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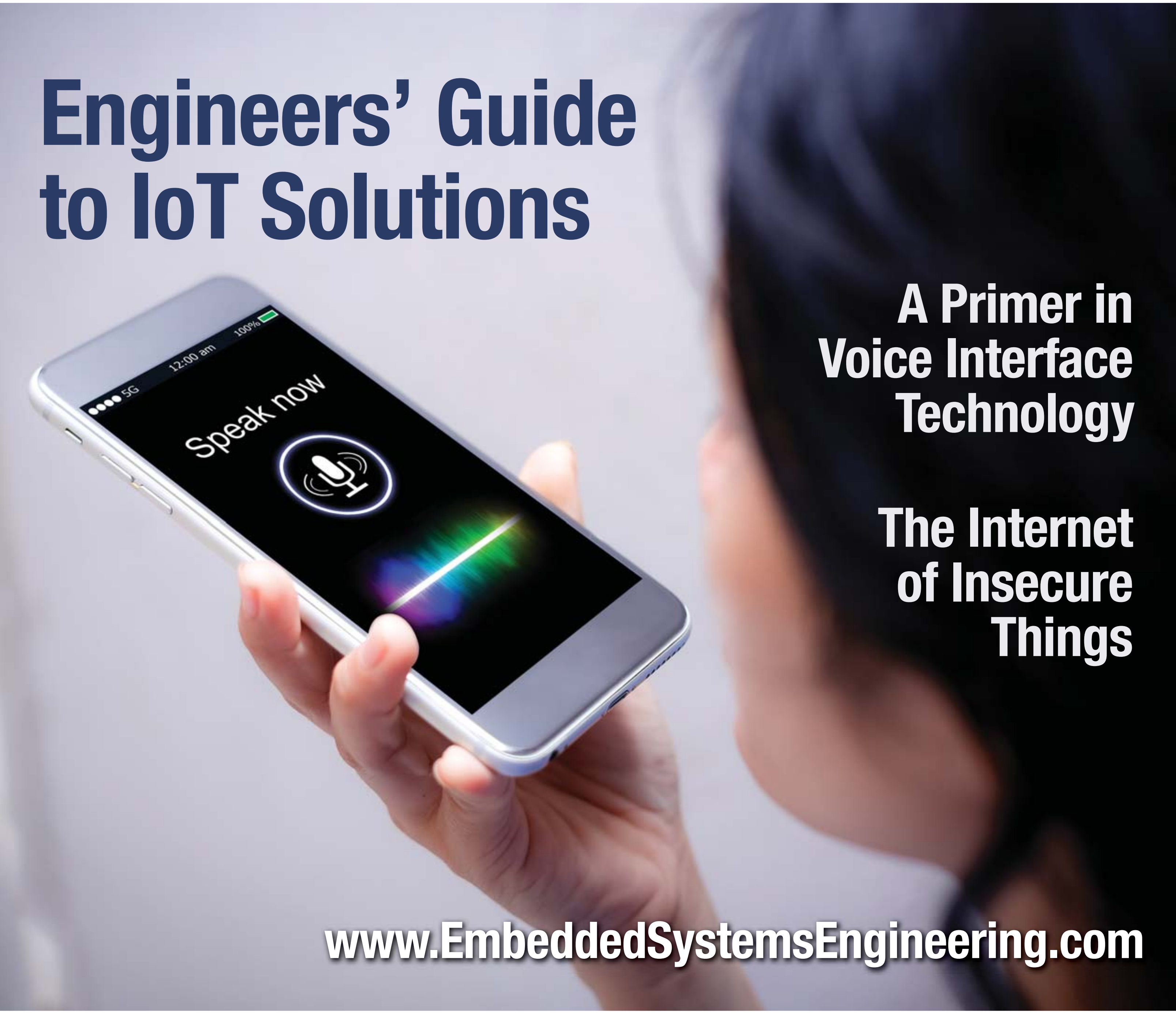

Engineers' Guide to IoT Solutions

A Primer in Voice Interface Technology

The Internet of Insecure Things

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A Primer in Voice Interface Technology

How to play to the strengths of Arm processors and DSPs.

By Munan Xu, Texas Instruments

Voice interfaces have emerged as an exciting new spin on how users interact with computers. How do these new systems work? What are the hardware requirements for creating such a device? As voice-controlled interfaces become more and more ubiquitous, I've dug in a little deeper to provide some insight into the technology that makes these devices tick.

(Courtesy Texas Instruments)

WHAT IS A VOICE INTERFACE?

Speech recognition has been around in some form since the 1950s, when engineers at Bell Labs built a system to recognize individual digits. Speech recognition is only one aspect of a complete voice interface, however. A voice interface incorporates all aspects of a traditional user interface: it should be able to present information and provide a way for users to control it. In a voice interface, control—and sometimes the information presented—happens through speech. A voice interface may also be an additional option alongside more traditional user interfaces such as buttons or a display.

Your first encounter with a device that had a voice interface was probably a cellphone, or a very basic speech-to-text program on your PC. Those systems were slow, inaccurate and often had a limited vocabulary.

What took voice recognition from afterthought to the darling of the computing world? First, there came significant improvements in both computing power and algorithm performance (bonus points if you know what a hidden Markov model is). Then, the ability to leverage cloud technologies and big data analytics improved speech-recognition algorithm training and increased the speed and accuracy of recognition.

ADDING VOICE RECOGNITION TO YOUR DEVICE

Several people have asked me for advice about how to add some kind of voice interface to their projects. Texas Instruments offers several different products, including the Sitara™ family of Arm® processors and the C5000™ DSP family, that are capable of speech processing. Both families have distinct strengths that make them better suited for particular use cases.

A key factor when choosing between a DSP and an Arm solution is how (or if) the device will leverage a cloud-based speech platform. There are three types of scenarios: offline, where all of the processing occurs locally on the device; online, through cloud-based voice processing in devices like Amazon Alexa, Google Assistant, or IBM Watson; or a hybrid of both.

OFFLINE: IN-CAR VOICE CONTROL

Although it may seem like everything under the sun needs to connect to the internet these days, there are still applications where internet connectivity just might not make sense, whether from a cost perspective or even the lack of a reliable internet connection. Many infotainment systems in modern cars are a great example of an offline voice-interface system. These systems typically only use a limited set of commands such as "Call [name here]," "play "Holland Road," by Mumford and Sons," and "volume up/down." Although there has been great progress in voice-recognition algorithms for traditional processors, their performance can leave something to be desired. In such cases, a DSP like the C55xx will offer the best performance for your system.

ONLINE: SMART HOME HUB

Much of the buzz around voice interfaces centers around connected devices such as Google Home and Amazon Alexa. Amazon in particular has generated a lot of attention, since it allows third parties to integrate into its voice-processing ecosystem with Alexa Voice Services. There are also other cloud services such as Microsoft Azure that provide speech-recognition services and function in a similar fashion. For these devices, it is critical to note that all voice processing happens in the cloud.

Whether or not the easy integration is worth offering up data to one of these voice service providers is up to you to decide. However, with a cloud provider doing the heavy lifting, the device side of things becomes much simpler, and in fact, a minimally featured Alexa enabled device really only needs to be able to play and record audio files, as the speech synthesis aspect of the interface also occurs in the cloud. Since no special signal processing functionality is needed, an Arm processor is sufficient to handle the interface duties. This means that if your device already has an Arm processor, you can probably integrate a cloud-based voice interface.

It's important to note what services like Alexa are not. Alexa does not implement any sort of device control or cloud integration directly. Much of the "smarts" that drive Alexa are cloud-based functions provided by developers that leverage the speech-processing capabilities of Alexa to drive input into their existing cloud applications. For example, if you tell Alexa to order you a pizza, your favorite pizza shop must have programmed a "skill" for Alexa. A skill is code that defines what should happen when you order a pizza. Alexa invokes the skill every time you ask for a pizza. This skill ties into an online ordering system that places the order for you. Similarly, smart home device makers must implement a skill that defines how Alexa interacts with their device and online services. Amazon provides several skills, and third-party developers have supplied many more, so even without developing any skills yourself, Alexa devices can be very useful.

HYBRID: CONNECTED THERMOSTAT

Sometimes, it is necessary to ensure some base functionality even without an internet connection. For example, it would be really problematic if your thermostat refused to change temperature if the internet went down. To prepare for this eventuality, a good product designer would design some of the voice processing locally so that there is no functionality gap. To enable this, a system might have a DSP such as the C55xx for local speech processing and an Arm processor to implement the connected interface to the cloud.

BUT WHAT ABOUT VOICE TRIGGERING?

You may have noticed that up until this point, I have not mentioned the truly magical aspects of the new generation of voice assistants: the always-listening "trigger word." How can they follow your voice anywhere across a room, and how do these devices still hear you even when they are playing audio? Unfortunately, there is no magic under the hood—just some very clever software. This software is independent of cloud-based voice interfaces and can be implemented for offline systems as well.

The easiest aspect of this is the "wake word." A wake word is a lightweight local speech-recognition routine continuously sampling the incoming audio signal looking for a single word. Since most voice services will happily accept audio without a wake word in it, the word does not necessarily have to be specific to any particular speech platform. For this type of functionality, since the requirements are fairly low, it is possible to accomplish on an Arm processor using an open-source library such as Sphinx or KITT.AI.

In order to hear you from across the room, voice-recognition devices use a process called beamforming. Essentially, these devices determine where a sound is coming from by comparing the arrival time and phase differences between different microphones. Once it determines the location of the targeted sound, the device uses audio-processing techniques such as spatial filtering to further reduce noise and enhance signal quality. Beamforming depends on microphone geometry, and true 360-degree recognition requires a nonlinear microphone array (often a circle). For wall-mounted devices, even two microphones can enable 180 degrees of spatial discrimination.

The final trick voice assistants employ is automatic echo cancellation (AEC). AEC works somewhat like noise-cancelling headphones, but in reverse. The algorithm takes advantage of the fact that the output audio signal, such as music, is known. While a noise-cancelling headphone uses this knowledge to cancel out external noise, AEC cancels out the effect of the output signal on the input microphone signal. Your device can ignore the audio that it puts out itself and still hear the speaker, regardless of what might be playing. AEC is computationally intensive and best implemented in a DSP.

To implement all of the features discussed: wake word recognition, beamforming, and AEC requires an Arm processor and DSP working together: the DSP powers all signal-processing functionality, and the Arm processor controls the device logic and interface. Leveraging a DSP plays to its strengths in performing operations on pipelines of incoming data deterministically, thus minimizing processing delays and enabling a better user experience. The Arm is free to run a high-level operating system such as Linux to control the rest of the device. Such advanced functionality all occurs locally; a cloud service, if used, only receives the end result of this processing as a single audio file.

CONCLUSION

Voice interfaces seem to have attained significant popularity and will likely be with us in some form for a long time to come. Although several different processing options exist to enable voice-interface technologies, TI has an offering to fit whatever your application may need.

RESOURCES

- Jump-start your audio design with the new Audio Pre-Processing System Reference Design for Voice-Based Applications Using 66AK2G02.

- Download our newest white paper "Voice as the user interface – a new era in speech processing."

Munan Xu is a Digital Field Applications Engineer at Texas Instruments. His interests include voice recognition, and natural human machine interfaces. Munan graduated from Johns Hopkins University with a B.S. in Electrical and Computer Engineering in 2015, and completed his M.S. in Electrical Engineering at Johns Hopkins University in 2016. Munan can be reached at munan@ti.com.

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The Future of Healthcare May Reside in Your Smart Clothes

When most people think of wearables, they often think of the obligatory smart watches, fitness monitors, and heart rate monitors that are typically worn on the wrist. However, the wearables market extends well beyond just these standard devices and into multiple emerging markets across some different industries.

By Peter Brown, Mouser Electronics

One such emerging market is smart clothing for healthcare--the idea of weaving electronics into a shirt, a blanket, a bandage, a knitted cap, or pants to perform specific patient care functions.

Smart clothing, or e-textiles, as a whole is still in its infancy, and practical applications that are being used in hospitals and other care facilities are few and far between.

Yet, interest in the potential of this technology is vast with many healthcare providers and medical device manufacturers actively monitoring smart clothing pilot projects and research into the latest e-textiles technology. In fact, smart clothing holds such promise in healthcare it is being seen as a major disruptive force in the industry in the next five years.

"Healthcare in general is experiencing its own crisis especially in the US (also in the UK)," said Aditya Kaul, research director for market research firm Tractica. "Therefore, the focus is more on fixing healthcare rather than on technologies like smart clothing. We see a slow growth for the market in the next three to four years, but beyond that, we see a bright, fast growing market."

Tractica forecasts smart clothing for healthcare to grow from just $2.4 million today to a whopping $1.2 billion by 2021, with the majority of growth coming in the years 2019-2021.

WHAT IS AN E-TEXTILE AND HOW DOES IT WORK?

Smart clothing is seen as a way to revolutionize the practice of healthcare, and it's hoped that a widespread use of garments used to monitor health or help with treatment could reduce reliance on costly equipment and a heavily burdened healthcare system. Clothing that can track chronic disease or conditions, help with a growing aging population, or make patients more comfortable during a stay at a hospital or treatment facility is seen as a way to create value, boost health insights, and reduce costs.

E-textiles are designed to feel comfortable on the skin but at the same time be functional. These smart fabrics consist of traditional fabric woven with conductive fibers as well as electronic elements such as biomedical sensors, microcontrollers, fiber optics and wearable antennas, such as Mouser's line of Internet of Things system-on-modules.

An example of a biomedical sensor that could be used in e-textile applications is the Analog Devices' AD8232/33 Heart Rate Monitor Front End . It is an integrated signal conditioning block for ECG and other biopotential measurement applications, designed to extract, amplify, and filter small biopotential signals in the presence of noisy conditions. The Intel® Edison development platform is designed to lower the barriers to entry for a range of inventors, entrepreneurs, and consumer product designers to rapidly prototype and produce "Internet of Things" (IoT) and wearable computing products. It is both a system-on-module solution and an item that incorporates a wearable antenna.

In some cases, e-textiles are created, in part, on a typical tabletop sewing machine that embroiders thread into fabric in a pattern via a computer program. Instead of thread, however, metallic fibers from metals such as silver, nickel, carbon, copper, aluminum, and stainless steel, like Adafruit's wearable electronic platforms from Mouser, are used that feel the same as traditional thread to the touch. These products allow you to realize any wearable project. They are fully featured, round, sewable, and Arduino-compatible devices. They are small enough to fit into any project and low cost enough to use without hesitation.

Depending on how the conductive fibers are woven in and the electronics included in the smart clothing, the fabric is durable and able to be washed similar to regular clothing. While durability is still an on-going issue in many projects, it is a consideration that most researchers and companies are working on as an important step toward mass commercialization of smart clothing for healthcare.

MARKET DRIVERS AND CHALLENGES FOR SMART CLOTHING

So far, there have been relatively few e-textile commercial successes. One of the reasons for this is a lack of willingness by companies in the healthcare field to invest in research projects or academics instead taking a wait-and-see approach. In its place, some manufacturers have turned to the wellness/sports market where the consequences for a wrong signal are much lower.

However, with a continued rise in many parts of the world of chronic disease—such as diabetes, heart disease, cancer and respiratory disorders—aging populations that are living longer and an increase in the number of surgeries performed in key healthcare markets such as Europe and the US, e-textile developments are on the rise to make use of emerging electronics and medical technology. In some clinical trials, smart clothing has shown to protect against infectious disease, help sense the state of the wearer's health, and help prevent, treat, and manage health.

There are lots of opportunities in healthcare development, especially textiles," said Luciano Boesel, group leader for adaptive textiles and hydrogels at Swiss research house Empa (Figure 1). "The need for long-term, unobtrusive monitoring of risk patients at home will stimulate quick development. In five years' time, I believe we'll get to see many innovative textile solutions in healthcare."

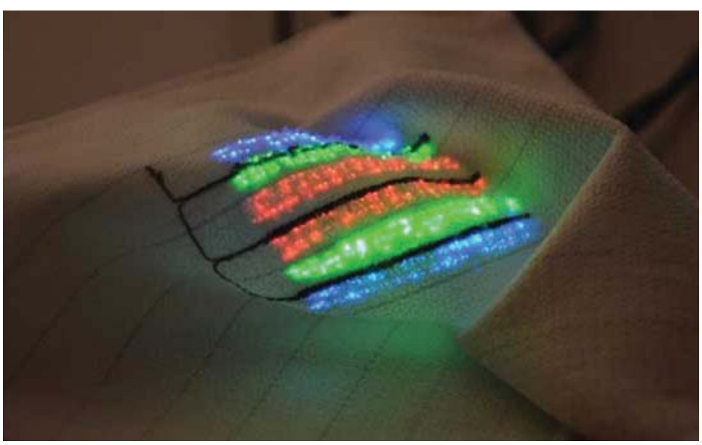

Figure 1: Fiber optics integrated into a blanket or shirt in order to monitor skin circulation to prevent bed sores or monitor heart rates is what researchers at Empa are working on. (Source: Empa)

Boesel admits e-textiles face challenges that must be overcome including further development in reliability, liability, and certification. Regulatory approvals also present a challenge for device manufacturers and researchers as FDA consent can take many years. Then getting approval and certification from insurance companies is another hurdle. So many smart clothing projects that have been introduced will take between three to five years to come to fruition. Many experts see this inflection point happening in the 2020 time frame.

SOLVING CURRENT PROBLEMS

James Hayward, technology analyst with market research firm IDTechEx, believes that if an immediate financial or economical gain to the technology can be had, the more likely smart clothing will be adopted by providers.

E-textiles such as a bed sheet or mattress that are integrated with pressure sensors to manage and prevent bed sores by making sure the patient is moving around on the surface enough is something that is garnering a lot of interest from companies, Hayward says. Conditions such as bed sores and incontinence in the elderly cost hospitals and care facilities money and time. Moisture sensors integrated into smart clothes for mapping incontinence in patients could prove to be a very worthwhile investment in the long run.

"If e-textiles continue to prove to be successful, it will start off as a high-end luxury feature before it gets adopted on mass," Hayward said. "These things take time and while typical medical device lead times are coming down slightly, we can expect to see some in five years, more in 10 years. But there is a lasting value here, so I do think it will come to healthcare gradually."

Clothing+ is working with Jabil to mass produce textile-integrated sensors that meet the necessary FDA requirements for medical grade solutions. Some of the ideas for the e-textile include a bioimpedance vest, whichmeasures water accumulation in the lungs to indicate heart conditions, that can be worn at home for trend analysis before hospitalization, saving time and money. Other ideas in development are a chest belt to provide a lung's performance through a topographic picture of the lungs and a light therapy blanket for babies with jaundice allowing them to be removed from cradle light therapies and held by parents or loved ones instead.

Edema ApS is developing a washable stocking to measure and monitor changes in leg volume with patients suffering from edema (fluid accumulation or swelling) in the lower limbs (Figure 2). While not yet available for patients, the stocking is being prepped for clinical trials and validation. Future uses of the stocking could be to monitor congestive heart failure or pre-eclampsia, which happens during pregnancy and involves hypertension, edema, and protein in the urine.

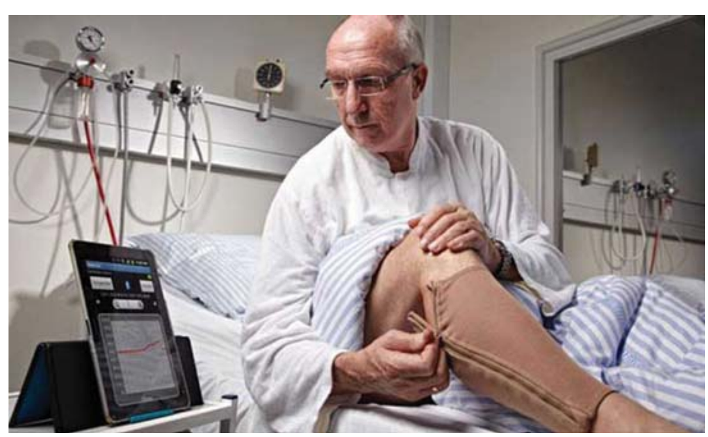

Figure 2: A wearable, washable stocking that can be worn at home for use in monitoring edema in patients' legs is moving into the clinical trial and validation phase. (Source: Edema ApS)

"The stocking will be washable and durable enough for home use, which is the main concept idea of the project. Being able to monitor people when they are home and avoid long problematic trips just to have an eye assessment of the increase or decrease," said Klaus Østergaard, CEO of Edema. The stocking would be monitored via a smartphone app where the user could self-regulate during exercise, identify the need to elevate or reposition legs or call the doctor for medical adjustment, Østergaard says.

Wearable body metrics vendor Hexoskin has been active in developing smart clothing for sports/fitness markets but is also working on e-textiles for healthcare in the areas such as cardiology, respiratory, neurology, mental disorders, and pediatrics. Currently, Hexoskin is conducting trials for long-term remote monitoring of clinical-grade sensors woven into a smart shirt for precise electrocardiography (ECG) cardiac monitoring with lung function and activity monitoring.

ACADEMIA LEADING THE WAY

Among those developing e-textiles for the healthcare market, work being done at the university level offers much promise for the future of patient care technology.

One interesting project is being developed by VTT Technical Research Center of Finland, where researchers have created smart fabric that can be used as clothing or blankets that calculate whether a patient needs to be cooled or warmed based on the initial date measured from the person and the environment. These garments could also be used by surgeons that get too hot during an operation with the clothing adjusting to the temperature of the body during surgery.

"Hospital patients have been asked about their most unpleasant experience, and the most common answer is feeling cold—pain comes only second," said Pekka Tuomaala, principal scientist at VTT.

Ohio State University's ElectroScience Laboratory is working toward functional e-textiles that gather, store or transmit digital information by weaving antennas-such as the Intel® Edison development platform-into something like a brain cap that senses activity in the brain to help treat conditions such as epilepsy or addiction (Figure 3). The researchers are also working on a smart bandage that tells a doctor how well the tissue beneath it is healing without removing the bandage.

Figure 3: Ohio State University is working on integrating antennas and circuits into clothing for the future of healthcare monitoring and treatment. (Source: Ohio State University)

"Our goal is to understand how we think. Imagine if we can enable our brain into regeneration. To do that we need to understand the brain and how many neurons are working together," says John Volakis, director of the ElectroScience Laboratory at Ohio State University. "These smart clothes could tell an epileptic person to sit down before they have an attack or how to activate or deactivate cells in patients with Parkinsons."

Figure 4: Researchers at the University of Bristol are working to integrate soft robotics into clothing to support those vulnerable to falls or have trouble walking up stairs. (Source: University of Bristol)

Meanwhile, the University of Bristol is working on soft robotic clothing that could help vulnerable people avoid falls by supporting them while they walk and giving others bionic strength to move between sitting and standing positions or climb stairs (Figure 4). The smart clothing involves nanoscience, 3D fabrication, electrical stimulation, and full-body monitoring technologies. Researchers believe this technology could ultimately lead to potentially freeing wheelchair-bound people from having to use the devices.

"Many existing devices used by people with mobility problems can cause or aggravate conditions such as poor circulation, skin pressure damage or susceptibility to falls, each of which is a drain on health resources," said Dr. Jonathan Rossiter, professor of robotics in the Department of Engineering at the University of Bristol. "Wearable soft robotics has the potential to improve many of these problems and reduce healthcare costs at the same time too."

Switzerland's Empa research center is integrating optic fibers into e-textiles to monitor the skin's circulation to prevent bed sores and has created a fitted cap that measures heart rates. The garments are being made to withstand a disinfection wash cycle, which would make it ideal for hospitals.

Researchers believe this technology could be used eventually to measure oxygen saturation or to measure pressure on the tissue or respiration rate. The e-textiles could also be turned into chemical or biosensors, such as those offered by Maxim Integrated to analyze body fluids or vapors. Maxim's ultra-low power and secure development boards are based on Maxim's series of ultra-low power ARM® Cortex®-M microcontrollers. These ARM Cortex-M4F 32-Bit MCUs are ideal for the emerging category of wearable medical and fitness applications because their architecture combines ultra-low-power, high-efficiency signal processing functionality, and ease of use. The Maxim MAX30102 Pulse Oximeter & Heart-Rate Sensor is

E-Paper Displays Mature

How innovative solutions are taking E-paper displays from niche to mainstream IoT applications.

By HD Lee, Pervasive Displays

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Adding to the existing strengths of Electronic Paper Displays (EPDs)—ultra-low power consumption, superb readability, and compact size—are several breakthrough enhancements, including new colors, faster display updating, even lower power usage, and a much wider operating temperature range.

Integrating these next generation EPDs into IoT devices can undoubtedly improve the functionality and lower the cost of current IoT systems. But more exciting still, these new EPDs also have the potential to enable fresh IoT applications that will give early adopters in the development community an opportunity to pioneer entirely new markets.

WHY ELECTRONIC PAPER IS ALREADY IDEAL FOR IOT APPLICATIONS

To understand why EPDs are poised to revolutionize IoT devices and make possible wholly new IoT applications, it is helpful to first understand current generation EPD technology's key advantages over older flat panel display technologies, such as LCDs and OLEDs.

As the name suggests, an Electronic Paper Display displays images and text that are easily readable in natural light, just like printed ink on a sheet of paper. In this, an EPD is fundamentally unlike other display technologies, which all require their own internal luminance source—one that is power hungry, bulky, complex to design and manufacture, usually impractical to maintain, and prone to defects including uneven brightness, burn in, gradual dimming, and failure.

The EPD technology used by Pervasive Displays creates images from hundreds of minute charged ink particles within each of the tiny capsules that form each pixel. By varying the electrical field across the capsule, ink particles of the desired color are moved to the top surface of the paper, instantly changing the pixel's color. As the particles are solid ink-like pigments, they create a clear and sharp image that looks like ink on paper. Users find the EPD graphics and text are not only more quickly read and understood, but are also more visually pleasing, and reduce eye strain, because they so precisely mimic the appearance of traditional printing and writing technologies that have been used for thousands of years.

For the IoT, a slim, compact, high-contrast EPD which is clearly visible in natural light is a huge boon. Such a display requires far less power than other technologies and is visible in a wide range of lighting conditions, from dim interior lighting, to bright sunlight that makes other displays painful or impossible to read. In addition, EPDs provide a very wide viewing angle and they help users to read and comprehend critical information without delay.

An EPD shares another similarity with ink on paper: it is bi-stable. Energy is only consumed when the image is being changed. On the other hand, display technologies that are not bi-stable constantly drain power to refresh and illuminate the image, whether it changes or not. For IoT applications, which often display static images and text for hours on end, and may rely solely on battery or environmental

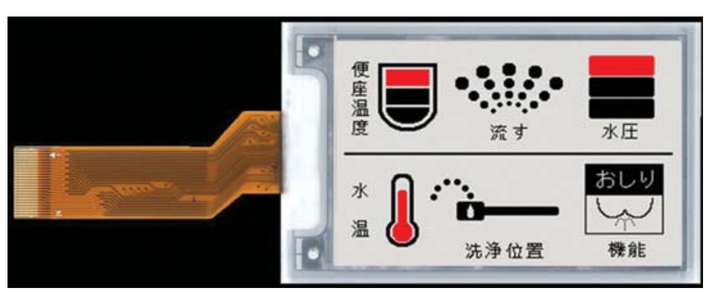

Figure 1: A 2.71-inch e-paper display showing bidet/washlet information

engineers guide to **IoT Solutions**

power, this is yet another huge energy saver, adding to the power saved by not requiring a constant internal light source. EPDs are such frugal energy users that some can provide an updating display that is driven and maintained simply by the residual energy available when a battery-free RFID tag is scanned.

The zero-power static display capability of electronic paper also frees users from the inconvenience of having to switch on a battery-powered display every time they need to briefly check the device status. Instead, the device condition is always instantly readable at a glance, minimizing unnecessary energy drain. For a typical IoT device with a 2-inch display that may only be updated a few times per day, a traditional LCD will consume well over 250 times more power than an EPD module. By slashing the energy consumption of the display—one of the most power-hungry components—to a minimum, IoT devices can operate in the field, perhaps with zero maintenance, for years. In the same situation, a constant LCD display could deplete its battery in a matter of days.

However, while the EPD's crystal-clear display, ultra-low energy use and slim size seem almost tailor-made for the IoT—certain limitations have, until recently, frustratingly prevented full use of EPDs in some of the most promising IoT markets. Today, however, several new EPD technologies are set to sweep those barriers aside.

EPDs are already ideal for a wide range of IoT applications, but the latest electronic paper technology enhancements and innovations are about to expand EPD reach and usability much further—bringing the IoT to new environments and new markets.

WIDER TEMPERATURE RANGE EXTENDS GLOBAL MARKETS AND CREATES NEW APPLICATIONS

Many IoT applications require devices to be usable in the field, often outdoors, and in extreme temperature conditions. Early generations of EPD technology had a narrow operational temperature range. This limited their deployment in some IoT applications or required additional hardware to stabilize the temperature.

Fortunately, recent innovations have dramatically extended EPD operating temperature range. Today, EPD modules can operate from -20 °C to +40 °C. This much wider temperature range makes an unmodified EPD-equipped IoT device usable in far more global climate environments, all-year round, and also in high- and low-temperature facilities. The temperature range extension has been achieved largely by improving the sequence and timing of the display's driving waveforms.

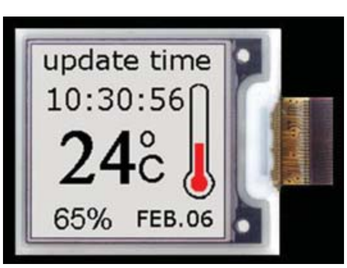

Figure 2: A 1.6-inch e-paper display with weather information

With an extended operating temperature, the sheer quantity of potential new applications now fully opening up to EPD-equipped IoT products is too numerous to mention. It includes industrial, logistics, transportation, and automotive—and to give more specific examples: cold-chain logistics temperature logging, and RFID tags, as well as many similar applications in outdoor and harsh environments.

FASTER REFRESH RATES FOR MORE TIMELY, DYNAMIC INFORMATION

Older EPDs had relatively slow update times of a second or more, possibly delaying operator response to new information. This made the screens less practical when rapid display changes were required, for example in sensing and monitoring applications, for fast-changing data, and for animation.

This limitation existed mainly because the entire screen had to be cleared and redrawn to make even a small change. However, by only updating the section of the display that has been changed, the latest EPDs can now update important data with almost no significant delay. These partial updates can achieve refresh speeds of 300-600 ms—a four-fold improvement. In addition, these partial updates use even less power than a full screen refresh, further reducing the EPD's already very low energy consumption.

Figure 3: The partial update process only updates the information on the screen which needs to change, such as the room temperature and energy usage information.

In brief, partial updates are performed by comparing the previous image and the new image to get a delta image. This delta image is then input into the EPD. Because of the physical characteristics of the EPD's ink particles, the waveform used to program the delta image into the display is adjusted based on ambient temperature. There is no limit to the size of screen that partial updates can work on, although larger sizes of screen updates will require more RAM and faster CPU speeds to drive the waveforms properly.

Partial updates do have some limitations. Numerous partial updates without performing a full screen refresh can result in ghosting artifacts, especially for black to white pixel transitions. This can be mitigated by minimizing these black to white transitions. For three color screens, partial updates work on all three colors. However, as the third color (red or yellow) updates relatively slowly, taking a few seconds, partial updates generally only make sense to be done on the black and white pixels in the image.

Adding BLE to Your IoT Application Just Got Easier

Energy-efficient and economical Bluetooth® Low Energy (BLE), also known as Bluetooth Smart, was created for the Internet of Things (IoT). This wireless technology is poised to power a wide range of connected applications, from wearable fitness devices to smart homes to the latest entertainment products to in-store advertising using beacons, and more. Now you can build better end applications with lower power consumption using two next-generation BLE solutions. The RN4870 and RN4871 support the latest Bluetooth 4.2 specification and have a Bluetooth stack on board with an easy-to-use ASCII command interface making the devices easy to configure and greatly reducing development time.

Bluetooth 4.2 Module with Shield and Built-In Antenna (RN4870)

Bluetooth 4.2 Module with Shield and Built-In Antenna in a Small Package (RN4871)

Highlights

- User-friendly ASCII Command Interface
- Fully certified to save you additional time and money
- On-board Bluetooth 4.2 Low Energy stack for drop-in connectivity

www.microchip.com/RN4870

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Figure 4: E-paper displays from Pervasive Displays are now available in black, white and yellow as well as black white and red.

Moreover, unlike earlier versions of partial update technology, the latest EPD modules do not require additional dedicated electronics for partial updating, thereby providing potential for more reductions in display module cost, complexity, size, and power consumption.

In general, just like the other recent innovations discussed here, partial update technology opens up new applications and markets for EPDs. Partial update technology combines all the power consumption and readability advantages of an EPD with a responsive, rapidly updated display.

MORE COLORS: ATTRACTIVE, INFORMATIVE, SAFER

Moving beyond early EPDs that only offered monochrome black and white displays, the latest EPDs from Pervasive Displays provide three colors: black, white and red, and most recently, black, white and yellow. For retail applications, these additional vivid eye-catching colors greatly enhance the attention-grabbing power of pricing, signage, and product displays. This allows retailers to draw customers' attention to special offers, and deals, or special conditions—improving stock throughput, saving staff and customers' time, and increasing customer satisfaction.

For industrial and monitoring applications, bright colors are perfect for instantly bringing attention to critical data—such as warnings or sensor measurements that are outside of nominal range. Simply adding color hints can greatly enhance efficiency and safety, as well as reducing operator fatigue.

In addition, with EPDs providing sharp display resolutions of up to 200+ DPI, these additional colors provide more options for dithering (displaying alternate adjacent pixels in different colors) to generate new shades beyond the standard three, a strong tool for creating attractive retail displays.

RETHINKING THE EPD: A NEW GENERATION OF DISPLAY

Adding all these improvements in refresh rate, power consumption, operating temperature, and color to EPDs demands a rethink of the EPD's role in the IoT. In a sense, these EPDs are almost a new class of display technology. The new EPD can now replace LCDs and OLEDs in applications that require features like responsive display updates and color highlighting, and it can be used across a huge area of the globe, from the arctic to the equator, and in environments from the heat of a desert oil well or an iron foundry to the chill of a medical sample storage area or a refrigerated goods truck.

And EPDs can achieve all this without compromising their unbeatable natural light visibility, and with power consumption lower than 0.5 percent of an equivalent LCD screen—offering the potential for five to seven years of battery life on a coin cell battery and practical operation driven by solar and other environmental power sources.

HD Lee is Founder, CTO and President, Pervasive Displays. Lee has over 17 years' experience in research and development for advanced displays, specializing in TFT-LCD, OLED and e-paper. Lee was a co-founder of Jemitek, a mobile LCD design house, which was acquired by Innolux in 2006. In 2011 he co-founded Pervasive Displays Inc., a world-leading low power display company that focuses on industrial applications and has sold more than 10 million e-paper displays. The company was acquired by SES-imagotag in 2016. Privately, Lee holds 43 granted patents with more patents pending. He has an MS and BS in Electronic Engineering from the National Taiwan University.

The Internet of Insecure Things

Results from Barr Group's 2018 Embedded Systems Safety & Security Survey reveal startling news on the state of security for Internet of Things (IoT) devices.[1] Based on responses from more than 1,700 qualified embedded systems engineers from around the world, it has been determined that an alarming number of engineers continue to neglect implementing some of the most fundamental industry-recommended design practices known to raise security levels of embedded systems. Further exacerbating the problem, of the embedded systems developers working on internet-connected or IoT projects, 22 percent do not list security as a product requirement for their current project.

"Current projects are utilizing more CPUs, are more complex and are inherently more difficult to secure…"

"Current projects are utilizing more CPUs, are more complex and are inherently more difficult to secure," said Barr Group CTO Michael Barr. "Prioritizing security in every internet-connected embedded device is essential to maintaining the integrity of the IoT."

REFERENCES

1. https://barrgroup.com/Embedded-Systems/Market-Surveys

EMAC Inc.

CutiPy Industrial IoT Edge / Gateway

Compatible Operating Systems: MicroPython & FreeRTOS
Supported Architectures: ARM

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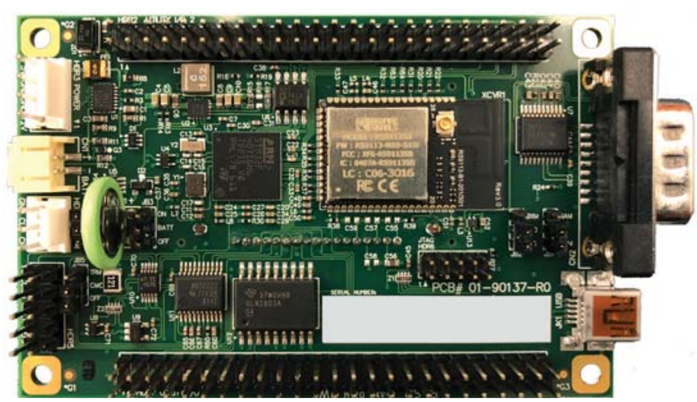
- Zigbee, Thread , Bluetooth Low Energy & Wi-Fi
- MicroPython & FreeRTOS



TECHNICAL SPECS

- 1x CAN 2.0B Port (Internal Shared w/Transceiver, External Shared w/o Transceiver), 2x USB 2.0 Full Speed OTG Ports (1x Internal, 1x External)
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- 13x A/D Channels with 12-bit Resolution (3 Unique A/Ds), 2x D/A Channels with 12-bit Resolution, 802.11 a/b/n Wi-Fi, Bluetooth Low Energy (BLE), 802.15.4 Zigbee & Thread
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APPLICATION AREAS

Internet of Things, Industry 4.0, Industrial IoT

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