even heavy-duty trucks.

The modular design, the company adds, provides a low center of gravity, thereby maximizing energy efficiency, increasing agility and stability, and improving performance. Once again, these are critical factors in the future success of the electric- and autonomous-vehicle revolution.

By integrating components formerly found under the hood of the car into the wheels, REE's solution also reduces vehicle size and weight. "The concepts of the past are limited and restrict the ability of the automotive industry to realize the electric and autonomous reality they are striving for," says Daniel Barel, CEO and co-founder (with Avishay Sardes) of REE. "Until now, the industry has operated by making incremental improvements on the traditional design of the automotive vehicle. At REE, we believe that in order to hasten the automotive revolution, we need to reinvent the wheel—quite literally."

Barel and Sardes are also the founders of SoftWheel, theTel Aviv, Israel company behind an in-wheel suspension system for use in wheelchairs, bicycles, and in the automotive
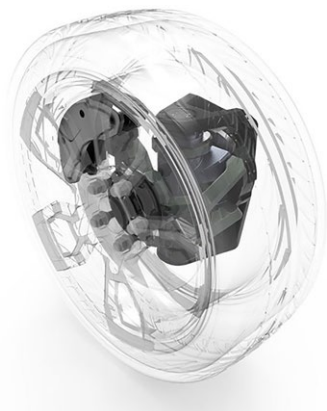
The motor, steering, suspension, brakes, and electronics are all placed into the wheel. (Source: REE).

sector. SoftWheel's technology improves performance by using suspension arms set equidistant around a central hub to provide shock absorption, no matter the angle of impact from an obstacle. The suspension system actuates only when an obstacle or rough terrain is encountered, immediately returning the vehicle and rider to a level ride.

Going forward, REE reports it's already collaborating with major automotive industry partners including Mitsubishi Corp., Musashi Seimitsu Industry (a Tier1 global auto parts supplier), Tenneco, American Axle, Fiat Chrysler Automobiles, and bearing manufacturer NSK.

This article first appeared on Electronic Design - www.electronicdesign.com

Wearable technology seeks new materials

By Antonios Oikonomou

Created in 1780, the world's first pedometer was developed using an earlier mechanism of a self-winding watch. Technology to ensure we meet those all-important 10,000 steps has come a long way since then, but the wearable technology market for health and fitness is constantly looking for new materials, to continue development and innovation.

Dubbed as the 'year of wearables', 2014 witnessed a surge in wearable technology for health applications and, since then, the rate at which products are released has not slowed down. According to a report by Euromonitor, units of wearable technology are projected to exceed 305 million by 2020, with a compound annual growth rate (CAGR) of 55 per cent.

Health and fitness are amongst the most successful application areas for wearable technology. Research by Gartner states that worldwide shipments of wearable devices will reach 225 million in 2019, an increase of 25.8 per cent from 2018. However, despite an increase in sales, the technological advancements of wearable healthcare devices have decelerated.

Take fitness tracking as an example. While there have been a huge number of products released, such as smart watches, activity bands and clip-on trackers, there has been little development in technology beyond style, design and aesthetics.

Smarter wearable devices, such as those that can be weaved into clothing, implanted in shoes or concealed on the wearers skin, are only now being developed into marketable products. For instance, Graphene Flagship partner ICFO designed wearable health tracker, that is flexible, transparent and disposable, rather than a typical watch-style design. This patch has the

Sole-shaped screen-printed graphene-based force sensors from CamsmartTechnologies.

potential, in the future, to accurately monitor several aspects of the wearer's bodily functions, including heart rate, hydration, oxygen saturation, breathing rate and temperature.

As a smaller device, it would be easy to assume it is less powerful than its wrist-based predecessors. However, by using optical sensors exploiting graphene, the transdermal fitness patch surpasses the current limitations of existing fitness trackers, with improved accuracy. This is thanks to a combination of optoelectronic and mechanical properties.

Gait analysis, another area of fitness which is already using wearable technology, is also being improved with the integration of graphene. Pressure sensing insoles are not a new phenomenon. However, lightweight graphene-embedded foam could allow for these to be integrated into any type of shoe. This was demonstrated by a prototype developed by Graphene Flagship researchers at the University of Cambridge, and showcased with an interactive prototype at the 2019 Mobile Word Congress, whereby users could control a snowboarding avatar on a screen.

Giving runners greater freedom to use these insoles during personal training, thanks to ease of adding or removing insoles from shoes, this technology could allow for better insight into running techniques. For sportspeople and athletes, this would allow continuous monitoring of any biomechanical abnormalities in their gait cycle, helping to improve technique and avoid injury.

We have come a long way since the early examples of pedometers for counting steps. Wearables for the health and fitness market are in high demand. However, in order to improve their performance and capabilities, product designers must begin experimenting with new advanced materials, such as graphene and related materials.
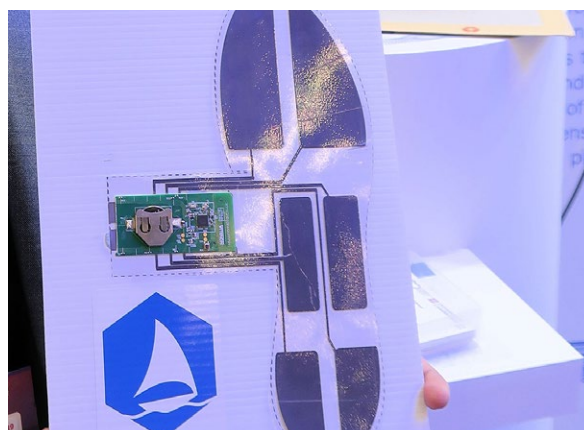
Antonios Oikonomou is Business Developer for Wearables and Optoelectronics at the Graphene Flagship - https://graphene-flagship.eu

Swiss event-based vision startup launches next-gen chip

By Peter Clarke

Event-based machine vision system developer Insightness AG (Zurich, Switzerland) has announced its second image sensor, the SiliconEye 2.

Insightness appears to provide a point of differentiation from similar event-based vision companies by allowing both event-based sparse data capture and traditional high-resolution images on the same pixel grid. The companies state the two modalities share the same pixel grid and can co-exist without interference.

This has the advantage of allowing traditional advance photo system (APS) computer vision software on frames while also allowing low-latency low power, low light event capture.

Insightness is aiming its chips and sensors at spatial aware-

ness for mobile devices, drones and robots and applications in augmented reality.

The company develops biologically-inspired vision sensor chips that contain smart pixels that compress information in the pixel thereby saving time, power and computation.

The SiliconEye 2 offers a resolution of 1,024 by 768 pixels, greyscale and global shuttering as well as event capture. The chip is in a stacked back-side illuminated (BSI) manufacturing process with pixels on a 7.2-micron pitch. The chip has a 1-inch by 1.7-inch form factor.

The Rino 4 sensor based on the SiliconEye is available in the 3Q19. Insightness was founded in 2014 by PhD students as a spin-off from University of Zurich and ETH Zurich.
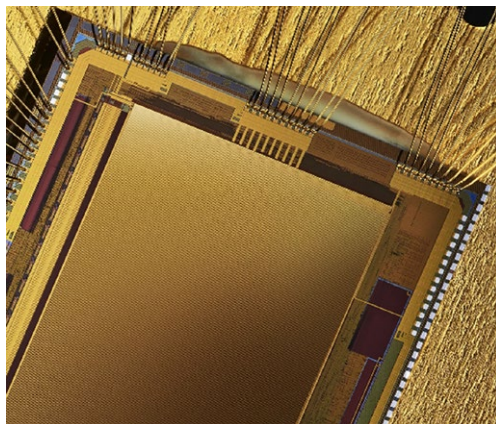
Bio-inspired compound eye to improve 3D object tracking

By Julien Happich

Researchers from Tianjin University in China have designed a biologically inspired compound eye offering unprecedented 3D location accuracy by analyzing light location and intensity distribution.

They created a dome light cone about 20mm in diameter and sporting 169 microlenses on its surface, each with a radius of about 1mm. The conical structure also integrated of a lot of optical fibre wires, 6μm in diameter, and object image capture was combined with a purposely developed algorithm.

Because the fields of view of adjacent microlenses overlap in the same way that ommatidia do for most insects, the compound eye obtained can detect objects from a 90° field of view. ,

The work was presented in the Optics Letters in a paper titled "Detection of three-dimensional trajectory of object based on curved bionic compound eye", evaluating together the effect of the illumination intensity, the position of the target's center, and the non-repeatability and reporting a relative standard uncertainty in 3D positioning at only 8.6%.

"Imitating the vision system of insects has led us to believe that they might detect the trajectory of an object based on the light intensity coming from that object rather than using precise images like human vision," explained Le Song, a member of the research team. "This motion-detection method requires less information, allowing the insect to quickly react to a threat."

One of the challenges in making an artificial compound eye is

that image detectors are flat while the surface of the compound eye is curved. Placing a light guide between the curved lens and an image detector allowed the researchers to overcome this challenge while also enabling the component to receive light from different angles uniformly.

"This uniform light receiving ability of our bio-inspired compound eye is more similar to biological compound eyes and better imitates the biological mechanism than previous attempts at replicating a compound eye," explained Song.

To use the artificial compound eye for measuring 3D trajectory, the researchers added grids to each eyelet that help pinpoint location. They then placed LED light sources at known distances and directions from the compound eye and used an algorithm to calculate the 3D location of the LEDs based on the location and intensity of the light. The researchers found that the compound eye system was able to rapidly provide the 3D location of an object. However, the loca-

A curved compound lens containing 169 microlenses on the surface. Credit: Le Song, Tianjin University

tion accuracy was reduced when the light sources were farther away, which could explain why most insects are near-sighted.

Such bio-inspired compound eyes able to detect an object's 3D location could be useful for small robots requiring fast detection from a very lightweight system. Next, the researchers aim to embed the localization algorithm into integrated circuits to allow the system to be incorporated into other devices. They are also developing ways to mass produce the compound eye lenses to reduce the unit cost.

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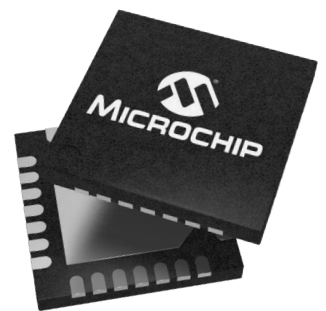
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New OLED chemistry has tunable chirality for brighter output

By Julien Happich

Researchers from the Departments of Physics and Chemistry at Imperial College have managed to control the chemistry of OLED materials so as to control the chirality of the light emitting polymers, hence controlling the polarization of the light output.

Presenting their findings in a paper titled 'Inverting the Handedness of Circularly Polarized Luminescence from Light-Emitting Polymers Using Film Thickness' published in ACS Nano, the researchers report that blending achiral polymers with chiral small-molecule additives in the new polymer OLEDs chemistry allowed them to control the handedness/sign of the circularly polarized light through absolute stereochemistry. Another interesting finding is that tuning the circularly polarized light output was performed as a function of the active layer thickness, for a fixed optical isomer of the chiral additive.

The paper reports bright circularly polarized polymer OLEDs (CP-PLEDs) capable of delivering 8000 cd/m^2 with an effi-

ciency of 4.0 cd/A and a high dissymmetry of emission of both left-handed (LH) and right-handed (RH) light, depending on the emitter's thickness. In th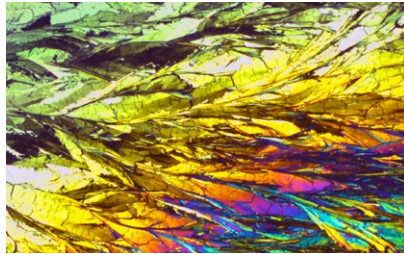eir experiments and using the same additive, varying the film thickness from 110nm to 160nm was enough to switch the handedness of the polarized light.

The implications for OLED displays is important, as typically, over half of the light they emit is blocked by the polarized anti-glare filter fitted onto the screens of smartphones and TVs. Engineering OLEDs with a precisely controlled circularly polarized light output to match the polarization of the anti-glare filter would yield an overall much brighter display or one that would have double the energy efficiency for the same brightness while maintaining a good readability even on a bright sunny day.

While their study was focused on OLEDs for displays, the team anticipates that the new chemistry and the polarised light generated by their materials could also find applications in the storage, transmission and encryption of information through the design of new photonic devices.

Blue OLED chemistry emits efficiently below bandgap voltage

By Julien Happich

Leveraging specially crafted organic molecules with a large singlet-triplet splitting, researchers from North Carolina State University demonstrated blue OLED chemistries able to form triplet excitons via direct charge injection.

Through subsequent triplet fusion, this allows the organic molecules to become electroluminescent below bandgap voltages, close to their triplet energy, yielding OLEDs operating with a low driving voltage.

The researchers disclosed their results in a Nature Communications paper titled "Realization of high-efficiency fluorescent organic light-emitting diodes with low driving voltage", reporting a blue fluorescent OLED more power efficient than some of the best thermally activated

delayed fluorescent (TADF) and phosphorescent blue OLEDs reported so far, in spite of a lower quantum efficiency. The deep blue fluorescent OLED tested in the study exhibited a sub-bandgap turn-on voltage of 2.4V, with luminances of 100 cd/m^2 and 1000 cd/m^2 at 2.9 and 3.4 V, respectively. As a comparison, 3.4V is still less than 50% of the voltage required by other tested blue OLEDs, the authors highlight, hinting that the novel OLEDs could drastically reduce power consumption for a given brightness.

The research, led by Nextgen Nano's New Fusion division at the NCSU laboratory, means that future OLED display applications could provide superior levels of luminosity while using half the energy, which would also extend the operational life of the device.
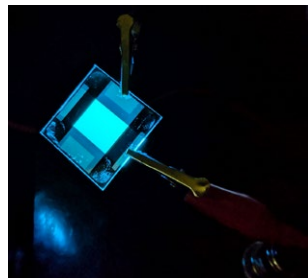
Startup raises $4.3 million to miniaturize solid-state lidar

By Peter Clarke

Voyant Photonics Inc. (New York) has raised $4.3 million to develop its silicon photonics approach to lidar. The money has come from Contour Venture Partners, LDV Capital, NEU Venture Capital and DARPA, according to reports.

Voyant was founded in April 2018 by Chris Phare, CEO, and Steven Miller, CTO, who had both been PhD graduates from Cornell University and visiting researchers at Columbia University specializing in nano-optics. Miller's research has focused on integrated non-linear optical frequency combs generated in on-chip micro-resonators.
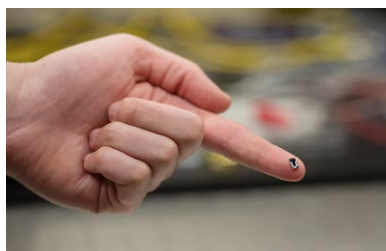
The company has already produced a silicon optical phased array that operates with infrared light but changes the phase of the light travelling through waveguides on the chip. The result is a beam of non-visible light that can illuminate a wide swathe of the environment at high speed without moving parts.

Many existing lidars use time-of-flight at 905nm wavelength but suffer range limitations due to eye-safety considerations as well as concerns about multi-user crosstalk. These problems can be avoided using frequency modulated continuous wave (FMCW) lidar on a chip designed to operate at 1550nm wavelength.

Creating nano light emitters out of monolayer MoS$_2$

By Julien Happich

An international team headed up by Alexander Holleitner and Jonathan Finley, physicists at the Technical University of Munich (TUM), has succeeded in placing light sources in atomically thin material layers with an accuracy of just a few nanometers.

Described in a paper titled "Site-selectively generated photon emitters in monolayer MoS$_2$ via local helium ion irradiation" published in Nature Communications, the new method allows for a multitude of applications in quantum technologies, from quantum sensors and transistors in smartphones through to new encryption technologies for data transmission.

Previous circuits on chips rely on electrons as the information carriers. In the future, photons which transmit information at the speed of light will be able to take on this task in optical circuits. Quantum light sources, which are then connected with quantum fiber optic cables and detectors are needed as basic building blocks for such new chips.

Here, the quantum light sources were created in atomically thin material layers through localized irradiation, with nanometer accuracy.

"This constitutes a first key step towards optical quantum computers," said Julian Klein, lead author of the study. "Because for future applications the light sources must be coupled with photon circuits, waveguides for example, in order to make light-based quantum calculations possible."
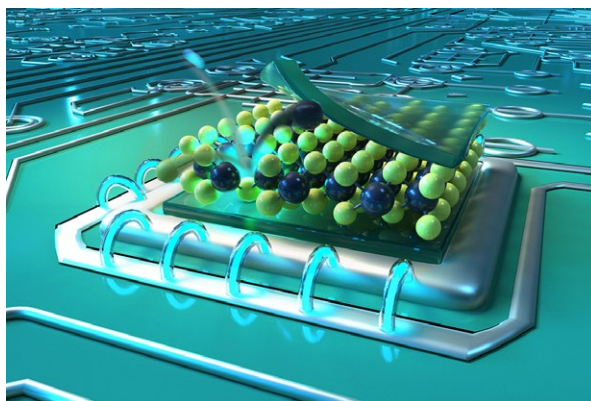
The critical point here is the exact and precisely controllable placement of the light sources. It is possible to create quantum light sources in conventional three-dimensional materials such as diamond or silicon, but they cannot be precisely placed in these materials.

The physicists used a layer of the semiconductor molybdenum disulfide (MoS$_2$) as the starting material, just three atoms thick. They irradiated this with a helium ion beam which they focused on a surface area of less than one nanometer. In order to generate optically active defects, the desired quantum light sources, molybdenum or sulfur atoms are precisely hammered out of the layer. The imperfections are traps for so-called excitons, electron-hole pairs, which then emit the desired photons.

Technically, the new helium ion microscope at the Walter Schottky Institute's Center for Nanotechnology and Nanomaterials, which can be used to irradiate such material with an unparalleled lateral resolution, was of central importance for this.

Together with theorists at TUM, the Max Planck Society, and the University of Bremen, the team developed a model which also describes the energy states observed at the imperfections in theory.

In the future, the researchers also want to create more complex light source patterns, in lateral two-dimensional lattice structures for example, in order to thus also research multi-exciton phenomena or exotic material properties.

Since the light sources always have the same underlying defect in the material, they are theoretically indistinguishable. This allows for applications which are based on the quantum-mechanical principle of entanglement.

"It is possible to integrate our quantum light sources very elegantly into photon circuits," says Klein. "Owing to the high sensitivity, for example, it is possible to build quantum sensors for smartphones and develop extremely secure encryption technologies for data transmission."

Atomically-thin LED scales across large areas

By Julien Happich

Researchers at the Duisburg-Essen University have leveraged the direct bandgap of atomically thin transition metal dichalcogenides (here WS$_2$) to design low-power red emitting LEDs which they say could be designed as large area emitters. Their paper "Scalable Large-Area p–i–n Light-Emitting Diodes Based on WS$_2$.

Monolayers Grown via MOCVD" published in the ACS Photonics journal describes a vertical p–i–n device architecture using organic and inorganic injection layers on the anode and the cathode side, respectively, sandwiching WS$_2$ monolayers as the active region. They report red electroluminescence (at 619.5 ± 0.9nm) from an active area of 6mm^2 starting already at a driving voltage of about 2.5V.

The novelty is the scalability of their process, using an industrially relevant and reproducible deposition approach in a commercial horizontal multi-wafer AIXTRON MOCVD reactor. Deposited on a 2-inch sapphire wafer, the 0.7nm thick WS$_2$ monolayers could be used to manufacture large area vertically-emitting devices, reaching a luminance of almost 1cd/m^2 at 7V.

The paper also reports that operating the LED in pulsed electroluminescent mode reduces heat dissipation, enhancing the device efficiency by a factor of almost 4.

Glass coated with indium tin oxide (ITO) is used as the anode material, with poly(3,4-ethylenedioxythiophene):poly-(styrenesulfonate) (PEDOT:PSS) as a hole injection layer, and poly[N,N′-bis(butylphenyl)-N,N-bis(phenyl)benzidine] (poly-TPD) as organic hole transport layer. On the cathode side, a ZnO quantum dot (ZnO-QD) layer serves as the electron injection layer on an aluminium cathode.
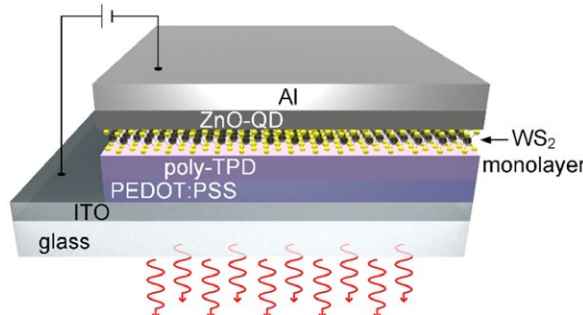
Optical waveguide is atomically-thin

By Julien Happich

Researchers at the University of California - San Diego, have developed what they claim to be the thinnest optical device in the world, a waveguide only three layers of atoms thin.

The work is a proof of concept for scaling down optical devices to sizes that are orders of magnitude smaller than today's devices. It could lead to the development of higher density, higher capacity photonic chips.

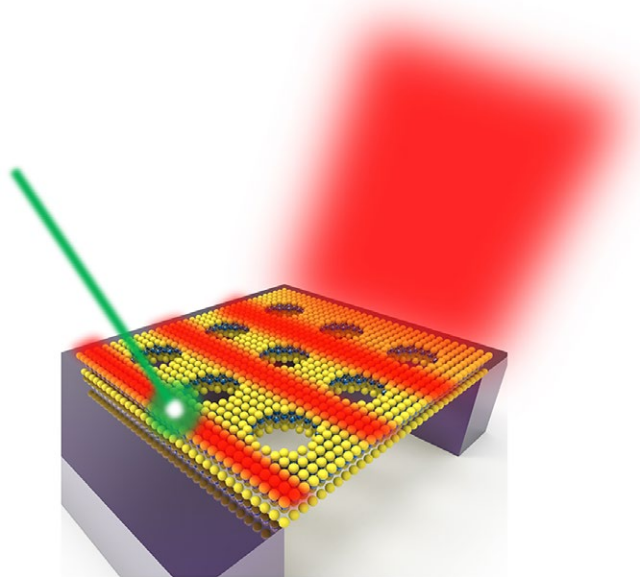Illustration of a monolayer of tungsten disulfide crystal suspended in air and patterned with a square array of nanoholes. Upon laser excitation, the monolayer crystal emits photoluminescence. A portion of this light couples into the monolayer crystal and is guided along the material. At the nanohole array, periodic modulation in the refractive index causes a small portion of the light to decay out of the plane of the material, allowing the light to be observed as guided mode resonance. Credit: Cubukcu lab

The new waveguide measures about six angstroms thin—that is more than 10,000 times thinner than a typical optical fiber and about 500 times thinner than on-chip optical waveguides in integrated photonic circuits. It consists of a tungsten disulfide monolayer (made up of one layer of tungsten atoms sandwiched between two layers of sulfur atoms) suspended on a silicon frame. The monolayer is also patterned with an array of nanosized holes forming a photonic crystal.

"Fundamentally, we demonstrate the ultimate limit for how thin an optical waveguide can be built," said senior author Ertugrul Cubukcu, a professor of nanoengineering and electrical engineering at UC San Diego.

What's special about this monolayer crystal is that it supports electron-hole pairs, known as excitons, at room temperature. These excitons generate a strong optical response, giving the crystal a refractive index that is about four times greater than that of air, which surrounds its surfaces. By comparison, another material with the same thickness would not have as
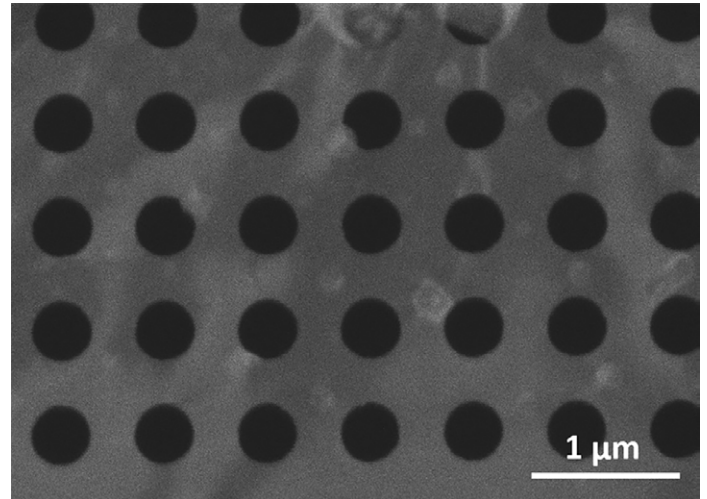
SEM image of the waveguide structure: a suspended tungsten disulfide monoloayer patterned with nanosized holes. Credit: Cubukcu lab.

high of a refractive index. When light is sent through the crystal, it is trapped inside and guided along the plane by total internal reflection. This is the basic mechanism for how an optical waveguide works.

Another special feature is that the waveguide channels light in the visible spectrum. "This is challenging to do in a material this thin," Cubukcu said. "Waveguiding has previously been demonstrated with graphene, which is also atomically thin, but at infrared wavelengths. We've demonstrated for the first time waveguiding in the visible region."

Nanosized holes etched into the crystal allow some light to scatter perpendicular to the plane so that it can be observed and probed. This array of holes produces a periodic structure that makes the crystal double as a resonator as well.

"This also makes it the thinnest optical resonator for visible light ever to be demonstrated experimentally," said first author Xingwang Zhang, who worked on this project as a postdoctoral researcher in Cubukcu's lab at UC San Diego. "This system does not only resonantly enhance the light-matter interaction, but also serves as a second-order grating coupler to couple the light into the optical waveguide."

Advanced micro- and nanofabrication techniques were used to create the waveguide. The process starts with a thin silicon nitride membrane supported by a silicon frame. This is the substrate upon which the waveguide is built. Then an array of nanosized holes is patterned into the membrane to create a template. Next, a monolayer of tungsten disulfide crystal is stamped onto the membrane. Ions are then sent through the membrane to etch the same pattern of holes into the crystal. In the last step, the silicon nitride membrane is gently etched away, leaving the crystal suspended on the silicon frame. The result is an optical waveguide in which the core consists of a monolayer tungsten disulfide photonic crystal surrounded by a material (air) with a lower refractive index.
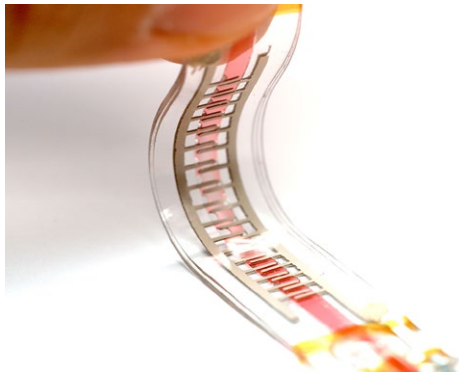
Moving forward, the team will continue to explore the fundamental properties and physics pertaining to the waveguide.

Stretchable pump powers lightweight soft robots

By Julien Happich

Researchers at EPFL have developed a tiny flexible and stretchable pump that could be used in the development of autonomous soft robots, lightweight exoskeletons and smart clothing. Flexible, silent and weighing only one gram, the tiny pump could replace the rigid, noisy and bulky pumps currently used in soft robotics.

Bending the pump © Vito Cacucciolo / 2019 EPFL

Publishing their results in Nature under the title "Stretchable pumps for soft machines", the scientists created the soft flexible pumps to eliminate the rigid pumps tethered so far to soft robots.

Soft robots have a distinct advantage over their rigid forebears: they can adapt to complex environments, handle fragile objects and interact safely with humans. Made from silicone, rubber or other stretchable polymers, they are ideal for use in rehabilitation exoskeletons and robotic clothing. Soft bio-inspired robots could one day be deployed to explore remote or dangerous environments.

In the new pump design, even the electrodes are flexible. The pump is completely silent and consumes very little power, which it gets from a 20x20mm circuit that includes a rechargeable battery.

"If we want to actuate larger robots, we connect several pumps together," explains Herbert Shea, director of EPFL's Soft Transducers Laboratory (LMTS). Soft pumps can also be used to circulate liquids in thin flexible tubes embedded in smart clothing, leading to garments that can actively cool or heat different regions of the body. That would meet the needs of surgeons, athletes and pilots, for example.

The soft and stretchable pump is based on the physical mechanism used today to

A flexible pump integrated to actuate a soft robotic finger © Vito Cacucciolo / 2019 EPFL

circulate the cooling liquid in systems like supercomputers. The pump has a tube-shaped channel, 1mm in diameter, inside of which rows of electrodes are printed. The pump is filled with a dielectric liquid. When a voltage is applied, electrons jump from the electrodes to the liquid, giving some of the molecules an electrical charge. These molecules are subsequently attracted to other electrodes, pulling along the rest of the fluid through the tube with them.

"We can speed up the flow by adjusting the electric field, yet it remains completely silent," says Vito Cacucciolo, a post-doc at the LMTS and lead author of the study.

The researchers have successfully implanted their pump in a type of robotic finger widely used in soft robotics labs. They are now collaborating with Koichi Suzumori's laboratory in Japan, which is developing fluid-driven artificial muscles and flexible exoskeletons.

The EPFL team has also fitted a fabric glove with tubes and shown that it is possible to heat or cool regions of the glove as desired using the pump. "It works a little like your home heating and cooling system" says Cacucciolo. This application has already sparked interest from a number of companies.

Intelligent textiles transmit data in the smart home

By Christoph Hammerschmidt

The basic principle of intelligent living environments is to install technical systems wherever they are needed in the home. However, the necessary power and communication connections are not always available. In the ConText research and development project, scientists are developing a user-friendly and intuitive technology for intelligent textiles with surfaces that make walls and floors in living areas usable for cable-based power supply and communication.

Thanks to the Internet of Things, residential objects can now be interconnected in such a way that they make our everyday lives easier in many ways. In general, however, private households lack comprehensive low-voltage and communication connections in order to install IoT devices such as temperature sensors, microphones or light signals at any desired location. In order to supply the systems with electricity, ecologically questionable and failure-prone batteries or unattractive power cables are used today. In addition, the devices require energy-intensive and interference-prone radio technologies for communication with each other. The joint project ConText, which has now been launched, aims at a flexible, user-oriented and intuitive system based on intelligent textiles that can be installed easily and without great effort in the living area.

To this end, partners from industry and research are developing an IoT infrastructure of smart wallpapers, carpets and textile surfaces, so-called Connecting Textiles, under the coordination of the German AI research institute DFKI with its research areas Cyber-Physical Systems and Interactive Textiles. IoT devices can not only be supplied with low power via these surfaces based on wires, but can also communicate with each other via standardized smart home protocols. The devices can be attached to the Connecting Textiles by the users themselves according to their individual requirements, e.g. by simple gluing, stapling or plugging. In addition, electronic textiles enable new, intuitive interaction possibilities, e.g. haptic interaction patterns such as pressing or painting, which can be used to control and configure the devices.

The research focus of the DFKI research area Cyber-Physical Systems under Dr. Rolf Drechsler lies in the fields of software and hardware design, verification of electronic systems and information security. Accordingly, the DFKI scientists in ConText are responsible for providing a secure communication infrastructure for electronic textiles that enables robust and reliable communication between smart home centres and IoT components. In the context of the project, data integrity and state-of-the-art encryption play a paramount role. The developed infrastructure should be open for different Smart Home protocols and support the simple connection of any IoT device.

In addition, the researchers in the project are developing software that uses artificial intelligence to recognize basic patterns of gesture interactions on textile surfaces and thus enables intuitive control and configuration of smart home devices. Residents will also be able to define their own control gestures and interaction sequences.

AI makes sense of taste to classify liquids

By Julien Happich

Scientists at IBM research have trained machine learning algorithms with potentiometry data from an array of multi-analyte electrochemical sensors being dipped into various liquids. The idea being that as for the human sense of taste, a sensing device could rely on the ability of few individual sensors to respond simultaneously to different chemicals (combinatorial sensing) to get a holistic sensing pattern or a global fingerprint of the liquid being tested (or tasted).

Dubbed Hypertaste, the small lime-slice shaped AI-assisted e-tongue packs an array of electropolymerized ion-sensitive films with a microcontroller for data acquisition. When the Hypertaste device is clipped on the side of a glass, the sensor's electrodes dip into the liquid to be tasted and a series of differential voltages can be recorded, collectively yielding a unique signature – the liquid's fingerprint - to be analyzed and classified on the cloud by a trained AI algorithm. That digital fingerprint can then be compared to a database of known liquids, and the algorithm figures out which liquids in the database are most chemically similar to the liquid being tasted.

The new approach was presented at the 2019 ISOCS/IEEE International Symposium on Olfaction and Electronic Nose (ISOEN) in a paper titled "A portable potentiometric electronic tongue leveraging smartphone and cloud platforms". The researchers report that for trained systems, inferencing tasks such as the classification of liquids are realized within less than one minute including data acquisition at the edge and inference using a cloud-deployed machine learning model.

IBM Research believes the low-cost Hypertaste could serve a wide range of industrial and scientific users be it for on-the-fly water quality checks or enabling beverage producers to identify counterfeit products or check raw materials. The quick, in-situ identification and classification of liquids would also be relevant to the pharmaceutical and healthcare industries.

Here, one big advantage of having the machine learning models running on the cloud is that the sensors could be rapidly reconfigured from anywhere without changing the hardware. Only a few changes of parameters in the machine learning models would make them adjust to the new sensor set. Crowdsourcing sensing data through field-deployed connected sensors would further reinforce the learning.

As emphasized by the researchers, fooling a combinatorial sensing system such as Hypertaste is much harder than fooling individual analyte-specific lab tests, as there is no single substance on which the identification relies.
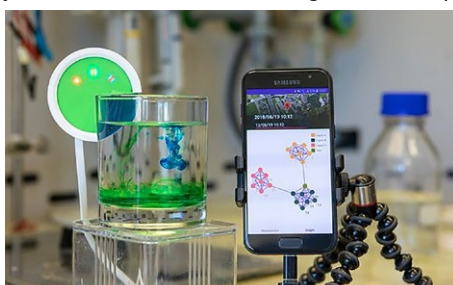
Haptic actuator goes roll-to-roll

By Peter Clarke

Senseg Oy (Espoo, Finland) has launched a range of elastomeric film actuators (ELFIAC) that can be manufactured roll-to-roll. The ELFIAC system has potential application in soft robotics, VR/AR devices, and interior integrated sensors, the company claims. It can also be used as the basis of a pressure sensor.

ELFIAC is a flexible actuator composed of insulated electrode films separated by silicone elastomer spacers, or pillars, that act like miniature springs. A high voltage, low current signal is driven to alternating electrodes while the remaining electrodes are kept at ground level. This causes the system to compress due to electrostatic attraction between electrodes on different film layers.

The actuation is a displacement of up to 20 percent of stack thickness and includes good low-frequency performance. Sensor size ranges from less than 1 square centimetre to very large and with thicknesses as low as 0.1mm. Operating voltage starts at a couple of hundred volts. The materials are flexible and can be roll-to-roll manufactured and put into any shape, flat or curved.

In addition, the materials are less expensive to produce than traditional piezo-electric actuators and use cheaper non-toxic materials, the company said.

The Senseg ELFIAC system is completed by the S220 high voltage driver chip, developed by Senseg with STMicroelectronics.

"With ELFIAC, Senseg is solving the problems of cost and materials usage in actuators, without degrading the experience," said Ramon Llamas, a research director at IDC, in a statement issued by Senseg. "This is a key component to the next wave of smart compute devices that are expected to perform rigorous functions while still delivering the types of experiences resident on other, more traditional, hardware."

Senseg was founded in 2006 and acquired by O-Film in February 2016.
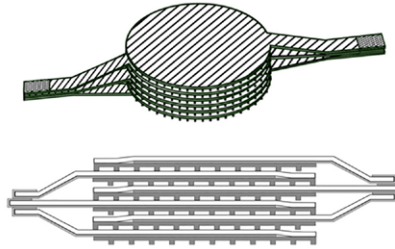
10-gram robots can jump and crawl in swarms

By Julien Happich

Inspired by the swarming behaviour of ants, a team of researchers from EPFL has developed tiny 10-gram robots which can communicate with each other and assign roles among themselves to complete complex tasks together. The reconfigurable robots are simple origami-based structures that combine multiple shape-memory alloy actuators to be able to jump and crawl across uneven surfaces. The work lead by Professor Jamie Paik at the EPFL National Center of Competence in Robotics (NCCR) Laboratory was published in Nature under the title "Designing minimal and scalable insect-inspired multi-locomotion millirobots". The paper describes untethered, battery-powered millirobot that can selectively switch gaits to traverse diverse terrain types, and groups of millirobots that can operate collectively to manipulate objects and overcome obstacles.

Individually and based on swarm-based terrain awareness, each palm-sized millirobot can chose to jump vertically for height, horizontally for distance, perform a somersault to clear an obstacle, walk on textured terrain and crawl on a flat surface. They are built through the integration of mechanical, material and electronic layers into a quasi-two-dimensional metamaterial sandwich which can fold and change shape to adopt various gaits.

Similarly to ants, the tiny robots only exhibit minimal physical intelligence on an individual level, but being connected, they can act collectively. Programmed with swarm-based algorithms, they can collectively detect and overcome obstacles, pass them and move objects much larger and heavier than themselves.

The Tribots (short for those three-legged T-shaped origami robots) can be assembled in only a few minutes by folding a stack of thin, multi-material sheets. They come equipped with infrared and proximity sensors for detection and communication purposes, but could carry more sensors if needed.

"Their movements are modeled on those of Odontomachus ants. These insects normally crawl, but to escape a predator, they snap their powerful jaws together to jump from leaf to leaf", explains Zhenishbek Zhakypov, the first author.

Despite having the same "anatomy", each robot is assigned a specific role depending on the situation. 'Explorers' detect physical obstacles in their path, such as objects, valleys and mountains. After detecting an obstacle, they inform the rest of the group. Then, the "leader" gives the instructions. The 'workers', meanwhile, pool their strength to move objects. "Each Tribot, just like Odontomachus ants, can have different roles. However, they can also take on new roles instantaneously when faced with a new mission or an unknown environment, or even when other members get lost. This goes beyond what the real ants can do" notes Paik.

In practical situations, such as in an emergency search mission, Tribots could be deployed en masse. And thanks to their multi-locomotive and multi-agent communication capabilities, they could locate a target quickly over a large surface without relying on GPS or visual feedback.

"Since they can be manufactured and deployed in large numbers, having some 'casualties' would not affect the success of the mission," explains Paik. "With their unique collective intelligence, our tiny robots are better equipped to adapt to unknown environments. Therefore, for certain missions, they would outperform larger, more powerful robots." The development of robots for search-and-rescue applications and the study of collective robotics are key research areas within the NCCR Robotics consortium, of which Jamie Paik's lab is part.
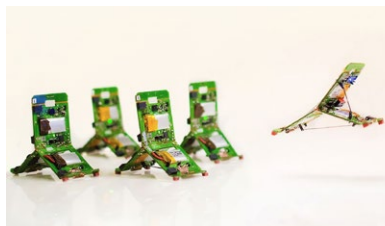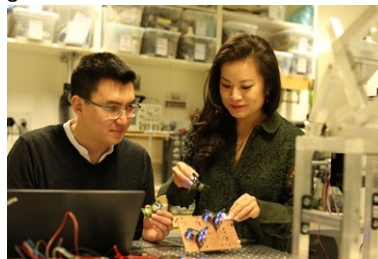
Optoelectronic black phosphorus used for neural networking

By Peter Clarke

Researchers at Royal Melbourne Institute of Technology (RMIT) have used thin layers of black phosphorous to develop neural network circuit that can be controlled optically.

Layered black phosphorous is a 2D material – similar to graphene – that tends to oxidize under ambient conditions. These intrinsic defect states give rise to novel photoelectronic effects including the ability to distinguish between UV-A and UV-B light. The researchers were able to generate a photocurrent that could be switched in polarity thus simulating synaptic behaviour. Switching between colours causes the current to reverse direction from positive to negative.

The research team also demonstrated that serially connected devices can be used to perform digital logic operations under optical control.

"We're able to simulate the brain's neural approach simply by shining different colours onto our chip," said research leader Sumeet Walia. Taimur Ahmed is lead author of the study, which was published in Advanced Functional Materials.

The technology was developed at the Micro Nano Research Facility and is compatible with existing electronics and has also been demonstrated on a flexible platform, for integration into wearable electronics.

European research centers unite on neuromorphic memory

By Julien Happich

Funded by ECSEL Joint Undertaking which supports public-private partnerships in the EU, the three-year TEMPO (Technology & hardware for nEuromorphic coMPuting) research program announced by imec will leverage cross-border collaboration between 19 research and industrial partners.

The program aims to develop process technology and hardware platforms based on emerging memory technologies for neuromorphic computing, addressing future applications in mobile devices that need complex machine-learning algorithms. Ultimately, the end-goal of this pan-European collaboration effort is to cram the capabilities of today's cloud-based server racks into neuromorphic chips able to execute the same algorithms within battery-powered mobile devices such as cars and smartphones (at the edge of the internet-of-things).

In the coming years, the demand for edge artificial intelligence and machine-learning algorithms is only set to grow further, running increasingly complex computational algorithms for natural-language processing, face-recognition-based security systems or autonomous vehicles. Today, high-end server parks process the data in the cloud, with the inevitable data latency and energy inefficiencies associated with sending the data, let alone privacy issues. Hence, the ultimate edge artificial intelligence applications will require intelligent energy-efficient local processing.

"We are delighted to enter in such broad European collaboration effort on Edge Artificial Intelligence, gathering the relevant stakeholders in Europe, including CEA-Leti and Fraunhofer, two of our most renowned colleague research centers in Europe. Thanks to our combined expertise, we can scan more potential routes forward than what would be possible by each of us individually, and as such, position Europe in the driver seat for R&D on AI. Imec looks forward to the progress we can make together in the TEMPO project and hopes this will lead to more similar collaborations in the future. Behind the scenes, we are already defining more public and bilateral agreements with several of the partners involved" said imec's CEO Luc Van den hove, in a company statement.

TEMPO will leverage the process technology platforms that are being developed by the European research technology organiza-

tions and cooperating foundries in the project, and combine it with the application and hardware knowledge from further partners. The TEMPO project will evaluate the current solutions at device, architecture and application level, and build and expand the technology roadmap for European AI hardware platforms. The project will leverage MRAM (imec), FeRAM (Fraunhofer) and RRAM (CEA-Leti) memory to implement both spiking neural network (SNN) and deep neural network (DNN) accelerators for 8 different use cases, ranging from consumer to automotive and medical applications.

"It is our aim to sweep technology options, covering emerging memories, and attempt to pair them with contemporary (DNN) and exploratory (SNN) neuromorphic computing paradigms. The process- and design-compatibility of each technology option will be assessed with respect to established integration practices and meet our industrial partner roadmaps and needs to prepare the future market of Edge IA where Europe is well positioned with multiple disruptive technologies", expressed Emmanuel Sabonnadiere, CEO at CEA-Leti.

"A key enabler for machine learning and pattern recognition is the capability of the algorithms to browse through large datasets. Which, in terms of hardware, means having rapid access to large memory blocks. Therefore, one of the key focal areas of TEMPO are energy efficient nonvolatile emerging memory technologies and novel ways to design and process memory and processing blocks on chip", said Prof. Hubert Lakner, Director of the Fraunhofer Institute for Photonic Microsystems (IPMS) and Chairman of the Board of Directors of the Fraunhofer Group Microelectronics.

TEMPO was kicked off on the 1st of April 2019 and has a duration of three years. The consortium of this ambitious project consists of no less than nineteen members. Imec takes the lead as the sole Belgian consortium partner. The other consortium members are, for France: CEA-LETI, ST-Microelectronics Crolles, ST-Microelectronics Grenoble, Thales Alenia Space and Valeo. For Germany: Bosch, Fraunhofer EMFT, Fraunhofer IIS, Fraunhofer IPMS, Infineon, Innosent, TU Dresden and Videantis. For the Netherlands: imec the Netherlands, Philips Electronics and Philips Medical Systems. For Switzerland: aiCTX and the University of Zürich.
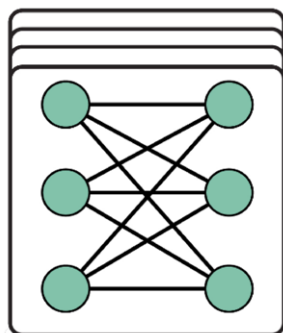
Arrays of U-shaped nanowire FETs probe neurons

By Julien Happich

The ability to read electrical activities from cells is the foundation of many biomedical procedures, such as brain activity mapping and neural prosthetics. Relying on the local readout of minute electric currents within neurons and nerve cells, one way to improve electrophysiological human-machine interfaces, is to increase the resolution (both spatial and temporal) of the probes in use, moving from micrometer-sized devices to nanometre-sized probes.

Following this trend, a team of researchers from the University of Surrey and Harvard University have devised U-shaped nanowire field-effect transistor (U-NWFET) arrays, using a scalable production process whereby they could accurately tune the probes' geometry. Because they could modulate the location, size and geometry of each probe (including the radii of curvature and the length of the FET sensing elements at the tips of the U-shaped nanowire probes), the researchers were able to systematically investigate how these parameters
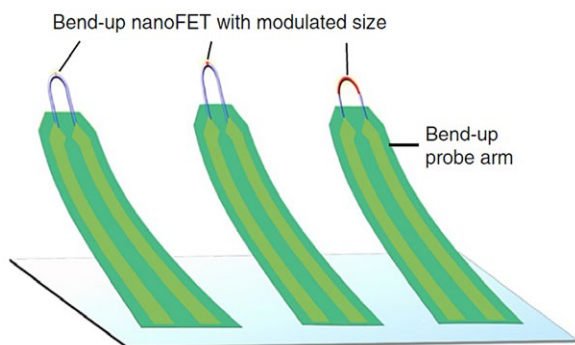
Probes bending upward after etching the Ni diffusion and sacrificial layers.

influenced intracellular electrophysiological recordings. Playing with various process parameters, they went on fabricating arrays of U-NWFET probes ranging from 15nm-diameter p-type Si nanowires with radii of curvature ranging from 0.75 to 2µm and active channel lengths from 50 to 2,000nm and then used them to probe cultured primary neurons and human cardiomyocytes.

The results published in a Nature Nanotechnology paper under the title "Scalable ultrasmall three-dimensional nanowire transistor probes for intracellular recording" revealed comparable recording signal-to-noise ratio and amplitude to those of patch clamp measurements, with the capability to record full amplitude intracellular action potentials from primary neurons and other electrogenic cells, while also offering the possibility to perform multiplexed recordings (with multiple wire tips of different curvatures).

"Our ultra-small, flexible, nanowire probes could be a very powerful tool as they can measure intracellular signals with amplitudes comparable with those measured with patch clamp techniques; with the advantage of the device being scalable, it causes less discomfort and no fatal damage to the cell (cytosol dilation). Through this work, we found clear evidence for how both size and curvature affect device internalisation and intracellular recording signal", commented Dr Yunlong Zhao from the Advanced Technology Institute at the University of Surrey, lead author of the article.
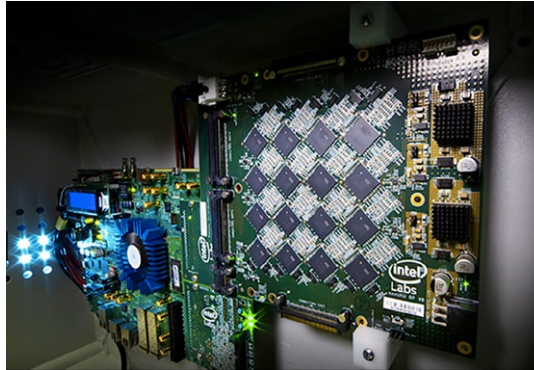
Intel scales up self-learning neuromorphic computing

By Peter Clarke

Intel has announced a board-level neuromorphic computer called Pohoiki Beach that comprises up to 64 Loihi chips.

Intel launched Loihi in 2017 as a 14nm FinFET chip capable of representing 130,000 neurons and 130 million synapses (see Intel launches self-learning processor). Unlike convolutional neural network (CNN) and other deep learning processors the Loihi test chip uses an asynchronous spiking model to mimic neuron and synapse behavior in a much closer analog to animal brain behaviour.

The Pohoiki Beach system comprises one or more Nahuku boards, each of which contains 8 to 32 Loihi neuromorphic chips. The Pohoiki Beach is capable of representing 8 million neurons and is suitable for research project on such things as sparse coding, graph search and constraint-satisfaction problems. "Pohoiki Beach will now be available to more than 60 ecosystem partners, who will use this specialized system to solve complex, compute-intensive problems," said Rich Uhlig, managing director of Intel Labs.

Chris Eliasmith, co-CEO of Applied Brain Research and professor at University of Waterloo, said that Loihi had been able to demonstrate a 100 times lower power consumption running a real-time deep-learning benchmark, compared to a GPU and 5 times lower power than specialized IoT hardware.

Later this year Intel plans to introduce a larger Loihi-based system called Pohoiki Springs capable of representing 100 million neurons.

EU project Tulipp delivers low-power vision-based systems

By Julien Happich

Concluding three years of research, the Tulipp (Towards Ubiquitous Low-power Image Processing Platforms) Consortium is announcing its results with the release of a comprehensive reference platform. The Tulipp reference platform enables computer vision product designers to readily address the combined challenges of low power, low latency, high performance and real-time image processing design constraints. It includes a full development kit, comprising an FPGA-based embedded, multi-core computing board, parallel real-time operating system and development tool chain with guidelines, coupled with 'real world' use cases focusing on diverse applications such as medical x-ray imaging, driver assistance and autonomous drones with obstacle avoidance. The complete Tulipp ecosystem was demonstrated earlier in the year to vision-based system designers in a series of hands-on tutorials.

Medical X-ray image before (left) and after (right) processing to remove sensor noise.

"The Tulipp project has achieved all of its objectives," said Philippe Millet of Thales and Tulipp's Project Co-ordinator. "By taking a diverse range of application domains as the basis for defining a common reference processing platform that captures the commonality of real-time, high-performance image processing and vision applications, it has successfully addressed the fundamental challenges facing today's embedded vision-based system designers."

Developed by Sundance Multiprocessor Technology, each instance of the Tulipp processing platform is 40x50mm and is compliant with the PC/104 embedded processor board standard. The hardware platform utilizes the powerful multicore Xilinx Zynq Ultrascale+ MPSoC which contains, along with the Xilinx FinFET+ FPGA, an ARM Cortex-A53 quad-core CPU, an ARM Mali-400 MP2 Graphics Processing Unit (GPU), and a real-time processing unit (RPU) containing a dual-core ARM Cortex-R5 32-bit real-time processor based on the ARM-v7R architecture. A separate expansion module (VITA57.1 FMC) allows application-specific boards with different flavours of input and output interfaces to be created while keeping the interfaces with the processing module consistent.

Coupled with the Tulipp hardware platform, is a parallel, low latency embedded real-time operating system developed by Hipperos specifically to manage complex multi-threaded embedded applications in a predictable manner.

Perfect real-time co-ordination ensures a high frame rate without missing any deadlines or data. Additionally, to facilitate the efficient development of image processing applications on the Tulipp hardware and in order to help vision-based systems designers understand the impact of their functional mapping and scheduling choices on the available resources, the Tulipp reference platform has been extended with performance analysis and power measurement features developed by Norges Teknisk-Naturvitenskapelige Universitet (NTNU) and Technische Universität Dresden (TUD) and implemented in the Tulipp ST-HEM toolchain.

Also, the insights of the Tulipp Consortium's experts have been captured in a set of guidelines, consisting of practical advice, best practice approaches and recommended implementation methods, to help vision-based system designers select
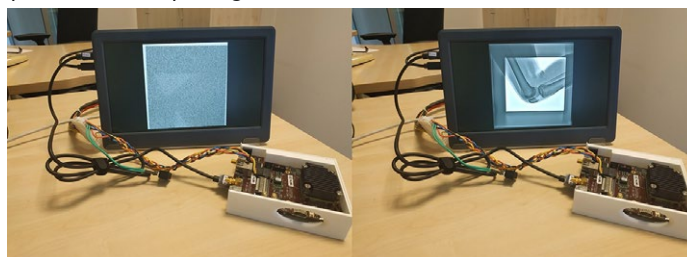
the optimal implementation strategy for their own applications. This will become a TULIPP book to be published by Springer by the end of 2019 and supported by endorsements from the growing ecosystem of developers that are currently testing the concept.

To further demonstrate the applicability of defining a common reference processing platform, comprising the hardware, operating system and a programming environment that captures the commonality of real-time, high performance image processing and vision application, Tulipp has also developed three 'real-world' Use Cases in distinctly diverse application domains – medical X-ray imaging, automotive Advanced Driver Assistance Systems (ADAS) and Unmanned Aerial vehicles (UAVs).

Tulipp's medical X-ray imaging use case demonstrates advanced image enhancement algorithms for X-ray images running at high frame rates. It focuses on improving the performance of X-ray imaging Mobile C-Arms, which provide an internal view of a patient's body in real-time during the course of an operation, to improve surgeon efficiency and accuracy with minimal incision sizes, aids faster patient recovery, lowers nosocomial disease risks and reduces by 75% the radiation doses to which patients and staff are exposed.

The Tulipp Starter Kit with Lynsyn PDM on a PC/104 carrier board.

The Tulipp project team at the HIPEAC 2019 event.

ADAS adoption is dependent on the implementation of vision systems or on combinations of vision and radar and the algorithms must be capable of integration into a small, energy-efficient Electronic Control Unit (ECU). An ADAS algorithm should be able to process a video image stream with a frame size of 640x480 at a full 30Hz or at least at the half rate.

The Tulipp ADAS use case demonstrates pedestrian recognition in real-time based on Viola & Jones algorithm. Using the Tulipp reference platform, the ADAS Use Case achieves a processing time per frame of 66ms, which means that the algorithm reaches the target of running on every second image when the camera runs at 30Hz.

Tulipp's UAV use case demonstrates a real-time obstacle avoidance system for UAVs based on a stereo camera setup with cameras orientated in the direction of flight. Even though we talk about autonomous drones, most current systems are still remotely piloted by humans. The use case uses disparity maps, which are computed from the camera images, to locate obstacles in the flight path and to automatically steer the UAV around them. This is the necessary key towards fully autonomous drones.

"As image processing and vision applications grow in complexity and diversity, and become increasingly embedded by their very nature, vision-based system designers need to know that they can simply and easily solve the design constraint challenges of low power, low latency, high performance and reliable real-time image processing that face them," commented Philippe Millet.

"The EU's Tulipp project has delivered just that. Moreover, the ecosystem of stakeholders that we have created along the way will ensure that it will continue to deliver in the future. Tulipp will truly leave a legacy."

Tulipp (Towards Ubiquitous Low-power Image Processing Platforms) was funded with nearly €4 million by the European Union's Horizon 2020 programme.

Light Communications Alliance forms around pureLiFi

By Julien Happich

Scottish LiFi pioneer pureLiFi has teamed up with communications and lighting leaders to form a global association called the Light Communications Alliance (LCA) with the aim to develop and refine LiFi's key use cases while driving standards for this emerging industry.

Along with pureLiFi, the founding members of the LCA include Nokia, Emirates Integrated Telecommunications Company (du), LEDVANCE, Liberty Global, Lucibel, LiFi Research & Development Centre, Velmenni, Zero.1, CEA Leti, and Institut Mines-Télécom.

Light Communication technologies include Light Fidelity (LiFi) and Optical Camera Communications (OCC), both of which have been attracting increased attention over recent years.

Global Market Insights predicts that the LiFi market will be worth $75 billion by 2025, creating broad, far-reaching opportunities for the related industries to benefit from Light Communications.

For pureLiFi, a scale-up based in Edinburgh, this new alliance represents a significant milestone in LiFi's journey to mass market adoption. At this year's Mobile World Congress pureLiFi demonstrated Gigabit LiFi solutions in form factors small enough to be designed into mobile devices.

"The founding members of the LCA represent the highest standard in lighting and communications. pureLiFi is honoured to be a founding member alongside these industry leaders and believe the Alliance will have the influence to drive education and greatly accelerate the global adoption of LiFi. We look forward to supporting the growth of this organisation over the coming years", expressed Alistair Banham, pureLiFi's CEO.

"pureLiFi have deployed LiFi solutions around the world, spanning 24 countries. Our customers want to see the Light Communications ecosystem grow so that they can leverage the opportunities that will arise from global standards, certification and interoperability within this growing market. These are key for LiFi's mass adoption. The LCA will help deliver the global consistent message our industry demands and be a significant catalyst for the growth of the LiFi market", added pureLiFi's CCO, Harald Burchardt.

The LCA is a non-profit organisation, open to membership from all industries spanning both light and communications including chip manufacturers, OEMs,

Underwater communication system uses battery-free sensors

By Rich Pell

Researchers at MIT have developed a battery-free underwater communication system that uses near-zero power to transmit sensor data.

Designed for underwater monitoring and exploration, the battery-free sensor system uses the vibration of piezoelectric materials to generate power and send and receive data. The system, say the researchers, could be used to monitor sea temperatures to study climate change and track marine life over long periods and even sample waters on distant planets.

The system is based on two key phenomena: The "piezoelectric effect," which occurs when vibrations in certain materials generate an electrical charge, and "backscatter," a communication technique commonly used for RFID tags that transmits data by reflecting modulated wireless signals off a tag and back to a reader.

With the system, a transmitter sends acoustic waves through water toward a piezoelectric sensor that has stored data. When the acoustic wave hits the sensor, the sensor material vibrates and stores the resulting electrical charge. The sensor then uses the stored energy to reflect a wave back to a receiver — or it doesn't reflect one at all.

Alternating between reflection in that way, say the researchers, corresponds to the bits in the transmitted data: For a reflected wave, the receiver decodes a 1; for no reflected wave, the receiver decodes a 0.

"Once you have a way to transmit 1s and 0s, you can send any information," says co-author of a paper on the research, Fadel Adib, an assistant professor in the MIT Media Lab and the Department of Electrical Engineering and Computer Science and founding director of the Signal Kinetics Research Group. "Basically, we can communicate with underwater sensors based solely on the incoming sound signals whose energy we are harvesting."

The researchers demonstrated their piezo-acoustic backscatter system in an MIT pool, using it to collect water temperature and pressure measurements. The system was able to transmit 3 kilobytes per second of accurate data from two sensors simultaneously at a distance of 10 meters between sensor and receiver.

Applications for such a system, say the researchers, extend beyond Earth's oceans, and could, for example, be used to collect data in the recently discovered subsurface ocean on Saturn's largest moon, Titan, where NASA is planning to send a rover in 2026 for exploration with its Dragonfly mission.

"How can you put a sensor under the water on Titan that lasts for long periods of time in a place that's difficult to get energy?" asks Adib. "Sensors that communicate without a battery open up possibilities for sensing in extreme environments."

Piezoelectric materials, say the researchers, offer a solution. They produce a small voltage in response to vibrations, but that effect is also reversible: Applying voltage causes the material to deform. If placed underwater, that effect produces a pressure wave that travels through the water.

Communicating relies on preventing the piezoelectric resonator from naturally deforming in response to strain. At the heart of the system is a submerged node - a circuit board that houses a piezoelectric resonator, an energy-harvesting unit, and a microcontroller. Any type of sensor can be integrated into the node by programming the microcontroller. An acoustic projector (transmitter) and underwater listening device, called a hydrophone (receiver), are placed some distance away.

If the sensor wants to send a 0 bit, when the transmitter sends its acoustic wave at the node the piezoelectric resonator absorbs the wave and naturally deforms, and the energy harvester stores a charge from the resulting vibrations. The receiver then sees no reflected signal and decodes a 0.

When the sensor wants to send a 1 bit, when the transmitter sends a wave the microcontroller uses the stored charge to send a voltage to the piezoelectric resonator. That voltage reorients the material's structure in a way that stops it from deforming, and instead reflects the wave. Sensing a reflected wave, the receiver decodes a 1.

The transmitter and receiver must be powered, say the researchers, but can be planted on ships or buoys, where batteries are easier to replace, or connected to outlets on land. One transmitter and one receiver can gather information from many sensors covering one area or many areas.

"When you're tracking a marine animal, for instance, you want to track it over a long range and want to keep the sensor on them for a long period of time," says Adib. "You don't want to worry about the battery running out. Or, if you want to track temperature gradients in the ocean, you can get information from sensors covering a number of different places."

Next, the researchers plan to demonstrate that the system can work at farther distances and communicate with more sensors simultaneously. In addition, they say, they hope to test if the system can transmit sound and low-resolution images.
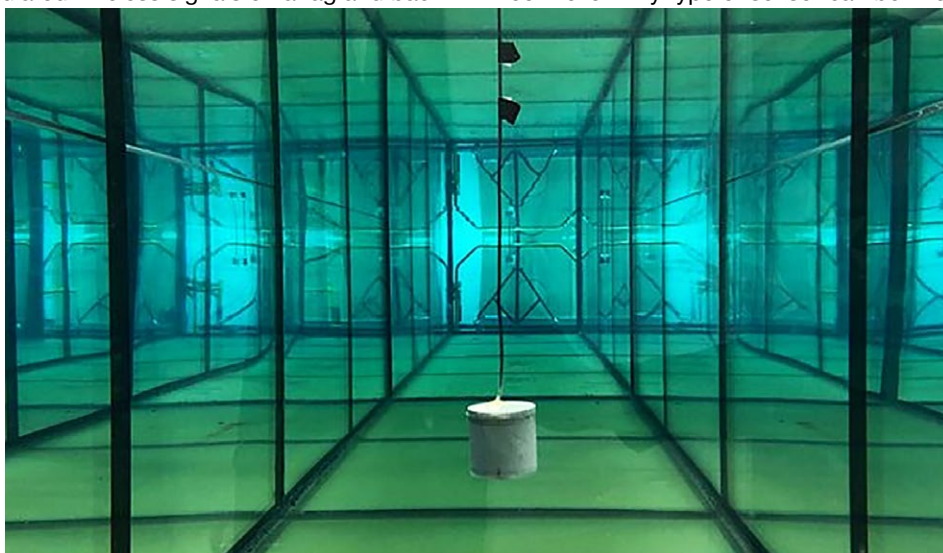
Glucose sensor bracelet is self-powered

By Julien Happich

A multidisciplinary team of researchers from the University of California, Berkeley has crafted a wrist-worn glucose sensor that operates purely on harvested energy and could be used for long-term yet real-time monitoring of glucose levels.
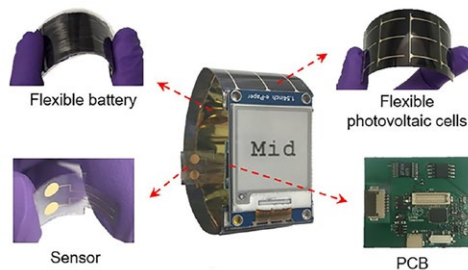

Flexible battery

Mid

Flexible photovoltaic cells

Sensor

PCB

Described in a paper titled "A Fully Integrated and Self-Powered Smartwatch for Continuous Sweat Glucose Monitoring" published in ACS Sensors, the device packs a thin flexible electrochemical sensor for sweat glucose monitoring, small control electronics, two flexible amorphous silicon (a-Si) photovoltaic cells forming the wristband and facing outwards for efficient energy harvesting, and three flexible $Zn-MnO_2$ rechargeable batteries connected in series, that can be charged up to 6.0 V. An electronic ink (E-ink) display completes the Glucose monitoring bracelet, giving the wearer simple to understand threshold-based readings for real-time monitoring.

Here, the two-electrode enzymatic sensor used for glucose monitoring (from sweat secretion) outputs amperometric signals which once amplified and digitized, can be processed into readable results. Current detection resolution for the sensor can reach 6nA, which corresponds to a glucose concentration of about 2µM. The sensor is fabricated on a thin flexible PET substrate and can be directly inserted into the PCB hosting the control electronics, for if it needs to be replaced. Hence, one could envisage a wrist-worn health monitoring platform capable of receiving multiple types of swappable sensors.

The feat which the authors seem to be the most proud about, is the use for this medical application of $Zn-MnO_2$ batteries based on quasi-solid-state aqueous electrolytes. While they eliminate safety concerns (having no flammable organic electrolytes), the batteries they crafted reportedly exhibited a capacity of 301 mA h g^{-1} at 0.3 A g^{-1}. They retained their capacities under bending and compression and withstood over 1000 charging/discharging cycles even at a high current density of 1.8 A g^{-1}.

The authors observed that the flexible batteries integrated in the glucose monitoring smartwatch would be fully charged (up 6.0V) within one hour under outdoor sunlight, enabling the system to then operate up to 8h with a cut-off potential of 3V. Even under relatively low illuminance (in a lit room), the solar cells would still charge the batteries to 4.2V in under 2 hours, to support system functions for about an hour.

Although their prototype proved to be sufficiently self-powered to operate without external power sources both indoor and outdoor, the researchers are confident they could still optimize their design to lower the system's overall power budget.

To provide clear signals to the wearer, the smartwatch display only gives out threshold-based alarm signals switching from "low" to "medium" and from "medium" to "high" according to the output currents of the sensors at glucose concentrations below 40µM, then over 40µM but under 120µM, and finally over 120µM, respectively.

Solar power generation and energy storage monitoring

By Richard Anslow and Martin Murnane

New government policy combined with new regulation is driving renewable energy generation, and the solar market is expected to have strong growth in the future. Due to the current increase of power density in solar inverters and the demand for energy storage balancing, this generation of solar power leads to a need to significantly monitor all elements of a solar system. For solar PV applications, RS-485 communications are used due to inherent noise immunity. Adding iCoupler isolated RS-485 transceivers provides a safe, reliable, and EMC robust solution for solar PV network communication interfaces.

RS-485 has several uses, the primary use being remote monitoring of power generation, power point trackers, and energy storage status (battery storage). For solar applications like energy storage communications is critical, as it alerts the user of power generation and consumption activities within their solar installation. Several systems strategies may be installed such as bill management, PV self-consumption, demand charge reduction, and backup power. Backup power is the most popular, especially in the U.S., due to the various hurricanes causing havoc in the states of Texas and Florida.

Solar generation, energy storage, and domestic consumption in a typical, 24-hour day is illustrated in figure 1. It is the primary reason why systems are designed for bill management in a solar system. During night time when there is no irradiation on the solar panel, energy consumed will be purchased from the grid where the grids are lowest. As soon as the sun rises irradiation appears on the solar panels, power is generated, and domestic self-consumption begins where any solar generation is either used in the household or is diverted to charge the energy storage unit. This allows bill costs to be controlled by reducing the energy drawn from the grid and using solar generated energy where low feed-in tariff areas are available from utility companies.

RS-485 is the communication application of choice for PC screen data updates such as current power, current consumption in the maximum power point trackers, battery charge and health, and CO_2 reduction, etc., are available, as can be seen in figure 2.

Figure 3 illustrates a typical solar system with input-for-input dc strings, dc-to-ac conversion, energy charging and storage, and battery management and communications. Analog Devices offers a complete power, communication, and control interface signal chain solution for solar PV and energy storage applications. iCoupler isolated gate driver solutions include the ADuM4135 and ADuM4223/ADuM3223; iCoupler isolated com-

Domestic Energy Storage Strategy	Definition
Bill Management Time of Use (TOU)	Minimizes electricity purchases during peak electricity consumption hours, while TOU shifts purchases to lower rates behind the meter customers. The goal of this strategy is to reduce the customer's bill.
PV Self Consumption	Minimize the export of electricity generated by behind-the-meter PV systems to maximize the financial benefits in PV areas where utility rates are high.
Demand Charge Reduction	Reduce costs when utility companies charge excessively during peak times so customers can store energy.
Backup Power	This is a more common strategy and is the charging of any storage capable devices to use when the grid is down or at night time. This is more a backup power strategy, where low utility charges are available at peak times and there is a low feed-in tariffs.

Table 1. Domestic energy storage strategies.

munication port solutions include the ADM2795E, ADM2587E, and ADM3054; and mixed signal processor solutions include the ADSP-CM419.

Why use RS-485 transceivers with iCoupler isolation?
iCoupler isolation provides a safe, reliable, and an EMC robust solution for solar PV network communication interfaces.

For solar PV networks the RS-485 or CAN communications interfaces often run over long cables in an electrically noisy environment. RS-485 communications are differential in nature and inherently noise immune. Adding iCoupler isolation increases noise immunity. The iCoupler family of digital isolation products has been tested and approved by various regulatory agencies, including UL, CSA, VDE, TÜV, CQC, ATEX, and IECEx. This regulatory agency testing provides a certified level of safety in the presence of high voltage transients and electrical surges that can occur in electrically harsh solar PV environments. The solar PV communications interface usually operates at low data rates—less than 500 kbps—which is an ideal operating range for RS-485 communications. Alternative implementations such as Ethernet operate at fixed data rates of 10 Mbps/100 Mbps or 1 Gbps, which are clearly overdesigned for the application requirement. iCoupler isolation has proven EMC robustness,
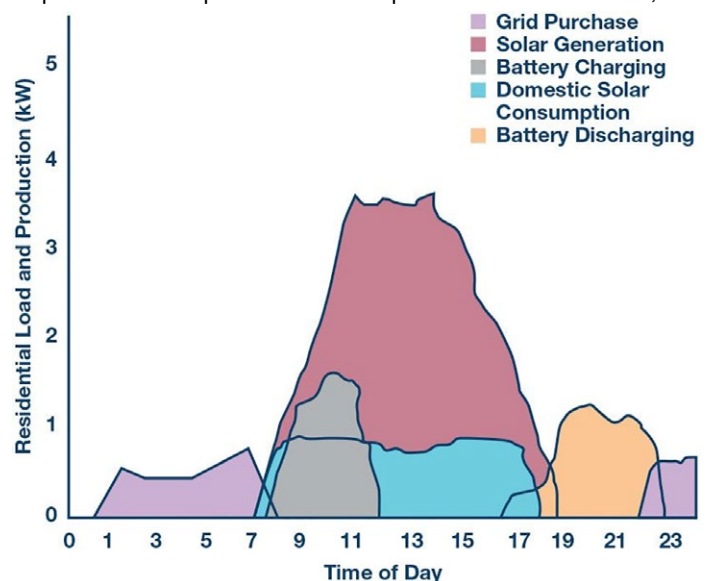

Fig. 1: Solar generation, energy storage, and domestic consumption in a typical 24-hour day.

Richard Anslow works on new product definitions and customer-facing roles related to Analog Devices' isolated communications portfolio – www.analog.com
Martin Murnane is a solar PV systems engineer in the Industrial and Instrumentation segment, focusing on energy/solar PV applications at Analog Devices – www.analog.com
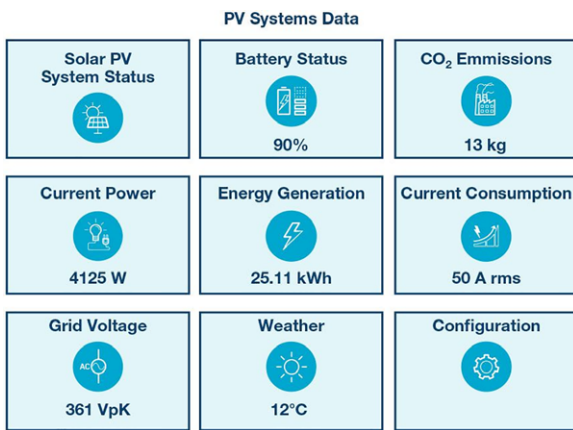
Fig. 2: Typical PV monitoring system data from a PV solar system.

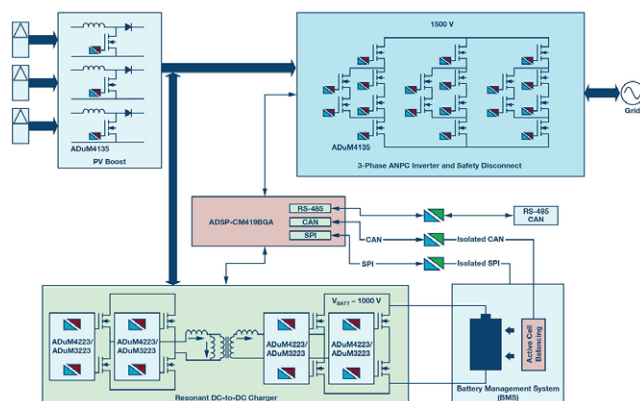which reduces field failures. Added EMC robustness reduces design and test time for interface circuits, allowing faster time to market for solar PV networks.
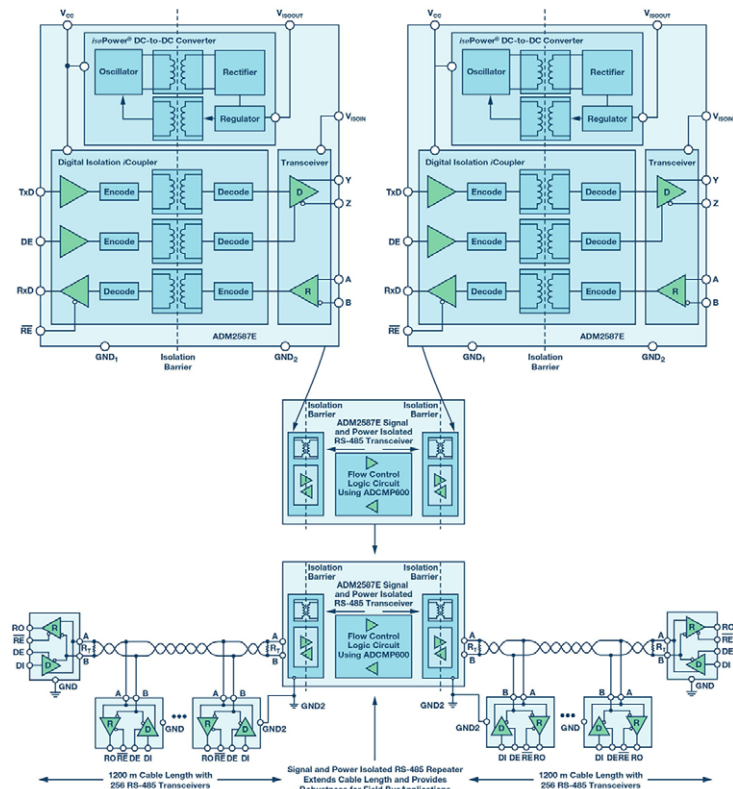
For existing installations of solar inverters, which do not include iCoupler isolation robustness on the communications port, the iCoupler isolated RS-485 repeater is a powerful drop-in solution. The compact, signal, and power iCoupler isolated RS-485 repeater delivers robust isolation protection against electrical noise in electromagnetic capability (EMC) harsh solar environments.

The iCoupler isolated RS-485 repeater design consists of two RS-485 transceivers and two high speed ADCMP600 comparators. The ADM2587E is a fully integrated signal and power isolated data transceiver with ±15 kV ESD protection, and is suitable for high speed communication on multipoint transmission lines. The device includes an integrated, isolated dc-to-dc power supply, which eliminates the need for an external dc-to-dc isolation block. An RS-485 repeater requires flow control, which is essential for controlling the direction of communication on the RS-485 bus. Using the ADCMP600 high speed comparator allows high speed flow control and directionality on the ADM2587E logic pins, which results in a reliable communication system.

When designing an EMC communications interface, the circuit designer is often faced with a design and test iterative cycle. The circuit needs to be designed to meet system-level EMC standards and customer requirements.


Fig 4: Signal and power iCoupler isolated RS-485 repeater.

System-level IEC standards, such as IEC 61131-2 for industrial automation, specify varying levels of protection against IEC ESD, EFT, and surge, as well as immunity to radiated, conducted, and magnetic disturbances.

Analog Devices' iCoupler signal isolated RS-485 includes additional certified EMC protection against these noted disturbances, reducing time to market for designs that need to meet strict regulatory targets. In particular, the ADM2795E RS-485 transceiver integrates isolation robustness and EMC protection, which saves significant printed circuit board (PCB) board space for the solar PV communication port interface.

The ADM2795E is a 5 kV rms signal isolated RS-485 transceiver that features up to ±42 V of ac-to-dc, peak bus overvoltage fault protection on the RS-485 bus pins. The device integrates Analog Devices iCoupler technology to combine a 3-channel isolator, RS-485 transceiver, and IEC electromagnetic compatibility (EMC) transient protection in a single package.

Fig. 3: Block diagram of a typical solar system with storage.
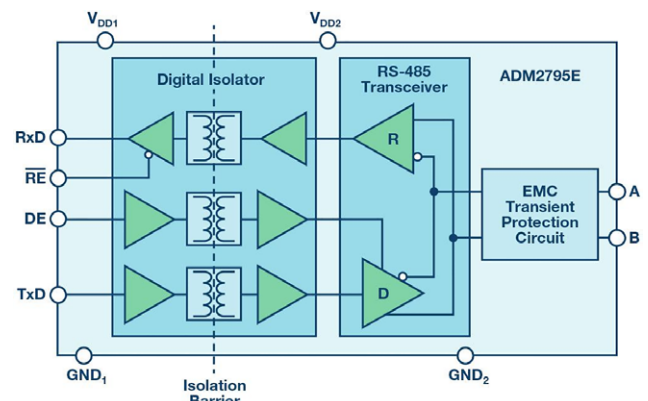
Fig. 5: iCoupler isolated RS-485 transceiver with added IEC 61000-4-5 surge robustness on the A and B bus pins.

# Self-powered fabric generates power for remote controls

By Nick Flaherty

Researchers at Purdue University have developed a self-powered fabric that allows wearers to control electronic devices through clothing. The waterproof, breathable and antibacterial self-powered fabric is based on omniphobic triboelectric nanogeneragtors (RF-TENGs). These use simple embroidery and fluorinated molecules to embed small electronic components. In this way, clothing can be used to control devices.

"It is the first time there is a technique capable to transform any existing cloth item or textile into a self-powered e-textile containing sensors, music players or simple illumination displays using simple embroidery without the need for expensive fabrication processes requiring complex steps or expensive equipment," said Ramses Martinez, an assistant professor in the School of Industrial Engineering and in the Weldon School of Biomedical Engineering in Purdue's College of Engi-

neering.

"This self-powered e-textiles also constitutes an important advancement in the development of wearable machine-human interfaces, which now can be washed many times in a conventional washing machine without apparent degradation," he added."While fashion has evolved significantly during the last centuries and has easily adopted recently developed high-performance materials, there are very few examples of clothes on the market that interact with the user," Martinez said. "Having an interface with a machine that we are constantly wearing sounds like the most convenient approach for a seamless communication with machines and the Internet of Things."

The self-powered fabric technology is being patented through the Purdue Research Foundation Office of Technology Commercialization. The researchers are looking for partners to test and commercialize the technology.
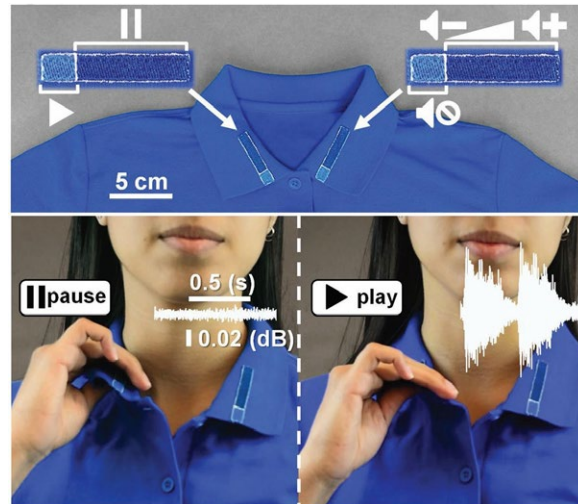
Wirelessly powered e-paper looks to smart display future

By Rich Pell

Wireless power technology company Ossia (Bellevue, WA), energy harvesting solution provider e-peas (Mont-Saint-Guibert, Belgium), and electronic paper display maker E Ink (Billerica, MA) have collaborated to develop a battery-less electronic paper display prototype that is wirelessly powered at a distance.

The wirelessly-powered Electronic Paper Display (EPD) prototype system can be successfully operated and wirelessly powered at a distance in a dynamic environment, without the need for any wires or batteries. Wireless power, say the companies, is seen as being a key enabler to the extensive use of smart display solutions in the Internet-of-Things (IoT) field, such as electronic shelf labels for retailers, digital signage, logistics tags, and distributed sensor networks.

Wireless power offers key advantages over using wiring or batteries: running wires to labels, tags, and sensors is often cost-prohibitive, while devices that are battery-powered remain constrained by the finite lives of batteries that eventually need to be replaced.

Through wireless power, say the companies, device lifetimes are significantly extended, well beyond the capacity currently offered by traditional batteries; device functionality is significantly enhanced as well.

Ossia is the developer of the FCC-approved Cota Real Wireless Power technology; e-peas is a leading semiconductor company developing energy harvesting power management ICs (PMICs) and extremely-low-power microcontrollers for battery-less IoT applications; and E Ink Holdings is the leading innovator of electronic ink technology.

"We are dedicated to expanding our FCC approved Cota technology to the largest sector in the world and increasing the overall potential of IoT solutions," says Preston Woo, Ossia's Chief Strategy Officer. "We are further pleased to collaborate with E Ink, the pioneer and commercial leader in ePaper technology, and E-PEAS, a leading semiconductor for IoT applications with the best-in-class solution for energy harvesting, processing, and sensing."

Geoffroy Gosset, CEO and co-founder of e-peas says, "Our vision at e-peas is to enable the seamless operation of all connected devices anywhere, anytime, in any conditions with smart innovative solutions. Enabling the broad proliferation of sustainable EPDs and smart IoT devices, in collaboration with top tier partners, is directly in-line with our core mission."

Johnson Lee, President of E Ink Holdings adds, "The development of wirelessly powered EPDs is another validation of our technology's durable and ultra-low power displays being applied to previously impossible and unimaginable applications. Ultimately, commercializing battery-less ePaper solutions will enable the potential of IoT applications that require ultra-low power consumption displays. It also makes digital transformation easier than one can imagine in various applications such as logistic tags, luggage tags, digital signage and other digital tags."

The companies plan to release this leading-edge technology for commercial use by the end of next year. It is presently available for demonstration purposes only.

TI builds on-chip thermal generator

By Nick Flaherty

A University of Texas at Dallas physicist is working with Texas Instruments to create an on-chip thermal generator that turns a temperature difference into energy The researches are working with TI on ways to build silicon 'nanoblades' that can be used for an on-chip thermoelectric generator. These could be built into a system-on-chip chip to power a processor and sensor from a temperature difference.

"Sensors go everywhere now. They can't be constantly plugged in, so they must consume very little power," said Dr Mark Lee, professor and head of the Department of Physics in the School of Natural Sciences and Mathematics at the University of Texas at Dallas. "Without a reliable light source for photovoltaic energy, you're left needing some kind of battery, one that shouldn't have to be replaced. If you have a steady temperature difference, even a small one, then you can harvest some heat into electricity to run your electronics."

Sensors embedded beneath a traffic intersection provide an example of convenient thermoelectric power. "The heat from tires' friction and from sunlight can be harvested because the material beneath the road is colder," Lee said. "So no one has to dig that up to change a battery."

However thermoelectric generation has been expensive, both in terms of cost per device and cost per watt of energy generated, he says. "The best materials are fairly exotic, they're either rare or toxic and they aren't easily made compatible with basic semiconductor technology."
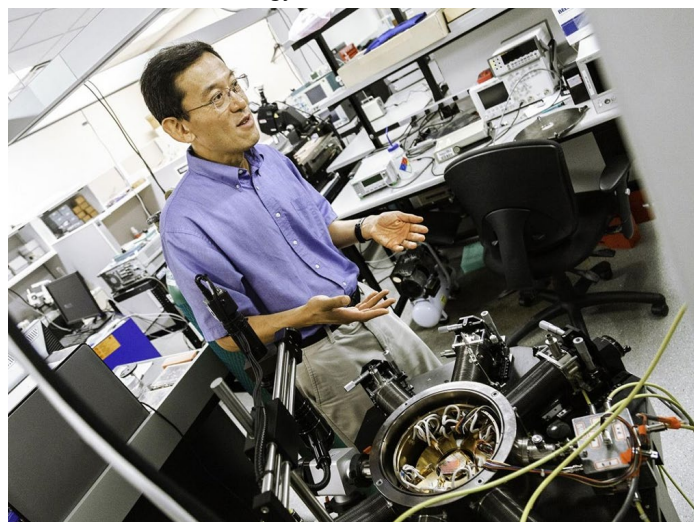
Another reason is that the nanowires at the heart of a thermoelectric generator are too small to be compatible with today's silicon process technology. To overcome this, Lee and his team developed the nanoblades, which are only 80nm long but more than eight times, 640nm, in width, which makes it compatible with silicon process rules.

The nanoblade shape loses some thermoelectric ability relative to the nanowire. "However, using many at once can generate about as much power as the best exotic materials, with the same area and temperature difference," said Lee.

Building the generator into a chip has other problems. Previous attempts failed because too much material was used. "When you use too much silicon, the temperature differential that feeds the generation drops," said Lee. "Too much waste heat is used, and, as that hot-to-cold margin drops, you can't generate as much thermoelectric power. There is a sweet spot that, with our nanoblades, we're much closer to finding than anyone else. The change in the form of silicon studied changed the game."

The team modelled the number of nanoblades per unit area that will produce the most energy without reducing the temperature difference. "We optimized the configuration of our devices to place them among the most efficient thermoelectric generators in the world," said researcher Gangyi Hu. "Because it's silicon, it remains low-cost, easy to install, maintenance-free, long-lasting and potentially biodegradable."

Lee said the work was also novel because they used an automated industrial manufacturing line to fabricate the silicon integrated-circuit thermoelectric generators.

"We want to integrate this technology with a microprocessor, with a sensor on the same chip, with an amplifier or radio, and so on. Our work was done in the context of that full set of rules that govern everything that goes into mass-producing chips," Lee said. "You can live with a 40% reduction in thermoelectric ability relative to exotic materials because your cost per watt generated plummets," he said. "The marginal cost is a factor of 100 lower."

Huawei claims lead with new AI processor and framework

By Jean-Pierre Joosting

Huawei has launched a new AI processor, the Ascend 910, as part of the series of Ascend-Max chipsets. The company also announced MindSpore, an AI computing framework that supports development for AI applications in all scenarios.

Huawei announced the processor's planned specs at its 2018 flagship event, Huawei Connect. After a year of ongoing development, test results now show that the Ascend 910 AI processor delivers on its performance goals with much lower power consumption than originally planned.

For half-precision floating point (FP16) operations, the Ascend 910 AI processor delivers 256 TeraFLOPS. For integer precision calculations (INT8), it delivers 512 TeraOPS. Despite its unrivalled performance, Ascend 910's max power consumption is only 310W, much lower than its planned specs (350W).

"Ascend 910 performs much better than we expected," said Eric Xu, Huawei's Rotating Chairman. "Without a doubt, it has more computing power than any other AI processor in the world."

Ascend 910 is used for AI model training. In a typical training session based on ResNet-50, the combination of Ascend 910 and MindSpore is about two times faster at training AI models than other mainstream training cards using TensorFlow.

In 2018, Huawei announced the three development goals for its AI framework: to dramatically reduces training time and costs; to use the least amount of resources with the highest possible OPS/W while aiming to be adaptable to all scenarios including device, edge, and cloud applications.

MindSpore marks significant progress towards these goals. As privacy protection grows more important than ever, support for all scenarios is essential for enabling secure, pervasive AI. This is a key component in the MindSpore framework, which can readily adapt to different deployment needs. Resource budget environments can be as large and complicated or small and simple as needed – MindSpore supports them all.

MindSpore helps ensure user privacy because it only deals with gradient and model information that has already been processed. It doesn't process the data itself, so private user data can be effectively protected even in cross-scenario environments. In addition, MindSpore has built-in model protection technology to ensure that models are secure and trustworthy.

The MindSpore AI framework is adaptable to all scenarios – across all devices, edge, and cloud environments – and provides on-demand cooperation between them. Its "AI Algorithm As Code" design concept allows developers to develop advanced AI applications with ease and train their models more quickly.

In a typical neural network for natural language processing (NLP), MindSpore has 20% fewer lines of core code than leading frameworks on the market, and it helps developers raise their efficiency by at least 50%, claims the company.

Through framework innovation, as well as co-optimization of MindSpore and Ascend processors, Huawei can help developers more effectively address complex AI computing challenges and the need for a diverse range of computing power for different applications. This results in stronger performance and more efficient execution. In addition to Ascend processors, MindSpore also supports GPUs, CPUs, and other types of processors.

When introducing MindSpore, Xu emphasized Huawei's commitment to helping build a more robust and vibrant AI ecosystem. "MindSpore will go open source in the first quarter of 2020. We want to drive broader AI adoption and help developers do what they do best."

Making AI a general purpose technology

Huawei defines AI as a new general purpose technology, like railroads and electricity in the 19th century, and cars, computers, and the Internet in the 20th century. The company believes that AI will be used in almost every sector of the economy.

According to Xu, AI is still in its early stages of development, and there are a number of gaps to close before AI can become a true general purpose technology. Huawei's AI strategy is designed to bridge these gaps and speed up adoption on a global scale. At Huawei Connect 2018, Huawei announced its AI strategy and full-stack, all-scenario AI portfolio, includ-

ing the Ascend 310 AI processor and ModelArts that provides full-pipeline model production services. Ascend 310 is Huawei's first commercial AI System on a Chip (SoC) in the Ascend-Mini series. With a maximum power consumption of 8W, Ascend 310 delivers 16 TeraOPS in integer precision (INT8) and 8 Tera-FLOPS in half precision (FP16), making it the most powerful AI SoC for edge computing. It also comes with a 16-channel FHD video decoder.

Since its launch, Ascend 310 has already seen wide adoption in a broad range of products and cloud services. For example, Huawei's Mobile Data Center (MDC), which employs Ascend 310, has been used by many leading automakers in shuttle buses, new-energy vehicles, and autonomous driving.

The Ascend 310-powered Atlas series acceleration card and server are now part of dozens of industry solutions (e.g., smart transportation and smart grid) developed by dozens of partners.

It also enables Huawei Cloud services like image analysis, optical character recognition (OCR), and intelligent video analysis. There are more than 50 APIs for these services. At present, the number of API calls per day has exceeded 100 million, and this figure is estimated to hit 300 million by the end of 2019. More than 100 companies are using Ascend 310 to develop their own AI algorithms.

Huawei's ModelArts provides model development services spanning the full pipeline, from data collection and model development to model training and deployment. At present, more than 30,000 developers are using ModelArts to handle 4,000+
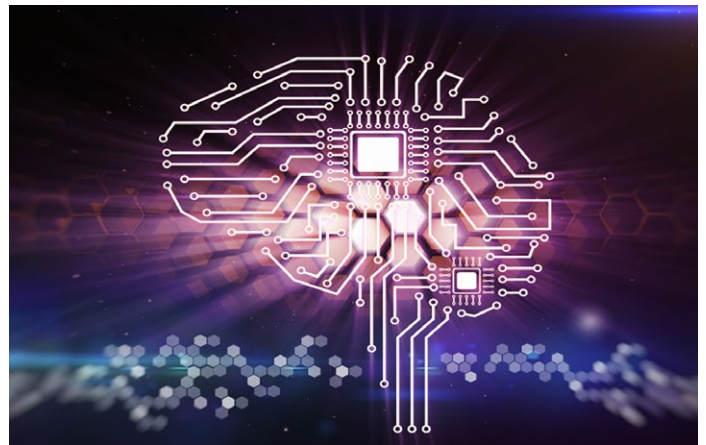
training tasks per day (for a total of 32,000 training hours). Among these tasks, 85% are related to visual processing, 10% are for processing audio data, and 5% are related to machine learning.

By launching the Ascend 910 and MindSpore, Huawei has unveiled all the key components of its full-stack, all-scenario AI portfolio. "Everything is moving forward according to plan. We promised a full-stack, all-scenario AI portfolio. And today we delivered," said Xu. This launch is a new milestone in Huawei's AI roadmap – it's also a new beginning. Huawei will debut more AI products at its upcoming conference, Huawei Connect 2019, which will be held between September 18 and 20 in Shanghai.

Co-creating the future of cities

Advantech and its co-creation partners are working together to deploy a range of IIoT solutions that are transforming the future of cities, including value-added Solution Ready Packages (SRPs) to accelerate growth. The third wave of digital revolution has officially begun.

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Machine learning for sensors

By Julien Happich

Researchers at the Fraunhofer Institute for Microelectronic Circuits and Systems IMS have developed an artificial intelligence (AI) concept for microcontrollers and sensors that contains a completely configurable artificial neural network.

AifES (Artificial Intelligence for Embedded Systems), as it is called, is a platform-independent machine learning library which can be used to realize self-learning microelectronics requiring no connection to a cloud or to high-performance computers. The sensor-related AI system recognizes handwriting and gestures, enabling for example gesture control of input when the library is running on a wearable.

A wide variety of software solutions currently exist for machine learning, but as a rule they are only available for the PC and are based on the programming language Python. There is still no solution which makes it possible to execute and train neural networks on embedded systems such as microcontrollers. Nevertheless, it can be useful to conduct the training directly in the embedded system, for example when an implanted sensor is to calibrate itself. The vision is sensor-related AI that can be directly integrated in a sensor system.

The new machine learning library, programmed in C, can run on microcontrollers but also on other platforms such as PCs, Raspberry PI and Android.

The library currently contains a completely configurable artificial neural network (ANN), which can also generate deep networks for deep learning when necessary.

"We've reduced the source code to a minimum, which means the ANN can be trained directly on the microcontroller or the sensor, i.e. the embedded system. In addition the source code is universally valid and can be compiled for almost any platform. Because the same algorithms are always used, an ANN generated for example on a PC can easily be ported to a microcontroller. Until now this has been impossible in this form with commercially available software solutions," says Dr. Pierre Gembaczka, research associate at Fraunhofer IMS.

Protection of privacy

Until now artificial intelligence and neural networks have been used primarily for image processing and speech recognition, sometimes with the data leaving the local systems. For example, voice profiles are processed in the cloud on external servers, since the computing power of the local system is not always adequate.

AIfES demonstrator for handwriting recognition. Numbers written by hand on the PS/2 touchpad are identified and output by the microcontroller.

"It's difficult to protect privacy in this process, and enormous amounts of data are transmitted. That's why we've chosen a different approach and are turning away from machine learning processes in the cloud in favor of machine learning directly in the embedded system. Since no sensitive data leave the system, data protection can be guaranteed and the amounts of data to be transferred are significantly reduced," explains Burkhard Heidemann, Embedded Systems group manager at Fraunhofer IMS. "Of course it's not possible to implement giant deep learning models on an embedded system, so we're increasing our efforts toward making an elegant feature extraction to reduce input signals." By embedding the AI directly in the microcontroller, the researchers make it possible to equip a device with additional functions without the need for expensive hardware modifications.

Reducing data

AIfES doesn't focus on processing large amounts of data, instead transferring only the data needed to build very small neural networks. "We're not following the trend toward processing big data; we're sticking with the absolutely necessary data and are creating a kind of micro-intelligence in the embedded system that can resolve the task in question. We develop new feature extractions and new data pre-processing strategies for each problem so that we can realize the smallest possible ANN. This enables subsequent learning on the controller itself," Gembaczka explains. The approach has already been put into practice in the form of several demonstrators. Thus for example the research team implemented the recognition of handwritten numbers on an inexpensive 8-bit microcontroller (Arduino Uno). This was made technically possible by developing an innovative feature extraction method. Another demonstrator is capable of recognizing complex gestures made in the air. Here the IMS scientists have developed a system consisting of a microcontroller and an absolute orientation sensor that recognizes numbers written in the air.

"One possible application here would be the operation of a wearable," the researchers point out. "In order for this type of communication to work, various persons write the numbers one through nine several times. The neural network receives this training data, learns from it and in the next step identifies the numbers independently. And almost any figure can be trained, not only numbers. "This eliminates the need
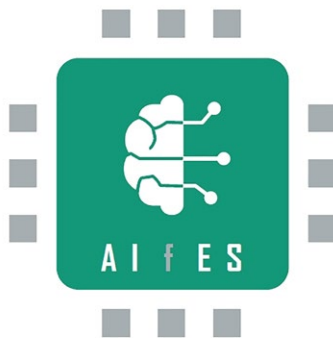
to control the device using speech recognition: The wearable can be controlled with gestures and the user's privacy remains protected. There are practically no limits to the potential applications of AIfES: For example, an armband with integrated gesture recognition could be used to control indoor lighting. And not only can AIfES recognize gestures, it can also monitor how well the gestures have been made. Exercises and movements in physical therapy and fitness can be evaluated without the need for a coach or therapist. Privacy is maintained since no camera or cloud is used. AIfES can be used in a variety of fields such as automotive, medicine, Smart Home and Industrie 4.0.

Decentralized AI

The library makes it possible to decentralize computing power for example by allowing small embedded systems to receive data before processing and pass on the results to a superordinate system. This dramatically reduces the amount of data to

be transferred. In addition, it's possible to implement a network of small learning-capable systems which distribute tasks among themselves.

Deep learning

AIfES currently contains a neural network with a feed-forward structure that also supports deep neural networks. "We programmed our solution so that we can describe a complete network with one single function," says Gembaczka. The integration of additional network forms and structures is currently in development. Furthermore the researcher and his colleagues are developing hardware components for neural networks in addition to other learning algorithms and demonstrators. Fraunhofer IMS is currently working on a RISC-V microprocessor which will have a hardware accelerator specifically for neural networks. A special version of AIfES is being optimized for this hardware in order to optimally exploit the resource.

Carbon nanotube processor breakthrough made at MIT

By Peter Clarke

Engineers at the Massachusetts Institute of Technology have built a 16bit RISC-V microprocessor using carbon nanotube based transistors; an achievement that could indicate a way beyond silicon-based electronics.

The work, which was supported by Analog Devices Inc., the National Science Foundation, and the Air Force Research Laboratory, was reported in Nature.

Carbon is being investigated as the active material in leading-edge transistors as it offers a faster alternative but one advantage of the research demonstrator made at MIT is that beyond the specialized carbon nanotube FETs (CNFETs) the development used standard commercial design tools and manufacturing infrastructure.

Silicon transistors have served the electronics industry well for many decades but scaling of the speed and physical size of these transistors has become increasingly complex and expensive; driving research into alternative materials and physical orientations.

Research indicates CNFETs could offer 10x the energy efficiency and 3x higher speeds than silicon but defects introduced during the, as yet, unscaled manufacturing process has hindered adoption.

MIT's major contribution is to have invented techniques fabricate that limit defects and enable controllable complementary CNFETs to be made and which can then be used as surrogates for CMOS manufacturing in conventional design flow.

The team used platinum or titanium metal contacts to define the transistors as P- or N-type and then coated them in an oxide compound to tune the transistors for performance or power consumption.

MIT's solutions include RINSE (removal of incubated nano-

tubes through selective exfoliation), MIXED (metal interface engineering crossed with electrostatic doping) and DREAM (designing resiliency against metallic CNTs).

The Nature paper describes the microprocessor design and includes more than 70 pages detailing the manufacturing methodology.

The result is a 16bit microprocessor built to the RISC-V instruction set architecture using more than 14,000 CNFETs. As a proof of its functionality the research team were able to program it to send the message: "Hello, World! I am RV16XNano, made from CNTs."
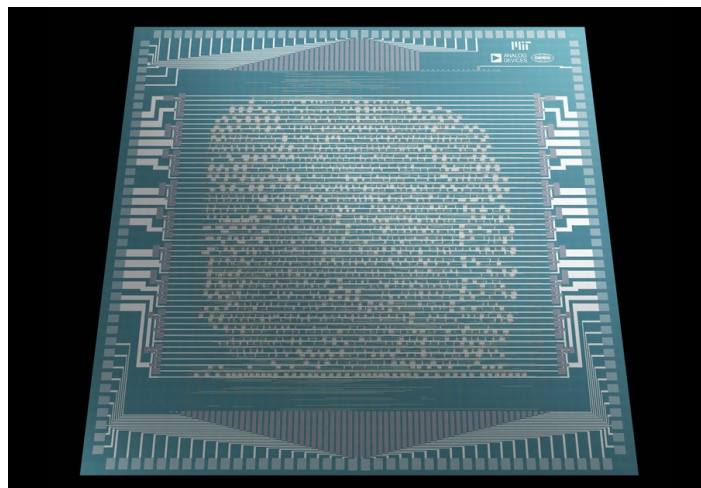
Much of the research work carried out by the team was designed to find ways round metallic CNTs that had either mandated unfeasibly high purity CNTs or killed transistor operation. By a series of work-arounds the team has allowed off-the-shelf materials to be married with conventional design flows and get CNT into practical production.

"The 'DREAM' pun is very much intended, because it's the dream solution," said Max Shulaker, the MIT physicist who led the work, in a statement on the MIT website. "This allows us to buy carbon nanotubes off the shelf, drop them onto a wafer, and just build our circuit like normal, without doing anything else special."

The researchers have started implementing their manufacturing techniques in a commercial foundry – believed to be Skywater Technology Foundry Inc. (Bloomington, Minnesota) – through a program run by the Defense Advanced Research Projects Agency. Shulaker is reported as saying improved versions of CNT chips could be in the commercial market place within five years.

RISC-V MCUs support migration away from ARM

By Peter Clarke

Fabless memory and MCU vendor GigaDevice Semiconductor (Beijing) Inc. has launched its GD32V series of general-purpose MCU products based on the RISC-V architecture as an alternative to its established ARM-based MCUs.
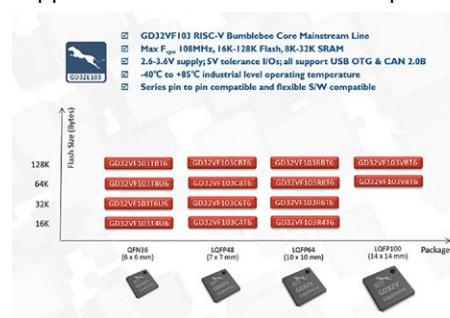
GigaDevice provides tool chain support from MCU chips to software libraries and development boards. The first product line within GD32V is the GD32VF103 series available in 14 models, including QFN36, LQFP48, LQFP64 and LQFP100, and are fully compatible with existing GD32 MCUs in software development and pin packaging. This allows developers to migrate easily from GD32 MCUs based on ARM to those based on RISC-V.

The products are targeted at embedded applications ranging from industrial control, consumer electronics, emerging IOT, edge computing to artificial intelligence and deep learning.

GD32VF103 is based on the Bumblebee processor core, which was developed by GigaDevice and Nuclei System Technology, a Chinese developer of processor cores. The Bumblebee core uses a 32-bit RISC-V open source instruction set architecture and supports custom instructions to optimize interrupt handling. It is equipped with a 64-bit real-time timer and can generate timer interrupts defined by the RISC-V standard.

The GD32VF103 range of microcontrollers. Source: GigaDevice.

Furthermore, the low-power management unit can support two-levels of sleep mode. The core supports standard JTAG interfaces and RISC-V debug standards for hardware breakpoints and interactive de bugging. Additionally, the Bumblebee core supports the RISC-V standard compilation tool chain, as well as Linux/Windows graphical integrated development environment.

The GD32VF103 MCU series operate at up to 153 and under the CoreMark test achieves shows 15 percent performance improvement compared to the GD32 Cortex-M3 core. At the same time, the dynamic power consumption is reduced by 50 percent and the standby power consumption is reduced by 25 percent.

The GD32VF103 series RISC-V MCUs provide a processing frequency of 108MHz, 16Kbyte to 128Kbye of on-chip flash and 6Kbyte to 32Kbyte of SRAM cache. Moreover, the Bumblebee core includes a single-cycle hardware multiplier, hardware divider and acceleration unit for advanced computing and data processing challenges. It requires a 2.6V to 3.6V power supply and the I/O ports can withstand a 5V voltage level.

10Th Gen Intel Processors

Core mobile processor family promises double digit performance gains Intel introduced eight additional 10th Gen Intel Core processors for modern laptop computing. The new mobile PC processors (formerly code-named "Comet Lake") are tailor-made to deliver increased productivity and performance scaling for demanding, multithreaded workloads while still enabling thin-and-light laptop and 2 in 1 designs with uncompromising battery life1. These processors are performance powerhouses that bring double digit performance gains compared with the previous generation. The lineup also includes Intel's first 6-core processor in the U-series, faster CPU frequencies, faster memory interfaces and the industry redefining connectivity with Intel Wi-Fi 6 (Gig+) and broader scaling of Thunderbolt 3. Earlier this month, Intel launched the first products in 10th Gen Intel Core processor family, which were developed on the 10nm process technology and focus on bringing high-performance artificial intelligence (AI) to the PC at scale, a big leap forward in graphics performance and best-in-class connectivity. The new processors share the same platform connectivity, while expanding the family with processors for scaling performance and frequencies for modern productivity workloads.

Intel
www.intel.com

Vulkan-based graphics and compute libraries for Deos RTOS

CoreAVI's Vulkan-based VkCore SC graphics and compute driver portfolio are now available for DDC-I's Deos real-time operating system running atop the Arm A53-based i.MX 8 applications processor with dual GPUs. Together, Deos and VkCore SC greatly accelerate the development, certification and deployment of high-performance avionics applications utilizing the i.MX8 processor's advanced graphics, imaging and computational capabilities. Vulkan is a new-generation graphics and compute API that provides high-efficiency, cross platform access to modern GPUs. Developed by the Khronos Group, an open consortium of leading hardware and software companies formed to create advanced acceleration standards, Vulkan promotes balanced CPU/GPU usage and is optimized to better distribute work across multiple cores. CoreAVI's new VkCore SC Vulkan-based graphics and compute driver portfolio, as well as its VkCoreGL SC1 OpenGL SC 1.0.1 and VkCoreGL SC2 OpenGL SC 2.0 application libraries, enable implementation of a full safe software stack on the i.MX 8 application processor. Drivers for automotive applications are certified as Safety Elements out of Context (SEooC). Drivers for avionics applications are available with DO-178C safety certification evidence to DAL A.

CoreAVI
www.coreavi.com

Kalray tapes-out Coolidge massively parallel processor

Kalray SA (Grenoble, France) has announced the tape-out of its Coolidge massively parallel processor on a TSMC 16nm FinFET manufacturing process.

Coolidge is Kalray's third generation of massively parallel processor array (MPPA) architecture and is designed to support machine learning applications in addition to high-performance computing.

Kalray first mentioned Coolidge back in May 2017 (see Kalray's Coolidge processor adds deep learning acceleration) and subsequently conducted an IPO of shares in the company to help fund its development (see Loss-making Kalray raises funds via IPO).

Coolidge includes 80, 64bit VLIW processor cores plus 80 coprocessors designed to boost performance for artificial intelligence and compute intensive applications, to reach up to 4 Tera FLOPS and 25 TOPS – about 25x the performance of the previous generation MPPA. The total chip consumes less than 20W.

The chip is provided with high-speed interfaces such as 100Gbit Ethernet and PCIe Gen4, while specialized interfaces such as CAN assure seamless compatibility with targeted applications such as autonomous cars.

Kalray said Coolidge will address data center and automotive markets. Embedded applications include intelligent cars and autonomous vehicles, advanced driver assistance systems (ADAS), aerospace and defense, medical equipment robots, data center, networking, high performance computing, high performance storage, as well as, machine learning and artificial intelligence applications.

"Since the IPO of Kalray in June 2018, it has been one of the main focuses of the company to bring to life this new product," said Eric Baissus, CEO of Kalray, in a statement. "Numerous customers have identified the potential of our breakthrough solution and are eager to get the first samples of Coolidge."

Coolidge includes security and safety mechanisms defined in collaboration with Kalray's partners in the aerospace, defense and automotive fields.
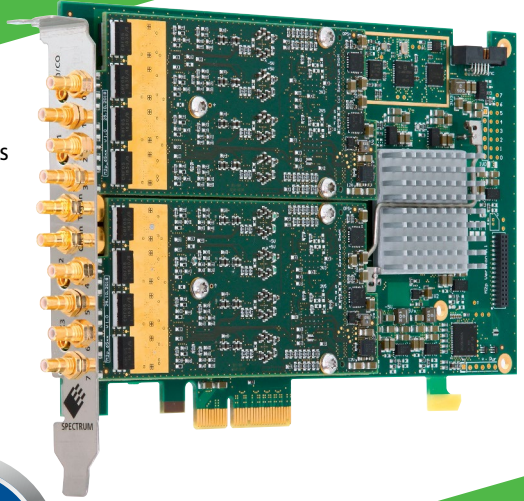
Coolidge will be delivered to Kalray customers and partners with an upgraded version of Kalray Software Development Kit, AccessCore including Kalray Artificial Intelligence code generation tool (KaNN) as well as reference boards.

Kalray SA
www.kalray.eu

Automated connectivity checking with formal verification

Tom Anderson

Formal verification traditionally has been regarded as an advanced technique for experts to thoroughly verify individual blocks of logic, or perhaps small clusters of blocks. The appeal of formal techniques is the exhaustive analysis of all possible behavior for the design being verified. This stands in sharp contrast to simulation, which exercises only a tiny fraction of possible behavior by running specific tests. If no test triggers a design bug, the bug will not be found. If the bug is triggered but no change in results is observed, the bug will not be found. Given a sufficiently robust set of properties to describe intended behavior, formal tools can not only find all bugs but also prove that there are no more bugs to be found.

Today, many more users can take advantage of the power of formal verification, and most of them are not experts. There are several reasons why formal adoption has grown so much. The broad deployment of standardized formats, most notably the SystemVerilog Assertions (SVA) subset, has reduced the level of expertise needed to write formal properties. Model-based mutation coverage can identify those parts of the design not covered by assertions, providing valuable guidance to users. Formal tools now have more automation and simulation-like debug features, making them easier to use. Regular breakthroughs in the power and performance of formal algorithms enable use on large blocks and clusters unimaginable just a few years ago.

However, the primary reason for the wider use of formal verification is that the majority of users are running applications ("apps") targeted for specific verification challenges. Apps typically generate most, or all, of the properties needed for formal analysis, with algorithms and tool features tuned for the target application. The result is a "pushbutton" solution requiring minimal training even for users with no formal experience. Further, apps are so efficient that many are run at the full-chip level even for very large system-on-chip (SoC) designs. The goal remains finding all bugs and proving that all bugs have been found, but only those bugs related to the specific challenge being addressed.

SoC connectivity challenges

Connectivity checking is one of the most widely used application for formal technology. The purpose of this verification task is deceptively simple to state: Ensure the proper interconnections among design blocks and I/O cells. This sounds easy enough, but in fact it is a significant challenge. A modern SoC contains complex subsystems built with thousands of instances of highly configurable modules and IP blocks. Programmable elements provide flexibility and adaptability, while multiplexed I/O pads allow user control of which protocols run on which pins. There may be hundreds of thousands of connecting paths, every one of them important for proper functional operation of the chip.

Signals that are supposed to be connected may go through multiple blocks and multiple levels of hierarchy, as shown in figure 1. Inverters may exist along the paths, so it is critical to track polarity. Paths may also include state elements such as registers and flip-flops, resulting in multi-cycle delays between starting and endin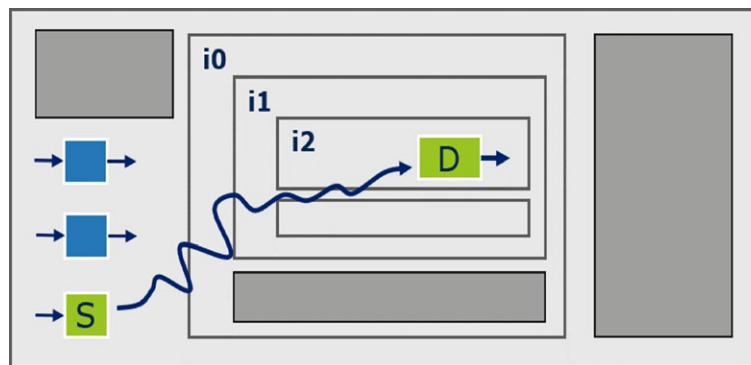g points. Some global signals such as clocks, resets, and scan enables are routed to thousands or millions of state elements, and the correctness of these connections should also be verified. All these reasons, plus the sheer number of connections to be checked, render connectivity verification by inspection completely impractical.

Fig. 1: Connectivity source and destination may be separated by levels of hierarchy.

Simulation or emulation of connectivity is more practical, but inherently incomplete. A test suite to cover every path required would be tedious to write, difficult to maintain as the design evolves, and time-consuming to run. Debug when errors are detected is not trivial; bug symptoms must be traced back to find the incorrect or missing connection. Of course, neither simulation nor emulation can provide any sort of proof of correctness, no matter how good the test suite may be. This is precisely why connectivity checking has become such a widely used application for formal technology. A formal tool can potentially find all the connection errors and prove that connectivity is complete after all bugs have been fixed.

Traditional formal connectivity checking

As previously noted, formal verification requires properties against which the design is checked. It is not hard to imagine writing a series of properties using SVA to specify the signals that must be connected, and this might be a tractable approach for small designs. Writing thousands of such properties would be daunting, and this is a key area where a connectivity checking formal app can help. The structure of connectivity properties is quite regular, so they can be generated automatically given a specification of intended connectivity. This is most often provided to the formal tool in the form of a traditional spreadsheet, as shown in figure 2.

Clearly, filling out this spreadsheet is much easier for users than writing assertions. The fields specify the source and destination for each connection path, the number of cycles of delay along the path, the condition under which the path should be enabled, and the relevant clock. The enabling condition is

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Tom Anderson is technical marketing consultant at OneSpin Solutions - www.onespin.com

```
# Source           # Destination      # Delay # Condition          # clock
top.a.b.c,         top.x.y.z
top.i1_m_s_bit.x,  top.i1_m_d_bit.y,  1,           top.debug_en==1'b0, top.clk
top.i2_m_s_bit.x,  top.i2_m_d_bit.y,  2:3,         top.debug_en==1'b0, top.clk
top.i1_m_s_bot.x,  top.i1_m_d_bot.y,  5,           top.debug_en==1'b0, top.clk
top.i2_m_s_bot.x,  top.i2_m_d_bot.y,  2,           top.debug_en==1'b0, top.clk
```

Fig. 2: Connectivity intent can be specified in a spreadsheet.

especially critical for paths containing multiplexors, such as I/O pads supporting multiple possible connections under different conditions. Given the information in the spreadsheet, a formal tool can generate all properties required with no manual specification. A combination of structural analysis and formal proof engines finds all bugs in the design (or errors in the spreadsheet) and then proves full conformance to the specification.

Like several other formal apps, connectivity checking is routinely run on full-chip designs. This is necessary since the full range of connections to be verified is visible only at the top level. Formal tools have capacity limitations, but connectivity checking is possible on large chips because only a small portion of the design is relevant to the problem at hand. Unrelated logic is trimmed away while building the formal model to speed analysis. However, today's very large heterogeneous computing platforms and similar SoCs stress the capacity of traditional formal tools. Further, filling out a spreadsheet with hundreds of thousands of entries rather than thousands is not realistic. Clearly, traditional formal connectivity checking must evolve.

The connectivity XL approach

A new methodology for connectivity verification, dubbed Connectivity XL by OneSpin Solutions, addresses the challenges of massive SoC designs. One of the key innovations is the elevation of connectivity intent specification to an abstract level. As shown in Figure 3, a spreadsheet remains the vehicle, but wildcards make the specification much more concise.

```
# Source                    # Destination
i:top.a.b, sig_c,           m:m_x,       sig_y
m:m_a,     sig_b,           i:top.x,     sig_y
m:m_s_b?p, sig_a,           m:m_d_b?p,   sig_x
m:m_s_b?t, sig_b,           m:m_d_b?t,   sig_y
m:m_s_b?o, sig_c,           m:m_d_b?o,   sig_z
m:m_s_*t,  sig_d,           m:m_d_*t,    sig_x
```

Fig. 3: Abstract connectivity specification is concise.

It is common for blocks to be instantiated multiple times with regular naming, so wildcards can compress the required number of spreadsheet lines significantly. This can reduce the time to specify intended connectivity from months to days.

A formal tool can read this abstract specification, compile it together with the design, and expand the wildcards to produce a traditional connectivity spreadsheet with a single connection per line. However, this specification may have hundreds of thousands of lines, so a traditional connectivity checking tool would likely have capacity issues. Ongoing improvements in the underlying formal algorithms of Connectivity XL support ever-longer connectivity specifications for ever-larger SoC designs. Machine learning based on many years of formal experience is used to select the best proof engine for the job.

Automatic abstractions reduce the formal model to the minimal require logic, speeding up runtimes and reducing memory usage. Another innovation of Connectivity XL is unifying structural and formal analysis for maximum efficacy. As part of generating detailed specifications, this analysis automatically detects delays and inverters in the connection paths and infers multiplexing conditions. In summary, Connectivity XL provides a more automated flow than traditional approaches, handles larger designs, and produces complete proofs even for the most complex chips.

Real-world verification results

At the recent Design and Verification Conference (DVCon) in China, Xilinx and OneSpin presented a case study of the One-Spin Connectivity XL App applied to a multi-billion-gate SoC. Using 7 nm technology, this chip contained 60 million instances of 35 thousand modules, 90 million flip-flops, and 80 thousand finite state machines. As one of the largest designs in the world, it stressed many tools in the design and verification flows. This was certainly true for connectivity checking since there were in excess of one million connections to specify, maintain across design iterations, and verify.
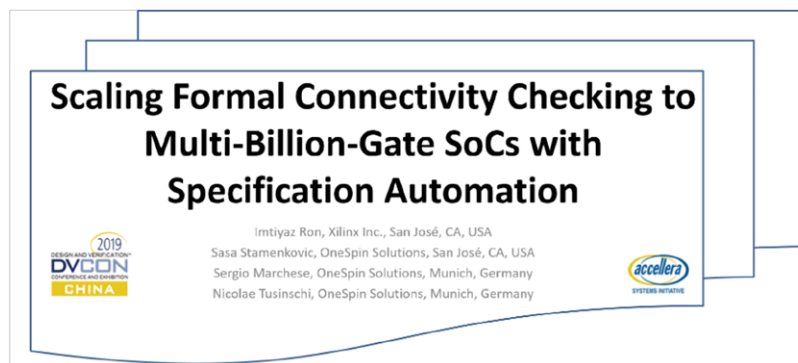

Fig. 4: A connectivity case study was presented at DVCon China 2019.

The verification team tried several traditional connectivity apps, including OneSpin's, and all failed to scale to this large chip. The effort to specify and maintain more than a million connections was unacceptable. Formal tool runtimes were excessive, and too often produced inconclusive proof results. With a tight design schedule, quality could not be compromised, and exhaustive verification was deemed critical. Connectivity XL proved to be up to the task. The abstract specification format reduced spreadsheet size by a factor of more than one hundred while making it easier to maintain the connection list.

Connectivity XL found several corner-case bugs that would have been very hard to detect using any other tool or method. The errors included incorrect block integration, multiple drivers enabled on paths, and re-convergent paths. The debug information provided enabled easy root-causing, even on paths with more then two thousand signals between source and destination. Once these issues were resolved, all one-million-plus connections were proven within a matter of days using multiple jobs running in parallel. There were no inconclusive results for any connections.

Conclusion

Ever-increasing chip size and complexity is making formal apps even more valuable, especially connectivity checking. There is no chance that simulation, emulation, or manual techniques will suffice. Even traditional formal tools do not scale. The Connectivity XL approach is the next generation of connectivity checking solution, with both greater capacity and improved automation. It has been validated on a real-world multi-billion-gate SoC design with more than a million connections. Designs will continue to grow but this new category of formal tools is positioned to provide a viable solution for years to come.

Connecting with e-textiles: Find the box!

By James Hayward

Commercial efforts around electronic textiles have been prominent for at least 25 years, starting with early patents and then early products throughout the 1990s. Electronic components including batteries, transistors/microprocessors, antennae for communication and so on, have all been demonstrated in a textile format, and examples of these are included in IDTechEx' latest research report "E-Textiles 2019-2029: Technologies, Markets and Players".

The majority of these demonstrations are a one-off proof of concept, and certainly not commercially mature enough for wider deployment. Therefore, as nearly all e-textile products will need these components, commercial options today typically include traditional rechargeable batteries and housed PCBs containing the other essential electronic components. The result is that these components need to be housed somewhere in the e-textile product, and hence it is typically possible to "find the box" which contains these components.

This electronic box can potentially be a good solution to the challenge of washing. Typically, e-textile products can be sold with multiple versions of the garment element and a single box to fit all of them. Then the box can be removed for washing and replaced onto copies of the garment element, just as would be the case for a smartwatch or chest strap. This requires a replaceable, reliable, durable and fool-proof connector option, for which traditional snap fasteners or magnetic versions are typically preferred. As our report shows, the industry has

E-textiles 2019-2029: Find the box!

finally started to converge towards some design standards after years of divergent approaches.

However, the case persists that the presence of these boxes remains a barrier towards increasingly widespread adoption. The boxes can be impractical, uncomfortable, unattractive, and therefore an unwelcome, if necessary, hindrance to the overall product. This said, e-textile product designers continue to improve these systems, making the boxes less visible, more practical and overall minimizing any negative aspects that their presence may create.

Some products have been demonstrated that can begin to move towards an option without a box. Some groups have demonstrated integration of electronic components directly into yarns; where components are small enough, they can be encased and connected, allowing integration of various sensor types. However, this is size limited, so unlikely to be feasible for larger components such as the battery. Nonetheless, this has been an interesting trend pursued by the like of Primo1D, Siren Care, Nottingham Trent University, and others.

Another idea to remove the box would be to minimise the volume that needs to be taken up by batteries. This could be by reducing the overall power consumption of the system, or by providing additional power to the device via a technique such as energy harvesting or wireless charging. Many of these ideas have been considered by e-textile companies. The report describes several techniques for energy harvesting in e-textiles, most of which are academic proof-of-concept so far, but some of which have been explored in a more commercial context. Similarly, wireless charging techniques, including RF charging, inductive charging, and so on, have also been explored by different companies in the space, and some examples of proposed partnerships and approaches are mentioned in the report.

A quarter of a century of commercial exploration around e-textiles has resulted in many companies that exist to serve this space, but still, the products remain outside of mainstream markets. As part of its report, IDTechEx Research has listed 200 players involved in this industry, spanning the entire value chain. The report is written to provide the most comprehensive overview of this emerging technology space, enabling readers to learn from the past, assess partners or competitors in the present, and plan for the future of this industry.

James Hayward is a leading industry expert and Principal Analyst at IDTechEx - www.IDTechEx.com

Find the box. Nearly all e-textile products today utilize traditional electronics where textile equivalents are not available. These need to be housed, typically in a small encapsulated box that can either be removed for, or tolerate, washing. Source: IDTechEx photos and company images, "E-Textiles 2019-2029: Technologies, Markets and Players".

Cable harness: The unseen challenge

By Christoph Hammerschmidt

With the automation of driving, electronics in cars are becoming increasingly complex, and OEMs are mulling new architectures that meet the demand of the future. However, the modernization so far has spared one central component of vehicle electronics: The wiring harness. Doug Burcicki, Automotive Director, Integrated Electrical Systems at EDA software provider Mentor, explains what is needed.

Over the past decade, car designers added tons of new electronic features and functions to new vehicle models. In lockstep with the number of functions increased the number of Electronic Control Units (ECUs): "Since the traditional ECUs were – and are – single-function devices, the developers had to add a new ECU for more or less every new feature," Burcicki says. The result is known: A jungle of ECUs grew under the engine bonnets.

Now, as vehicle electronics is setting off for high speed data communications, fuelled by the trend towards compute-heavy autonomous vehicles, the situation is more complex than ever. And the upcoming electrification of the drivetrain will not exactly contribute to a relief, Burcicki notes: With today's technology, connectivity, driving automation and electrification will more than quadruple the harness, he says. It is easy to see that without a careful, future-oriented redesign not only of the wiring systems, the road to more complexity leads to a dead end.

The rising significance of software is adding to the complexity. In today's cars it is not unusual that the embedded software amounts to millions of lines of code (LoC). The software modules distributed across dozens of ECUs need to communicate among each other, and they trigger more communications processes between sensors and ECUs, among the various ECUs and between the car and the backend infrastructure. And all these communications processes require wires for the transport of data. What's more, the evolution of the in-car networks is going to accelerate because future vehicle generations will increasingly add new functions even after they have left the production line – through over-the-air (OTA) updates.

The question is: What to do. In autonomous vehicles, the "thinking" part (of the "sense-think-act" chain of effects of automatic systems) is the toughest challenge for OEMs, Burcicki says. To master the challenge of this dynamic growth of complexity, it will be necessary to fundamentally re-design the harness architecture. "Wiring has to be adaptable to changes coming ten years down the road," the Mentor mastermind says.

Guiding lines for the re-design are, among other, the functional allocation and the software configuration of future cars. Towards this end, the harness systems need to become more flexible. An important aspect is in the future, the ECUs need headroom to grow into future application worlds, which means they need to be able to accommodate even more lines of code, and, if necessary, they need to be able to provide more computing power. Therefore, a certain level of redundancy will be required – at the ECU level as well as at the cable harness level.

To meet the requirement of flexible provision of computing horsepower, automotive electronics designers are typically betting on more centralized compute platforms in the vehicles, with former physical ECUs being

Mentor's Doug Burcicki: "OEMs need to evolve their processes".
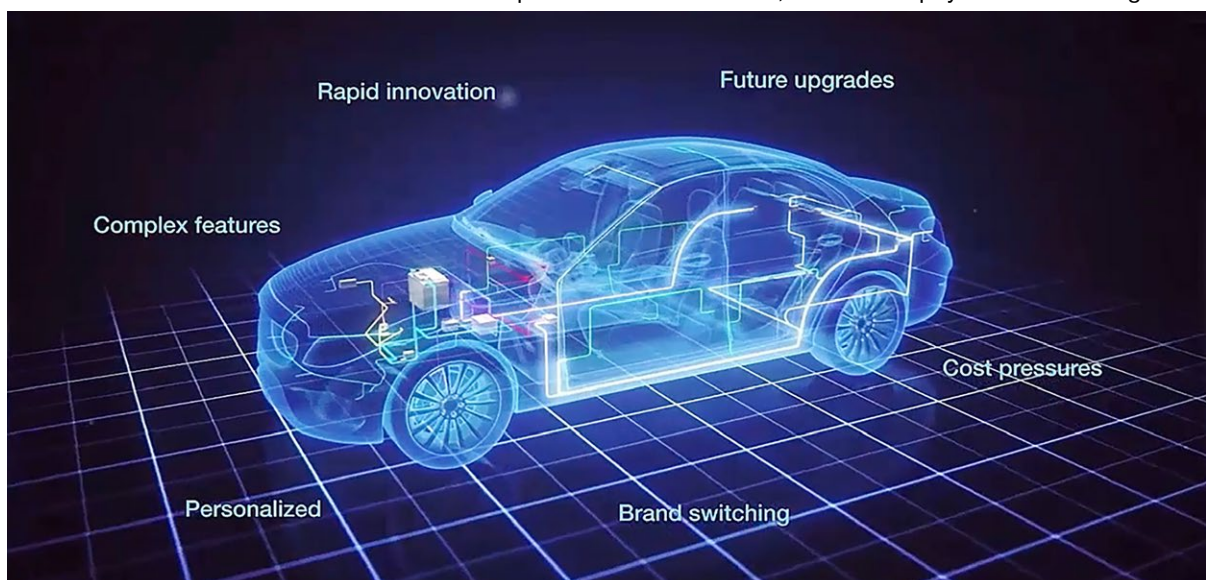
turned into virtual ones – the ECUs become a piece of software, running on a powerful compute platform. At first glance, it looks as if this approach reduces the cabling requirements. But Burcicki has also observed a contrary trend: "In future generations of autonomous vehicles, we will see more diversity, more different approaches, and more computing horsepower will migrate into the sensors", he says.

Under the bottom line, it becomes obvious that adapting the wire harness design to automated driving and vehicle connectivity won't be a trivial task. "Actually, this is one of the most challenging things in automotive design," Burcicki said. "OEMs need to evolve their processes to integrate across domains, automated design tasks and provide robust data coherency", he concluded.

Rapid innovation

Future upgrades

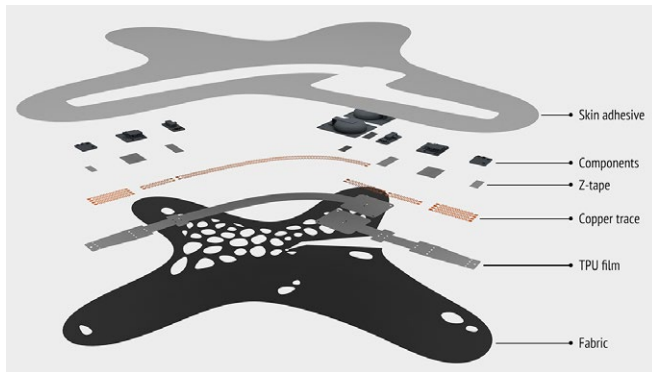Complex features

Cost pressures

Personalized

Brand switching

Custom electronic patches on-demand

By Julien Happich

A team of researchers at the Robotics Institute and the Department of Mechanical Engineering from Carnegie Mellon University has elaborated a novel design method to easily create customized electronic patches that fit specific functional requirements while conforming to any given body part.

They presented their results during the latest conference of Human-Computer Interaction (CHI 2019) in a paper titled "ElectroDermis: Fully Untethered, Stretchable, and Highly-Customizable Electronic Bandages", demonstrating electronic bandages that could be re-used over times by simply replacing the underlying medical grade and breathable adhesive film.

A multi-layer fabrication method to integrate multiple electronic modules into one laminate.

For their configurable electronic bandages, dubbed ElectroDermis, the researchers combined islands of small electronic circuits electrically wired together with flexible copper-clad film patterned into meandering conductive traces. The whole assembly is then press glued into cut-out shapes of stretchable fabric (spandex) specifically designed to conform to various body parts in 3D.

Most of the work here, relates to the actual design of 3D capable origami-based shapes that can be easily cut-out in 2D layers for ease of bandage assembly and fabrication.

For this purpose, the authors created an interactive design tool that lets end users select a target body region (say the elbow, the knee, the neck, the wrist etc..) from a predefined 3D model of the human body or a 3D scan of the wearer. The tool then leverages origami-based flattening algorithms to parametrically cut and flatten the 3D shape with minimal distortion. Once the 2D contour and cut-outs (for some of the folds) are obtained, the laser-cut fabric, stretchable wiring and electronic components can all be laminated into one bandage, with a foil of adhesive later affixed to interface with the wearer's skin.
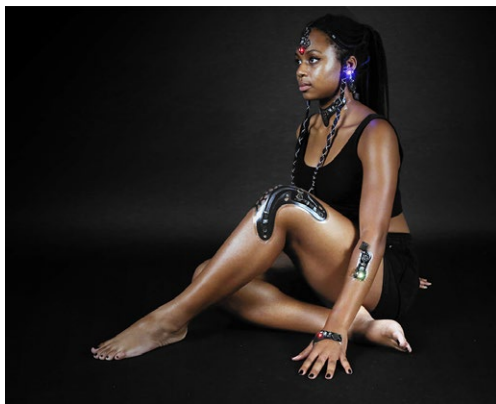
A model wearing wirelessly connected stretchable and on-skin compliant wearable electronics including a temperature mask, vital monitoring earrings, a context-sensitive necklace, a knee-worn motion tracker, a wound monitor on the forearm, and an environment-aware bracelet.

The researchers were able to demonstrate various combinations of sensors, serial communication, and batteries to yield an untethered on-skin wearable device stretchable enough to resemble electronic bandages. Each patch was built around an ARM Cortex-M4F processor for on-board signal processing and Bluetooth low energy (BLE) radio for wireless interactive control. Using their proprietary tool, they were able to customize any electronic bandage in less than an hour, creating a number of wearable designs such as a temperature mask, vital monitoring earrings with pulse rate detection, a context-sensitive necklace (tracking food intake via high-fidelity acceleration and sound monitoring at the neck), a knee-worn motion tracker, a wound monitor (featuring a camera and a LED) and an environment-aware colour mirroring bracelet.

Connector system for EV drivetrains support 400A continuous

Developed to meet the demanding requirements of electric and hybrid vehicle drivetrains, the PerforMore connector system from Stäubli Electrical Connectors can carry a continuous current of 400A or more with minimal power loss. The rugged devices are suitable for connecting the whole drivetrain, including batteries, inverters, motors and high voltage distribution units. Their low contact resistance is due to the company's proprietary M ultilam multi-contact system, which also guarantees strong resistance to vibration and elevated temperatures. With a pitch only usually found with significantly lower current ratings, the connector maintain s the clearances and creepage distances necessary for high operating voltages. In the mated condition in particular, its low profile gives a clear advantage in the efficient use of available vehicle space. The two pole connector has 10mm diameter contacts and is rated at 1000V, as defined in LV215 standards. Robust and reliable, it features ingress protection to IP67 and IP69 according to IEC 60529 when mated, and IP2X unmated. Mechanical keys and colour coding offer additional flexibility and safety if using more than one connector in a vehicle, by eliminating the risk misconnections.

Stäubli Electrical Connectors
www.staubli.com

Connector systems bring life to the PCB

Without the suitable components, a PCB is just a lifeless carrier of electronic elements with conductive tracks. Alongside other essential elements, is the connector system that breathes life into a PCB (printed circuit board). Connector systems often used include Wire-to-Wire (W-t-W) / Wire-to-Board (W-t-B) connections, which provide the important function of connecting two cables or connecting a cable to a PCB in order to guarantee the power supply and/or signal transmission. With five new product ranges: 499, 570, 589, 5113 and 5265, W+P ensures the demand for the particularly small pitches of the friction lock W-t-W / W-t-B product family. The series are offered as male (on PCB/Wire) and female (on Wire) headers, female housings and contacts. These are deliverable starting at a pitch of just 1.0mm, in horizontal or vertical alignment and some equipped with locking. The contact material consists of copper alloy and the insulator is made of thermoplastic according to UL94 V-0. The indicated components are offered with various finishes, designed for cable cross sections ranging from AWG 34 to AWG 22. The number of contacts varies between 2 and 50, the corresponding data sheets are available for download.

W+P
www.wppro.com

Connector assembly for simple motor connections

The new QPD installation system connector for assembly from Phoenix Contact has been designed specifically to connect motors such as those of retractable awnings or external blinds. The robust and vibration-proof housing is highly reliable and protected against splash water and dust due to its IP54 degree of protection. The Quickon fast connection makes this connector quick and easy to connect. It doesn't require the use of special tools. Simply tightening the union nut automatically makes contact with the untreated conductor and establishes strain relief. This reduces connection time by up to 80 percent. The plug connector is available as a 4-pos. unit, including PE connection, and transmits power up to 400 V and 17.5 A. Accepts conductors from 0.5 to 1.5mm².

Phoenix
www.phoenixcontact.com

Ready-made cable assemblies offers fully tested high reliability off-the-shelf

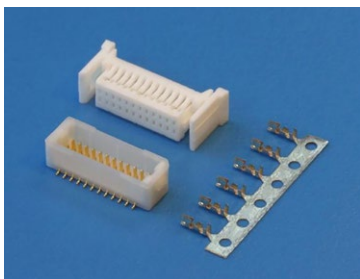In order to provide customers with simple plug-and-play solutions, Harwin has now introduced a range of off-the-shelf cable assemblies to accompany its popular Datamate series of high reliability connector components. Supplied in single- or double-ended format, with a set cable length of 150mm, these time-saving cable assemblies are certain to have considerable market appeal. They will give companies the quick and trouble-free access they need to the cabling without having to rely on their own in-house resources or make major investments into an expensive custom-built arrangement. The assemblies are available direct from stock, ready to order from Mouser eliminating long lead times. They cover both signal (Datamate J-Tek/L-Tek) and power (Datamate Mix-Tek) configurations. Inherently cost effective, they are particularly well suited to one-off prototyping work or small-batch projects. Each assembly is produced in accordance with IPC-A-620 standard concerning wire harnesses and cabling. They are given rigorous electrical testing and go through a comprehensive inspection process both during and after production. The cables used are PTFE insulated. The signal cables come with 24AWG gauge equipment wire, while the power cables are provided with either 10AWG or 12AWG gauge wire, with 40A or 20A current supported. The connector assemblies offer industry-leading resilience to shock (100G for 6ms), vibration (10G for 6 hours, 2 hours/axis) and extreme temperatures (-55°C to +125°C). Furthermore, they can cope with up to 500 mating cycles.

Harwin
www.harwin.com

10Gb/s USB Type-C connector

The C-Type USB 3.0 connector from Bulgin combines field-proven reliability with data transfer speeds of up to 10 Gb/s. The 4000 Series C-Type connector supports USB 3.1 Gen 2, and is also backwards compatible with USB 3.0 and USB 2.0 devices. The USB Type-C connector is reversible and can be connected either way up, making it more convenient and easy to use, it can provide up to 100W to support a wider range of devices, and achieve faster charging.

Tested to IP69K and IP68, the 4000 Series C-Type connector provides protection against dirt and water ingress: fully submersed up to two weeks at 10m, and resistant to high pressure, high temperature water jets. It also offers an extended operating temperature range from –40 to +80ºC. This means that the connector is well-suited for outdoor installations and harsh environments, including underground.

Bulgin
www.bulgin.com

Smart transceiver natively supports LonWorks and BACnet

Adesto's FT 6050 Smart Transceiver SoC now natively supports LON, LON/IP, BACnet/IP and BACnet MS/TP protocol stacks The device is designed to allow LON and BACnet to communicate simultaneously over the Free Topology (FT) channel. The FT 6050 Smart Transceiver allows BACnet workstations and LON network manager and integrator tools to field-configure and monitor controllers as either LON or BACnet devices, or both. This enables a flexible architecture that takes advantage of the fault-tolerant FT media. The FT 6050 enables differentiated architectures and therefore fewer SKUs are required. The FT 6050 Smart Transceiver SoC is supported in both LON and BACnet configurations by Adesto's SmartServer IoT, an open and extensible industrial edge server that supports multiple protocols.

Adesto
www.adestotech.com

Wire-to-wire connectors fit 12–18AWG industrial applications

AVX's 9286-300 Series wire-to-wire connectors offer simple strip-and-poke-home insertion, twist-and-pull extraction, and reliable wire retention in a small, sleek, colour-coded, flame retardant, reusable, and pottable package. Designed for 12–18AWG wire, the 9286-300 Series employ a one-piece phosphor bronze contact with high-force contact beams that provide both mechanical stability and reliable wire retention and an integral wire-stop that prevents over insertion. The series also accepts both solid and stranded wires, is smaller and sleeker than competing connectors. It has flame retardant UL94 V-0 glass-filled thermoplastic housings that protect connections from potting and coating materials.

AVX
www.avx.com

Plastic push-pull connector withstands extensive sterilisation cycles
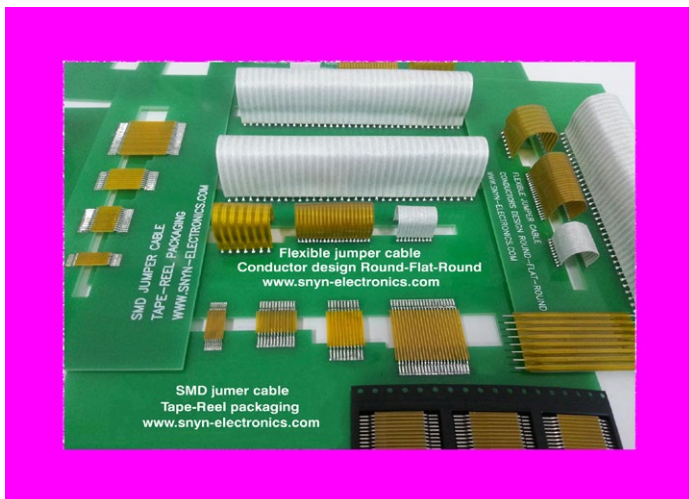
Lemo's latest addition to its lightweight REDEL plastic Push-Pull connector series, the SP features a patented internal push-pull latching system, embedded in the shell, which offers increased durability and very high contact density. Constructed with proprietary sulfone the connector can withstand extensive sterilisation cycles, is available with multiple contact configurations and in a variety of colours giving instant visual identification that is vital to avoid cross mating. An ergonomic grip incorporated in the shell design assists surgeons and medical staff to mate and align the connections making the connectors suitable for medical or measurement applications.
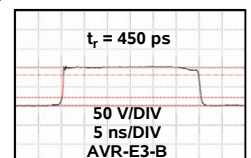
Lemo
www.lemo.com

Flexible jumper cable
Conductor design Round-Flat-Round
www.snyn-electronics.com

SMD jumer cable
Tape-Reel packaging
www.snyn-electronics.com

SMD JUMPER CABLE
TAPE-REEL PACKAGING
WWW.SNYN-ELECTRONICS.COM

MIPI CSI-2 4Gbps/lane SerDes chipset extends transmission to 15m

Thine has announced the high-volume availability of its MIPI CSI-2 extension chipset, THCV241A and THCV242, allowing engineers to extend MIPI CSI-2 transmission from 1 foot to over 15 meters. The new SerDes chipset also enables designs that can receive 2 different video inputs simultaneously, as well as applications that can copy and distribute (simultaneously replicate) 1 video stream into 2. THCV241A serializes up to 4 lanes of MIPI CSI-2 signals and converts it into 1 or 2 lanes of V-by-One, supporting up to 4 Gbps per lane which is robust enough to extend the transmission of 1080p60 2Mpixel uncompressed video for greater than 15 meters with typical cables. THCV241A's 2 lanes of V-by-One HS supports up to an 8 Gbps data rate with the capability to use the second V-by-One HS lane to support data copy and distribution (replication) applications. The THCV242 chip deserializes up to 2 V-by-One HS lanes back to the original MIPI CSI-2 signal. The chipset supports "Sub-Link" that aggregates bidirectional low speed signals, such as GPIO. The separation of high speed signal path, V-by-One HS, and Sub-Link enables easy debugging and gives more choices for physical harnesses including the utilization of Keyssa's contactless connection for systems benefiting from or requiring a ruggedized, low latency, detachable camera. Mirrored video signal redundancy supported by this chipset can be used for troubleshooting system problems or for applications such as agricultural robotics and 3D surgical equipment which require a secondary application processor that is distant from the source video camera.
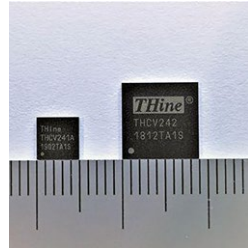
THine Electronics
www.thine.co.jp

32-bit MCUs targets space-constrained edge devices

Renesas Electronics has added four new RX651 32-bit microcontrollers to its portfolio, in ultra-small 64-pin (4.5x4.5mm) BGA and 64-pin (10x10mm) LQFP packages. This represents a 59% footprint reduction compared to the 100-pin LGA, and a 49% size reduction versus the 100-pin LQFP, claims the company. The 32-bit MCUs address advanced security needs for endpoint devices employing compact sensor and communication modules in industrial, network control, building automation, and smart metering systems operating at the IoT edge. The RX651 MCUs integrate connectivity, Trusted Secure IP (TSIP), and trusted flash area protection that enable flash firmware updates in the field through secure network communications. The increase in endpoint devices operating at the edge has increased the need for secure over-the-air (OTA) firmware updates. The new RX651 devices support this reprogramming requirement with integrated TSIP, enhanced flash protection, and other technology advancements that offer a more secure and stable solution than other available solutions on the market.

Renesas Electronics
www.renesas.com

Design your own far-field voice interface

This month, XMOS is giving away three VocalFusion Dev Kits for Amazon AVS (XK-VF3510-L71-AVS) for eeNews Europe's readers to evaluate and prototype far-field voice interfaces using the XVF3510 voice processor with the Amazon Alexa Voice Service. Worth $399, the VocalFusion development kit is a far-field 2-mic solution optimised for smart TVs and set-top boxes. It is built around the XMOS XVF3510 voice processor, running the company's next generation acoustic algorithms to support far-field voice capture with close range precision. Only costing $0.991, the XVF3510 enables manufacturers to embed a voice interface into mass-market smart TVs and set-top boxes economically. Developed in the UK and purpose-built for modern living spaces, XMOS' next generation acoustic algorithms can identify and isolate a voice command from every other sound in the room (including any media streaming through the device itself). They include a stereo acoustic echo canceller, an interference canceller to cancel out unwanted background noise, and an adaptive delay estimator that dynamically adjusts audio reference signal latency, ensuring the acoustic echo cancellation algorithms deliver a smooth, real-time experience.

Check the reader offer online at

www.eenewseurope.com

SMARC modules integrate Intel Atom/Pentium/Celeron series

Advantech's SOM-2569 is a SMARC (Smart Mobility Architecture) computer module targeting applications that require low power consumption, the flexibility to upgrade computing performance, and effective budget control in the system development process. Together with bundled the WISE-PaaS/DeviceOn software, SMARC modules can help end customers with operations management and ease maintenance. Measuring 82x50mm, the SOM-2569 features Intel Atom E3900, Pentium and Celeron N Series processors. Its supports up to three displays simultaneously and also supports several I/O, such as SATA, USB3.0/2.0, COM port, SMBus, and I²C. The board comes with 2 LAN controllers and onboard Wi-Fi and Bluetooth, a TPM and secure boot for enhanced security, and onboard design for all key components (such as memory, eMMC) for maximum reliability. The all-soldered board assembly has been tested for vibration at 0.028G²/ Hz, 3.5 Grms, bumping at 1 corner, 3 edges, 6 faces, and thermal shock resistance, ranging from -40 to 85°C at a slope 10°C per minute.
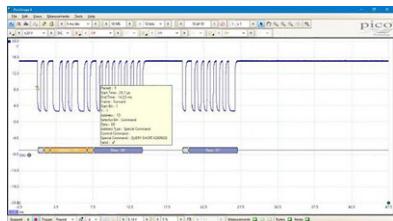
Advantech Europe BV
www.advantech.com

DALI decoding and analysis through USB PC oscilloscope

Pico Technology has added DALI decoding and analysis with the latest version of PicoScope 6 software. DALI (Digital

Addressable Lighting Interface) provides two-way communications between lighting fixtures ("luminaires"), ballasts and controllers. A DALI controller can talk to individual LED drivers and ballasts, and those devices can in turn talk back to the controller to report light failures, energy consumption, ambient light conditions and so on. "Networked DALI devices are at the heart of modern buildings management. Engineers and systems integrators developing modules and deploying DALI networks need tools to rapidly identify timing and signal integrity problems when they occur. PicoScope DALI decoder provides clear display of the data communications flow, and easy correlation with the waveform of frame errors due to signal integrity issues", commented Trevor Smith, Business Development Manager at Pico Technology. The decoder is included as standard with PicoScope 6.4.14 and is available to download free of charge. It is compatible with PicoScope 2000, 3000, 4000, 5000 and 6000 Series PC-based Test & Measurement oscilloscopes.

Pico Technology
www.picotech.com

World's largest FPGA boasts 9 million system logic cells

Xilinx has expanded its 16nm Virtex UltraScale+ family to include what it claims to be the world's largest FPGA, the

Virtex UltraScale+ VU19P. With 35 billion transistors, the VU19P provides the highest logic density and I/O count on a single device ever built, enabling emulation and prototyping of tomorrow's most advanced ASIC and SoC technologies, as well as test, measurement, compute, networking, aerospace and defense-related applications. Featuring 9 million system logic cells, up to 1.5 terabits per-second of DDR4 memory bandwidth and up to 4.5 terabits per-second of transceiver bandwidth and over 2,000 user I/Os, the new FPGA enables the prototyping and emulation of today's most complex SoCs as well as the development of emerging, complex algorithms such as those used for artificial intelligence, machine learning, video processing and sensor fusion. The VU19P is 1.6X larger than its predecessor and what was previously the industry's largest FPGA — the 20 nm Virtex UltraScale 440 FPGA. The VU19P is supported by an extensive set of debug, visibility tools, and IP, providing customers with a comprehensive development platform to quickly design and validate next-generation applications and technologies.

Xilinx
www.xilinx.com

XL-Flash storage class memory comes in 128 gigabit dies

Toshiba Memory Europe has launched a new Storage Class Memory solution dubbed XL-Flash, based on the company's BiCS Flash 3D flash memory technology. With 1bit-per-cell SLC, XL-Flash brings low latency and high performance to data centre and enterprise storage. Classified as persistent memory, with the ability to retain its contents similar to NAND flash memory, XL-Flash bridges the performance gap that exists between DRAM and NAND. While volatile memory solutions such as DRAM provide the access speed needed by demanding applications, that performance comes at a high cost. As the cost-per-bit and scalability of DRAM levels off, this new storage class memory layer in the memory hierarchy addresses that issue with a high density, cost effective, non-volatile NAND flash memory solution. Sitting in between DRAM and NAND flash, XL-Flash brings increased speed, reduced latency and higher storage capacities – at a lower cost than traditional DRAM. The memory will initially be deployed in an SSD format but could be expanded to memory channel attached devices that sit on the DRAM bus, such as future industry standard non-volatile dual in-line memory modules (NVDIMMs). It comes in 128 gigabit (Gb) die (in a 2-die, 4-die or 8-die package), with a 4kB page size and a 16-plane architecture for efficient parallelism.
Toshiba Memory Europe GmbH
www.toshiba-memory.com

STM32Trust Ecosystem consolidates cyber-protection resources

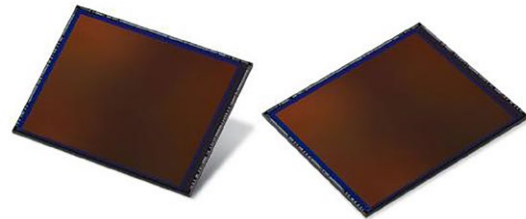STMicroelectronics has launched STM32Trust to guide designers' efforts to build strong cyber-protection into new IoT devices leveraging industry best-practices. STM32Trust combines knowledge, design tools, and ready-to-use original ST software. These help designers take advantage of features built into STM32 microcontrollers to ensure trust among devices, prevent unauthorized access, and resist side-channel attacks. All this averts data theft and code modification. Integrating all available cyber-protection resources for the STM32 family, STM32Trust helps designers implement a robust multi-level strategy leveraging security-focused chip features and software packages. Based on the Arm Cortex CPU architecture, the STM32 family contains almost 1000 variants with hardware cyber-protection features such as customized secure boot, a random-number generator to prevent hackers observing patterns in signals, dedicated encryption co-processors, and secure storage for encryption keys. ST also builds in tamper detection, firewall code-isolation mechanisms and implements Arm TrustZone technologies for extra protection of the most sensitive code. STM32Trust provides product developers with all they need to protect connected objects effectively using these features, including reference material and free software.
STMicroelectronics
www.st.com

108Mp image sensor delivers over 100 million effective pixels

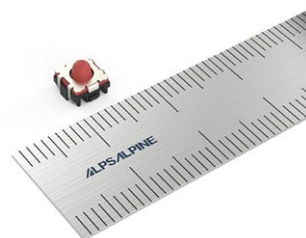Samsung Electronics has released a 108 megapixel image sensor, the Samsung Isocell Bright HMX, believed to be the first mobile image sensor to go beyond 100 million pixels, offering a resolution equivalent to that of a high-end DSLR camera. The new sensor is the result of close collaboration between Xiaomi Corp. and Samsung. With over 100 million effective pixels enabling extremely sharp photographs rich in detail, the Isocell Bright HMX also produces exceptional photos even in extreme lighting conditions. Being the first mobile image sensor to adopt a large 1/1.33-inch size, the HMX can absorb more light in low-lit settings than smaller sensors and its pixel-merging Tetracell technology allows the sensor to imitate big-pixel sensors, producing brighter 27Mp images. In bright environments, the Smart-ISO, a mechanism that intelligently selects the level of amplifier gains according to the illumination of the environment for optimal light-to-electric signal conversion, switches to a low ISO to improve pixel saturation and produce vivid photographs. The mechanism uses a high ISO in darker settings that helps reduce noise, resulting in clearer pictures. For advanced filming, the HMX supports video recording without losses in field-of-view at resolutions up to 6K (6016 x 3384) 30-frames-per-second (fps). Mass production for Samsung ISOCELL Bright HMX will begin later this month.
Samsung
www.samsung.com

Automotive TACT switch offers quiet operation

Alps Alpine has added a model with 0.9mm travel to its SKSU Series compact, middle-stroke TACT Switch lineup. The SKSUBCE010 offers push clarity along with quiet operation and a distinct click, suitable for automotive use. The newly developed product's 0.9mm travel places it at the longer end of the middle stroke range. While retaining the quiet sound and distinct click feel made possible by combining rubber and metal for an original contact structure, the new model delivers a clearer push sensation, both enhancing the clarity of operation and satisfying demand for a premium operating feel. The SKSUBCE010 also incorporates a pre-stroke design – a feature of existing automotive TACT Switch products – helping to prevent rattling while integrated into the end product. Because the SKSU Series has mounting compatibility with the existing SKTQ Series, customers using an existing product can choose the best operating feel for their vehicle brand without having to modify the board design.
Alps Alpine
www.alpsalpine.com

DISTRIBUTION CORNER

Arrow launches "AI Experience Tour" across EMEA

Arrow Electronics announced a series of events that will bring together leading authorities in the design and deployment of artificial intelligence (AI). Starting in September, the " AI Experience Tour " will demonstrate how AI is being used in commercial applications today and help attendees to understand how they can leverage AI to advance their own applications. Arrow is hosting this unique tour with Intel, Microsoft, Nvidia and other suppliers who are leading the way in AI.

Arrow Electronics
www.arrow.com

Avnet Integrated releases cost-optimized COM-based platform

Designed to enable engineers to bring HMI and IoT solutions to market more quickly, SimpleFlex by Avnet Integrated is a compact embedded platform that is easy to configure and flexible to match the requirements of various applications. MSC Q7-MB-EP5, the first SimpleFlex COM-based platform offered, is designed for Avnet Integrated's huge portfolio of x86- and ARM-based Qseven modules. The ready-to-use SimpleFlex platform is cost-efficiently adapted with the required interfaces and assembled in-house at full-automatic production lines. For the customization, 34 pre-validated interface combinations are available.

Avnet Integrated
www.avnet.com

Nordic's nRF9160 development kit now at Rutronik

The Nordic Semiconductor nRF9160 Development Kit (DK) is a cost-effective hardware development platform providing all necessary tools for evaluation and development of application firmware based on the nRF9160 SiP (System-in-Package). This supports both LTE standards, M1 and NB-IoT, and is globally compatible. The Development Kit includes a LTE antenna that supports bands in 690-960MHz and 1710-2200MHz. It has a dedicated GPS antenna for the nRF9160 version with built-in GPS, a 2.4GHz antenna can be used with Bluetooth 5, Bluetooth Mesh and IEEE 802.15.4 protocols, like Thread or Zigbee.

Rutronik
www.rutronik.com

Mouser Electronics opens customer service center in Vietnam

Mouser Electronics has just opened its Vietnam Customer Service Center, in Ho Chi Minh City. Located in the iconic Bitexco Financial Tower, the center will support local electronic design engineers, buyers and hardware innovators, helping them to locate the newest products for their designs. Mouser now has 26 service locations worldwide, with 10 locations in the Asia Pacific region. The electronics industry in Vietnam has seen rapid growth in the past decade. The new customer support center will better support existing customers while also enhancing Mouser's overall marketing efforts to serve new customers in the area.

Mouser Electronics
www.mouser.com

Faster Anglia Live offers enhanced free samples service

Anglia has upgraded Anglia Live, its e-commerce website, adding easier access to free samples, faster searches and improved keyword searching. Customers with an Anglia Live credit account are now able to request free samples to support design evaluations and initial prototype builds directly from the site. The distributor has offered comprehensive access to free samples and evaluation kits for some time, but until now this service has been offered through a separate portal. Now, free samples are fully integrated with Anglia Live allowing customers to search stock and order samples from the same site.
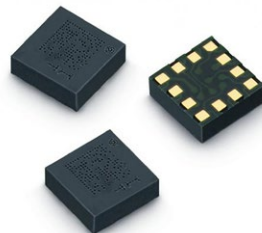
Anglia
www.anglia.com

Motion sensor comes with preset functionalities

Würth Elektronik has expanded its sensor program with a compact, versatile 3-axis acceleration sensor. Measuring only 2.0×2.0×0.7mm, the WSEN-ITDS sensor, is offered in an LGA package and uses a MEMS-based capacitive measuring principle. Thanks to an integrated temperature sensor, the sensor outputs calibrate data directly. Four measuring ranges are available for selection: ±2, ±4, ±8 or ±16 g. Register settings can be used to select the application-specific functionalities for free fall, wake-up, tap, activity, motion and orientation detection.

Würth Elektronik
www.we-online.de

LAST WORD

Backdoors are for houses, not security

William G. Wong

Attorney General Barr is only the latest to suggest that a "safe" backdoor should be added to products. That's a very, very bad idea.

Security has finally found a place in embedded applications as the Internet of Things (IoT) continues to rise in importance. Hacked systems have been the bane of PCs and smartphones, even as developers try to deliver more secure systems. It's hard enough to prevent attacks like ransomware without having to worry about backdoors.

These days, IoT solutions are hyping end-to-end security. This typically includes secure attestation, authentication, secure communication, and even secure updates. A lot of security layers and protocols are involved, and they're designed to secure a system and possibly isolate any breaches. Knowing that a breach has occurred is useful information by itself when considering the overall security of a system.

A security backdoor is one that bypasses the normal security features of a system. It usually provides unimpeded access and possibly control of a system. This can be handy for debugging and it's often why developers include one, but they should never be left in a shipping system. Unfortunately, many systems have been attacked through such a backdoor. Developers often have done very dumb things like simple, hard coded passwords.
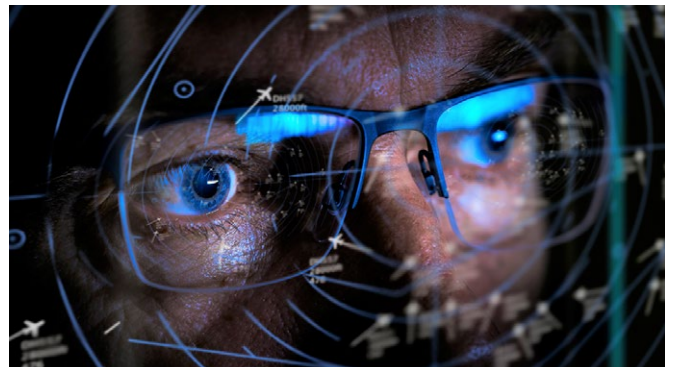
Granted, creating a secure backdoor could be possible, but it essentially places two security systems within a product. An attacker simply needs to bypass one of these to gain control. While the front door protection will usually be robust, the same can't be said for the backdoor, which is also secret. Security through obscurity is generally a bad idea.

Anyone who knows anything about security will tell you that backdoors are an extremely bad idea. Those that ignore security experts will be in for very bad surprises.

Unfortunately, Attorney General William Barr is just the latest to call for backdoors. He said, "Don't give me that crap about security, just put the backdoors in the encryption." Forcing this through legislation has been suggested as well. It could only end badly.

Good security is built on layers that have been tested and designed to work together. The latest systems are designed from the ground up for security, starting with private encryption keys that never exist outside of the chip. Secure boot is simply the next step of the process. All of this security, hardware, and protocols are designed to prevent specific types of attacks. There are many ways to attack a system, and it only takes one success to cause major headaches.

There are ways to provide hierarchical security within many systems, but that's by design. Backdoors bypass this design. It will be even worse if a backdoor gets added after the fact.

Another problem with backdoor security is that those who feel secure because of the primary security system have been deluded. The premise for a backdoor is that the "good guys" can do things the "bad guys" will not know about. Unfortunately, that's often not the case—the backdoor can be used for nefarious reasons regardless of who is controlling the backdoor. Gaining access by compromising a backdoor system or attacking a poorly designed one results in a system that's not only hacked, but the security layers designed to isolate other attacks are completely bypassed.

The bottom line is that backdoors should not be included in any system, and everyone should understand why. There's no secret sauce that will make a backdoor safe. Don't let anyone try to convince you otherwise.

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2019

24. – 25.10.

EUROPEAN EMBEDDED
VISION CONFERENCE

ICS Stuttgart, Germany

EVE 2019 will give insights into the capabilities of hardware and software platforms; will present applications and markets for embedded vision and will create a platform for the exchange of information between designers and users.

Organiser

emva
european machine vision association

Messe Stuttgart
Key to Markets

www.embedded-vision-emva.org