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ELECTRONIC PRODUCTS & TECHNOLOGY

SEPTEMBER 2020

CANADA'S INFORMATION LEADER FOR ELECTRONIC ENGINEERS AND DESIGNERS

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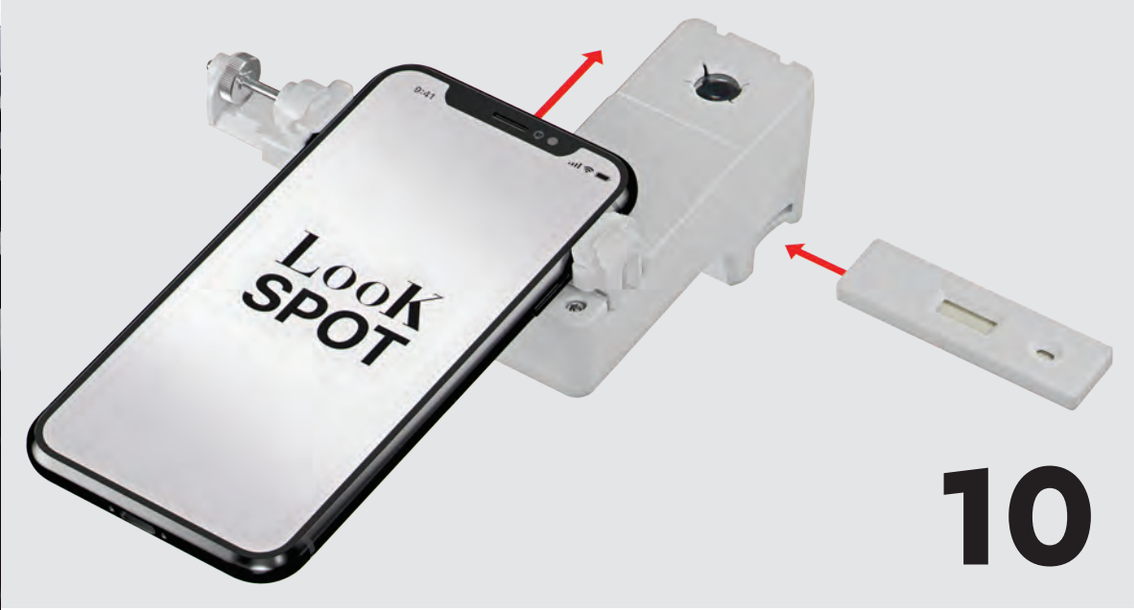

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Cover photo: Laipac Technology
Photos (this page, from top): Laipac; Gorodenkoff Productions OU; Laird Technology; NXP

IoT: Key to digital strategy

Most design sectors see obvious returns, says ARM sponsored report

The Internet of Things, or as we more commonly refer to as IoT – has come a long way in a short time since its emergence around 2013. Most of that acceleration has come over the past couple of years however. Between 2017 and 2020, a steep change in IoT adoption took place, according to a thorough report issued by The Economist magazine and sponsored by ARM, a UK-based provider of IoT devices, connectivity and data management platforms.

One of the longest-running business studies into IoT, the annual report examines *business index*, a measure of IoT adoption by the global business community.

Fundamental to digital strategy

The 2020 study reveals two-thirds of companies across sectors including manufacturing, healthcare, energy, IT and automotive now see IoT as fundamental to their digital strategies, the report says. Of those with extensive IoT deployments (13 percent of the total), more than 90 percent see real-time physical data from IoT networks as critical to their commercial artificial intelligence (AI) plans.

The link between AI and IoT is clear right across the board. Even amongst the companies still in IoT deployment planning or early rollout, the majority (>80 percent) say future IoT-driven data will fuel their AI strategy. This AI-driven momentum is backed up by IoT device-makers increasingly designing products that run AI workloads – locally and through gateway and cloud connections.

Some key findings from the study include:

- Since 2017, both internal and external-facing IoT adoption have advanced substantially. The score for the application of IoT to products and services jumped from 4.43 ("in planning") in 2017 to 5.96 (just shy of "early implementation"), meaning the average company is now on the cusp of early implementation of IoT-powered products and services. The score for IoT adoption in internal operations (such as monitoring the status of plant and equipment, tracking energy consumption, etc) jumped even further, from 4.34 to 6.82.
- This progress reflects increased investment. Of the executives surveyed, 82% say their organizations grew their IoT investment in the past three years, up from 62% who said the same in 2017. One in five businesses (20%) grew that investment by 50% or more. For 10% of manufacturers, it more than doubled.
- A "path to business value" for the IoT has emerged. Companies' first forays into the IoT typically focus on single, application-specific projects that provide a clear return on investment. But, value increases as IoT data is merged with other data sets, incorporated into predictive or prescriptive analytics, and used to integrate processes that cross divisional and organizational boundaries.

Employee productivity gains

The biggest leap is in the internal use of IoT technology to optimize business systems, services and processes, according to the report. For example, one in three companies said their biggest IoT win was in employee productivity gains. As a result, the survey shows 22 percent of respondents now have extensive internal IoT systems (up from 6 percent in 2017 and 5 percent in 2013), and a further 36 percent in early rollout.

The external use of IoT follows closely behind and 13 percent of companies that now have extensive deployments (up from 8 percent in 2017 and 5 percent in 2013) and 32 percent in early implementation. The biggest win companies got from external IoT was in the ability to offer new services and products (36 percent of companies reported this).

The 2020 survey shows that 41 percent of the companies surveyed (nearly double the 2017 result) report their IoT deployments are having a "major" positive impact on their business, presumably giving them advantages over less advanced competitors. As IoT spending in Canada continues to surge, along with activity at the design level – everything points to the continuation of upward trajectory of IoT acceptance and development in the coming years. **EP&T**

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Clarification

In the 'Go Dorigo Go' cover story of our August edition on page 11, there was an error in a quote made by Alex Chassels, vice-president operations of Dorigo Systems, which stated "There isn't a project we can handle". The content was meant to say: "There isn't a project we can't handle." EP&T apologizes for the error.

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WEEE

POLYTECHNIQUE MONTRÉAL AIMS FOR SUSTAINABLE ELECTRONICS

One of Canada's largest engineering education and research institutions Polytechnique Montréal has launched a country-wide initiative to improve the way electronic equipment waste (also known as WEEE, or e-waste) is reused and recycled.

While also heavily promoting eco-design, the initiative called 'Create Seed' (Collaborative Research and Training Experience in Sustainable Electronics and Eco-Design), will bring together some 20 Canadian and international universities and industrial partners

Create Seed intends to optimize the way valuable materials are gathered from e-waste, while at the same time rethinking how the electronics supply chain functions. Clara Santato, a Professor within the Department of Engineering Physics is an expert in organic electronics at Polytechnique Montréal, and is leading the Create Seed project.

Her team and partners have been awarded $1.65-million over the next six years for this initiative, granted by the federal government's Natural Sciences and Engineering Research Council of Canada.

The project will bring together 50 researchers, students, and partners, whose first objective will be to change conceptual thinking paradigms about electronics, break down information silos, and eliminate blind spots - particularly in the field of ecotoxicology.

The program seeks to establish a radically different approach in training the next-gen of engineers, designers, and analysts - transforming their vision of e-waste, thereby alleviating electronics' environmental footprint.

In terms of research, Create Seed will rethink electronic product design, using the best of conventional inorganic electronics and emerging organic technologies, combined with the development of manufacturing processes that minimize e-waste's environmental footprint.

Create Seed initiative will rethink electronic product design.

CONSUMER TECH

CES 2021 SHOW TO GO ALL DIGITAL

CES, one of the world's biggest technology conferences, will be a virtual event in January due to the COVID-19 pandemic.

The Consumer Technology Association, which organizes CES, had said in May that it planned to go ahead and hold some events in Las Vegas next year, but the thinking changed as COVID-19 cases spiked around the world, making it impossible to hold an indoor event in January 2021, according to CTA CEO Gary Shapiro.

There was also uncertainty over whether employees of big tech companies would be allowed to travel by then. For more than 50 years, CES has been the global stage for innovation. And CES 2021 will continue to be a platform to launch products, engage with global brands and define the future of the tech industry.

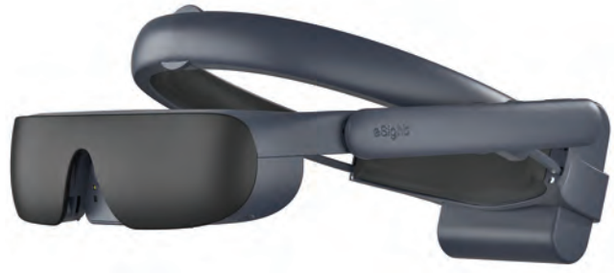
The four-day digital version of the CES gadget show begins Jan. 6.

eSIGHT UNVEILS NEXT GEN VISION TECH

Toronto-based eSight, a cutting-edge vision enhancement platform, launched its latest wearable assistive device that is clinically validated to significantly enhance vision for those who are living with eye disease and disorders that lead to low vision and legal blindness.

eSight 4 sets a new standard for enhanced vision technology by providing even greater visual clarity, a more versatile hardware design to enable unprecedented mobility and all-day use, and incorporates new advanced cloud-based capabilities and mobile apps.

eSight4 vision enhancement platform assists those living with eye disease, disorders and low vision or legal blindness.



"eSight launched as an unbelievable breakthrough in technology, and has since moved to a clinically validated solution for people living with eye disease and disorders that's widely acclaimed by leading low vision medical professionals," says Robert Vaters, eSight's CEO and president. "While the technology continues to advance, our mission remains the same: to create a more inclusive world and empower the low vision community to see new possibilities."

SMART TOOL TO SAFEGUARD WORKPLACES

Toronto-based tech firm iLobby has launched an innovative smart tool to safeguard workplaces of COVID-19 by automatically and discreetly scanning the body temperature of staff and visitors at sign-in, before they enter the facility.

The firm's FeverCheck device features a high-precision, smart thermal camera that accurately scans for elevated body temperature – a common symptom of COVID-19 – in seconds as part of the regular sign-in process, and flags people who might present a health risk.

Rather than sounding bells and singling people out when an individual has fever symptoms, though, the system protects their privacy by unobtrusively sending an instant notification to security or management, who can deny access if necessary.

iLobby CEO Ariel Mashiyev says an additional benefit of the game-changing technology in this new normal is that it not only enables businesses to automate logging of who is coming in and out of their facilities in order to protect the health of staff, but it also allows for easier contact tracing should there be any identified COVID-19 cases.

What makes the technology so unique, Mashiyev explained, is that it's able to deliver precise body temperature readings using intelligent technology that can zero-in to focus only on the person signing in, and is unaffected

by external factors such as indoor temperature or a hot cup of coffee in a person's hand.

SEMICONDUCTORS

INTEL'S STUMBLE IN CHIP RACE OPENS DOOR TO RIVALS

Intel has fallen behind in its ability to make commercially ready, leading-edge chips in sufficient volumes, opening the door to its main rivals, AMD and Nvidia, says GlobalData, a leading data and analytics company.

Intel's recent bombshell that it has stumbled - yet again - in the production of its 7-nanometer (nm) parts was a shock to the industry nonetheless, and the company implied that it would outsource manufacturing to TSMC to guarantee the supply of its next-generation chips by the current scheduled date of 2021 and 2022.

The delays have cost Intel's chief engineer Murthy Renduchintala his job, with Ann Kelleher taking over the development of 7nm chip technology processes.

"Intel has a vanishingly small prospect of catching up with TSMC's process technology over the next three years," says Mike Orme, thematic research consultant at GlobalData. "To protect its leading market positions in PCs and data centers, it

will need to join its main rivals in bidding for limited TSMC capacity. Industry insiders suggest it has placed a large order with TSMC for next year.

"The company faces what its former CEO Andy Grove called a strategic inflection point. It needs to go back to basics and rethink its historic business model, which is based on both designing and manufacturing all of its chips. It's a fair bet that it will now go beyond the immediate emergency measure of outsourcing manufacturing of the 7nm chips and outsource production of its leading-edge chips as a company policy to cover the next two generations of process technology, if needs be.

Photo: Intel

IOT

OCF LAUNCHES CLOUD-TO-CLOUD CERTIFICATION PROGRAM

Open Connectivity Foundation (OCF), a leading Internet of Things (IoT) standards body, announced its completion of OCF Specification Release 2.2.0 and launched the first ever Cloud-to-Cloud Certification Program. Specification Release 2.2.0 includes the OCF Universal Cloud Interface (UCI), the industry's first solution to unify the IoT ecosystem through cloud-to-cloud connectivity.

At present, IoT devices can be connected in three different ways:

- Directly by the controlling device through local connectivity (Device-to-Device)
- Via an IoT Cloud (Device-to-Cloud)
- Through multiple clouds (Cloud-to-Cloud) in which a cloud connects to devices

The OCF UCI offers a standardized way for device manufacturers to connect their clouds, making OCF technology a complete connectivity solution along with the Device-to-Device and Device-to-Cloud standards previously published by OCF.

Amongst its many benefits, Cloud-to-Cloud interfaces enable immediate connection between existing devices from different manufacturers with no need for device modification or updates, while the OCF UCI enables multi-vendor ecosystems to interoperate.

*Visit **ept.ca** for the latest new products, news, supply side and industry events.*

Innovate BC releases COVID funding

Gov't agency dedicates close to $3M to tech firms impacted by pandemic

Some tech companies based in British Columbia can expect to get a positive injection from COVID-19, as Innovate BC, a government agency organized to support innovation in British Columbia, has received extra funding to share with businesses as pandemic relief.

Supported by Western Economic Diversification Canada, tasked by the Federal government to support the Western Canadian economy, Innovate BC will distribute $2.95-million via two programs. The first will bolster new or existing tech start-ups and support them over the COVID-19 crisis, and the second is specifically designed to help main street businesses transition into the digital economy by helping companies develop digital skills to compete in the new economy, such as search engine optimization, paid ads, and content marketing.

Raghwa Gopal, president and CEO of Innovate BC.

innovate BC

Innovate BC funds and delivers programs that support labour market needs, encourage technology development, and promote product commercialization and adoption. Now that the COVID-19 pandemic has damaged jobs and the economy, it is critical for companies to review what options are available to weather, and better still, transition into the new post pandemic landscape.

West Tech Report recently had the opportunity to speak with with Raghwa Gopal, president and CEO of Innovate BC, to discover more about the funding announcement, what new entrepreneurs can expect, and how existing companies can benefit from the new funding sources. The group works to support companies at all stages of growth, across all sectors, all over British Columbia.

Help companies start, scale and stay in BC

"We even have programs, including the recently announced BC Tech Sector Resiliency Program, that helps non-tech businesses transition into the digital economy," explains Gopal. "Ultimately, one of our key goals is to help our companies start, scale, and stay in British Columbia and ensure that the benefits of our thriving tech sector are felt by people in all regions of the province."

BC's technology industry is substantial, according to Western Economic Diversification Canada, accounting for seven percent of BC's Gross Domestic Product and employing 5.2 percent of the province's workforce. And, COVID-19 has changed the rules for funding as well.

"COVID-19 has created an opportunity for Innovate BC to launch new programs and adjust eligibility requirements for existing programs to provide direct support to BC-based businesses who need additional relief during the pandemic," says Gopal. "Our website has eligibility requirements and application information for each program."

Turn whiteboard ideas into a reality

This means new entrepreneurs, existing tech companies, and even non-technology companies can find out how they can turn their whiteboard ideas into reality. There have been a lot of funds distributed by the government during this time through wage subsidies and programs such as the Canadian Emergency Response Benefit. It remains to be seen how this will impact future subsidies for the technology industry; however, so far, there have been promising indications that support will continue to grow.

"Governments at all levels have been very quick to respond to the pandemic. [One example is] the recent $3M in funding that came from Western Economic Diversification Canada," says Gopal.

Innovate BC's mandate is to help strengthen the Province's economy, support job creation, and ensure the benefits of technology and innovation are felt around the province. Gopal recommends that if you need support, to reach out to them directly.

"If you're a budding entrepreneur, reach out to Innovate BC and let's see how we can connect you to the funding, resources, and support you need to build a successful tech venture here in British Columbia. It's very easy to get a hold of us if you're hoping to talk to someone about a specific program".

To learn more, go to www.InnovateBC.ca. **EP&T**

Sohail Kamal *is EP&T's West Coast correspondent. sohail@nextgear.ca*

Photo: Credit tk here

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- DOSA Compatible Footprint

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iCH Series

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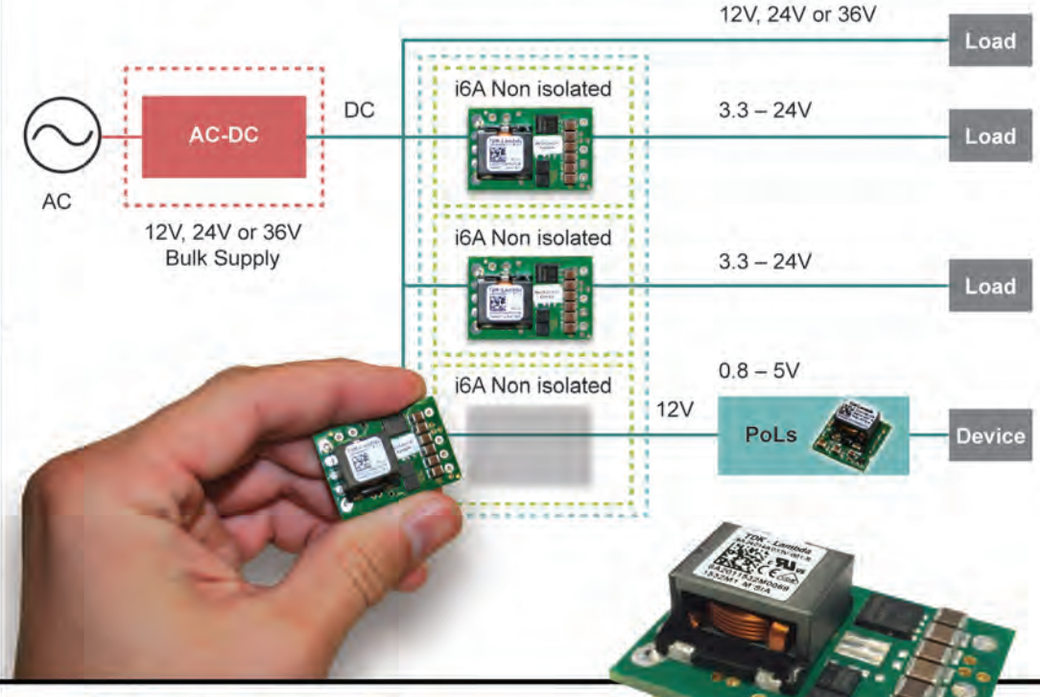

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TDK

Laipac puts the 'thing' in IoT

Toronto-area design firm wins over customers and users around the world.

BY STEPHEN LAW, EDITOR EP&T

Well before IoT was 'a thing', Laipac Technology Inc. was quickly establishing itself in the emerging Internet of Things design space. Founded in 1999 by Canadian entrepreneurs Diego Lai and Maria Pacini with a mere $10,000 to their firm's name, the Toronto-area business quickly grew to become a global leader in IoT products and services with customers all around the globe.

From its beginning, the vision of Laipac was simple according to Lai – "provide peace of mind to customers by crafting the absolute best, most reliable, and easiest-to-use locator devices on the market."

The hard work eventually paid off, as the IoT development and design firm has been recognized and decorated with a long list of innovator, design and even export related awards. Laipac has brought to market a bevy of successful IoT related devices and solutions. Among them include the LooK Watch - a standalone Smartwatch with cellphone connectivity, built-in SOS Button, WiFi Bluetooth, heart rate sensor, advanced quad core processor with GPS, multiple motion sensors, and a high-grade stainless steel body. The watch is also water resistant, equipped with an AMOLED display and eye-catching colours. Additionally, the LooK Watch comes with valuable and critical new smart-functions, like the SOS Button, preprogrammed with emergency contact numbers; fall detection, integrated accelerometers and compass sensors; false alarm detection, a built-in alarm system; geofence, enabling the customization of multiple virtual fences; virtual nurse, monitoring heart rates with medication reminders; and of course, a fitness tracker.

Another winner includes the S911 Enforcer electronic monitoring bracelet with tamper and security alerts that allows fast over-the-air configuration of single or multiple geofences, regular check-ins, security alerts, and prohibited zones. Of late, the firm released LooK SPOT, a smartphone-based point-of-care COVID-19 antigen test device using Lateral Flow Immunoassay (LFIA) technology. LooK SPOT uses AI and machine learning to identify the COVID-19 virus with a testing time under five minutes, and an accuracy over 95%.

EP&T took some time to speak with co-founder Diego Lai about Laipac's success formula and its somewhat unique approach to business.

Q Laipac Technology Inc. was launched with a mere $10,000. How did you spend that money to get things going?

We used that money to rent a 1,200-sq-ft office in Richmond Hill Ontario (northeast of Toronto) and bought computers and desks. That was pretty much what we did. We were new immigrants from Argentina with hope and also uncertainty in a new country. Today, our office is 8,000-sq-ft in Richmond Hill with a staff of eight engineers on site and 10 engineers working remotely.

Something we never thought about when we started the company. We never thought as immigrants, we could come to a country like Canada and offer employment opportunities to others. We were just focusing on hard work and hope for a better future.

Husand and wife founders of Laipac Technology Diego Lai & Maria Pacini.

How do your educational backgrounds and prior work experiences relate to what you have both created with Laipac?

I'm an electronic engineer by trade, and Maria has a business background and great ideas.

How important is it that you and your team achieve acknowledgment for its efforts?

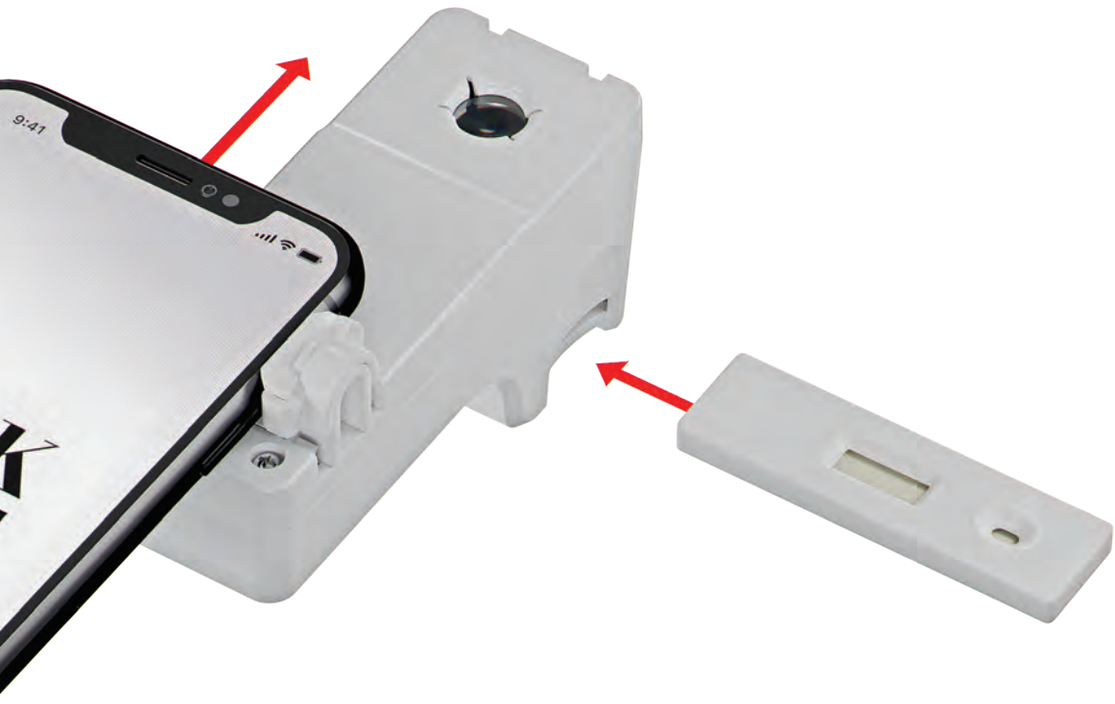
I think recognition is beneficial when we use them to improve ourselves. There is always someone who knows more than us and does better than us.

Are the products manufactured and branded by Laipac also all designed by your engineering team?

A Yes. We do concept to production by our own team. We manufacture all of our products in Greater Toronto Area using contract manufacturers.

You describe Laipac's work environment as very multicultural, filled with talented engineers & employees from all around the globe. Explain the advantages of working with a diverse team.

Photo: Laipac Technology Inc.



LooK SPOT point of care COVID-19 test kit uses AI and machine learning to detect the concentration of the virus, displaying results in less than 5-minutes on the smarphone of the test user.

We focus on the language of engineering, and we only see the talent, not the skin color or cultural background. If you can handle the engineering challenges and also don't mind working with "the glass is half-full' type of person, welcome!

Q **Has Laipac always been focused on creating IoT related devices? If not, what other areas of design?**

Actually yes. Before IoT, it was called M2M – or Machine to Machine. Prior to that, it was referred to as telemetry. Therefore, the IoT concept has been around for more than 20-years. We are blessed to be part of it since the beginning.

How does Laipac deliver all of the necessary design elements that go into an IoT design?

That is an interesting question, as most designs require constant updating to the technology. It also requires us to have the ability to learn fast. We have improved in this area and become more efficient along the way.

We also have a good relationship with our vendors, and they are also familiar with our roadmap. Therefore, we discuss new technology frequently.

Your designs and products have found their way into many diverse user sectors, such as security, law enforcement, trucking, banking and healthcare. How did you gain acceptance by OEMs in those sectors?

Most importantly, we are provided the opportunity to present the solution to our customers. We do study the problems they are experiencing.

A famous tech person once said that you must show the customer what they need before they even know it.

Laipac is also recognized as an industry leader in the vital field of mobile healthcare solutions. You state on your website: "We are dedicated to offering the safest, most reliable, durable, and affordable IoT devices on the market." How do you ensure that is always the case?

I guess that we have that confidence. Plus, we also do our homework.

How much of the company's energy goes into maintaining the success and the evolution of existing product designs versus the creation of new ones?

A We continuously see new solutions / ideas to solve the problems. Maria is the Chief of Innovation and she is very good with new ideas. We also want to make sure the products can have a longer life cycle. Therefore, we balance that and make sure we do not abandon the existing products unless the technology is too old.

Your company's mission is altruistic and quite heartfelt: "We desire to improve the quality of life, protect human beings & valuable assets, and ensure that any object is as safe and secure as possible. Our daily goal is to save one person at a time through our technology." Where does this vision of seeing a safer future come from?

It comes from our faith in Jesus Christ. We have the purpose of helping others with this gift we received from God. Otherwise, I wouldn't know how to explain all this.

Laipac is committed to maintaining its market-leading position by continuing to develop tailored solutions to meet its clients' needs, and currently exports products to over 100 countries across the globe. What percentage of Laipac's overall business is conducted with Canadian customers?

Below: S911 Lola personal tracking device uses 4G LTE technology to help monitor and protect users.

Photo: Laipac Technology Inc.

S911 Enforcer IoT law enforcement smart bracelet.

Laipac Technology helped design and create the Look Watch, among the first IoT ready smartwatches on the market globally. .

We are an export company, and our sales in Canada occupies only 5% of our total sales. We would like it to be more active in our local market. Our biggest markets are the USA, Latin America and Europe.

How has the Covid-19 pandemic impacted your business? Has the firm put more emphasis on the design and development of products – such as the LooK SPOT - Point-of-Care COVID-19 Test?

A The pandemic has impacted a lot because the whole world was shut down. All projects and orders were on hold. Some were canceled. The good thing is that there was no time to panic. We started to think about how we could help. We saw that we could provide an alternative test, which is real-time with IoMT (Internet of Medical Things) technology that may help for the economic recovery. Thus, the idea and concept of LooK SPOT was born in April 2020.

Of all the successful products Laipac Technology has released (LooK SPOT, S911 Enforcer, Guardian Angel Connect) is there any one device that you are most proud of, based on how it came together?
Well, they are like your babies. If there is any preference, one tends to keep it to oneself.

Regarding future plans for the company, where do you see Laipac in the next five years, given the continuing growth and acceptance of IoT related product into our everyday lives.
We hope that we can continue to provide peace of mind to people, some we know and some we don't. But, one thing is certain, we make the products with passion and love. All the good things come out from that, they are wonderful by-products. EP&T

Photo: Laipac Technology Inc.

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COVID-19 and medical IoT device security

Mitigating risk by implementing PKI at design level. **BY ELLEN BOEHM**

IoT (Internet of Things) has rapidly bridged the gap between our physical and digital worlds through wearable consumer devices, smart home appliances and mission-critical systems like autonomous cars, power grids and medical devices.

Device manufacturers and IoT product designers face cybersecurity expectations and an inherent feeling that, as an industry, we don't know how to do security right just yet. Cybersecurity is important in all connected devices, but, it becomes most critical in devices that keep people alive.

The sheer volume of online and connected devices is growing exponentially year over year. When it comes to security, every new device expands IoT attack vectors. Medical devices like insulin pumps and pacemakers deliver regulated signals to monitor patient health and inform treatment plans. If a cyber-attacker can access the device, they can intercept and modify data, impacting everything from dosage delivery to the device's software and firmware – potentially impacting the device's function and more importantly, patient safety.

Common security risks include:

Weak authentication: Many low-cost medical devices like connected insulin pens have limited data and capabilities, so manufacturers often invest little into security. Yet it's important to prioritize not necessarily the device, but what data the device has access to.

Hard-coded credentials: Hardcoded passwords and keys are common in software and firmware to simplify deployment and scale. Developers embedding credentials in plain text into source code make it easier for

Many IoT devices deployed today have poorly implemented security, as manufacturers continue to ship devices with default passwords.

access when needed, but a high risk if discovered or published online.

Shared and unprotected keys: Many devices use symmetric encryption, where identical keys are used to encrypt and decrypt data. This is a more secure option than static or hardcoded credentials, but problems can occur when trying to securely provision and/or store these keys. In the event of a key leak on the device or its connected endpoints the entire system could be compromised. Asymmetric encryption can address shared key issues as it uses mathematically related shared key pairs, but if the private key isn't securely stored, the device remains at risk. This is particularly hard to overcome for developers working to tight timelines.

Weak encryption: Encryption is only as strong as the cryptographic keys and algorithms it uses. With correct implementation, encryption is practically impenetrable, but weak algorithms and poor entropy sources can undermine cryptography used in IoT devices. Lightweight devices with limited power and ability to generate adequate entropy face greater risk as they lack the random input needed to produce strong encryption keys. A limit or lack of sufficient random number generation can be exploited by attackers, making it easier to access and derive the private key – compromising the device.

Unsigned firmware: Code signing is becoming a popular tool for developers to help verify the authenticity and integrity of code they push into production.

COVID-19: Rapid device production leads to rapid rise in security risks

In response to the COVID-19 pandemic, governments worldwide have called on manufacturers to re-tool their lines in support of critical technology production. Availability of these devices will make a positive impact on the world's response to treating the outbreak, as long as any connected products are sufficiently secured. Many IoT devices deployed today have poorly implemented security, as manufacturers continue to ship devices with default passwords or shared cryptographic keys across devices – making entire product lines vulnerable.

Ensuring device security is an important first step that starts at design and stands up through the device lifecycle. Over the last few years industry regulators have released frameworks and guidelines to help manufacturers align to best practices.

The pandemic has led those same regulators to relax some rules in support of government's call for diagnostics, systems and device production to combat the pandemic. Even in these unprecedented times, it's important to ensure that anyone producing connected devices has the framework and tools they need to make them secure.

One example is the FDA, who issued pre and post market guidance for medical device manufacturers to meet market submission security requirements. The IoT Security Foundation (ISF) and Industrial Internet Consortium (IIC)

DESIGN	MANUFACTURING	COMISSIONING	LIFECYCLE	END-OF-LIFE
Define unique ID policy and determine appropriate crypto-libraries based on hardware or design restrictions.	Embed credentials, preferably using on-device key generation and a hardware root of trust (HRoT) to store private keys.	Authenticate the device with other trusted devices and applications using the digital certificate.	Manage the lifecycle of keys and trust anchors, and enable digital signature verification for firmware updates and secure boot.	Revoke or replace digital certificates during a change of ownership or device end-of-life.

Photo: Gorodenkoff Productions OU

released similar frameworks.

Unlike traditional IT, the inherent nature of IoT devices means that a deploy first, secure later approach would be expensive and hard to achieve due to the sheer magnitude of IoT deployments. The diversity of hardware, software and protocols is another factor. Regardless of application, IoT implementations share common security requirements: a trusted device identity, data confidentiality, and integrity of data and firmware running on the device. These translate into authentication, encryption and signing.

Secure IoT deployments require:

- Strong mutual authentication between connected devices and applications;
- Encryption of data at rest and in transit;
- Signing and validation of firmware on the device;
- Ability to securely update credentials, cryptography and firmware over time. (See table).

Enabling security at design with PKI technology

Public Key Infrastructure (PKI) is a trust framework composed of hardware, software, policies and procedures needed to manage trusted digital certificates and public key encryption.

For decades, PKI has served as the backbone of Internet security, and today it's a flexible and scalable solution used to address the data and device security needs of the IoT. The real advantage PKI delivers is the ability to implement these safeguards with minimal footprint on the device and at massive scale. It addresses the complexity and diverse security challenges of designing and delivering IoT products to market – providing unique identity, authentication encryption, and secure signals and over the air updates for millions of connected devices.

Key considerations for IoT PKI include:

- Knowing where the certificate root of trust is hosted and identify whether certificates are issued from an internal PKI, public CA or managed PKI.
- Knowing where certificates are stored whether in a TPM or secure element embedded in the device.
- Ensuring connectivity at the factory, whether certificates are generated locally, via a signed CA at the factory, or in advance.
- Understanding risks and regulations that determine the length of certificate validity, key sizes, algorithms and required audit trails.

PKI is a fundamental security tool used by most organizations today, but enterprise PKI is much different than PKI that fits within complex hardware supply chains and IoT device lifecycles – especially for device manufacturers with little to no knowledge of cryptography.

Innovators that provide strong security at scale will differentiate their products, protect their brand and prevent warranty claims or expensive device recalls. PKI done right is a compelling solution for scalable IoT security, particularly as we navigate rapid production through these unprecedented circumstances. **EP&T**

Ellen Boehm *is senior director of IoT product management at Keyfactor, providers of secure digital identity management solutions. www.keyfactor.com.*

Photo: Keyfactor

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em|aura-sense Rain RFID sensor transponder IC chip combines capacitive sensing used for long range application purposes. Target applications and market segments include smart manufacturing and industry 4.0 applications, predictive maintenance, Internet of Things (IoT), industrial sensing and home automation. Device is compliant with ISO/IEC 18000-63 and EPC Gen2v2. Device allows to interface and capture sensing data with external sensor(s). Sensor commands are available to request sensing acquisition and store in the memory.

www.emmicroelectronic.com/product/epc-and-uhf-ics/em-aura-sense

SINGLE-BOARD COMPUTER ACCELERATES IOT TIME TO MARKET

AVNET

MaaXBoard Mini single-board computer accelerates time-to-market and reduce costs for IoT developers. Based on NXP's i.MX 8M

Mini processor, the production-ready unit is suitable for embedded computing and smart edge IoT applications. Product builds on the success of the original MaaXBoard and adds a hardware video encoder to power versatile video applications such as monitoring, visual inspection and video conferencing. Product delivers everything a developer needs to support and create a Linux, Android, Windows 10 IoT Core, or other OS based system.

www.avnet.me/maaxboard-mini

SOFTWARE SUPPORTS NEXT-GEN WIRELESS IOT CONNECTIVITY

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MYTHINGS Central 3.0 latest version of network and device management software for Low-Power Wide Area Networks leveraging MIOTY. Through its powerful plug-in system and API-driven design, this update to MYTHINGS Central includes backend

integration with major cloud solutions like Microsoft Azure, AWS and Cumulocity, as well as other third-party applications and IoT platforms such as Ericsson IoT Accelerator. Built for integration and interoperability, MYTHINGS Central enables customers to easily connect, configure, and manage thousands of IoT sensors for innumerable IoT applications.

behrtech.com/mythings-central

BATTERY-POWERED GPS FOR ASSET TRACKING HAS CUSTOM LORAWAN STACK

DIGITAL MATTER

Oyster battery-powered GPS device meets demands in industrial LoRaWAN asset tracking and logistics verticals, delivering 5-year battery life, ultra-rugged housing and simple integration. Device is LoRaWAN Certified using firm's LoRaWAN stack, which is optimized for low-power operations and enhanced battery life. The high-precision device provides vital location and movement history data so businesses can protect and recover their most important assets, such as equipment, vehicles, trailers, bins, and more.

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densely congested outdoor environments such as airports, smart cities, campuses, parks, and massive industrial sites—all while reaching combined wireless speeds of up to 1.8Gbps. Solution can manage an unlimited number of APs from anywhere.

www.engeniustech.com/engenius-cloud/hardware

OPEN EDGE SOFTWARE PLATFORM SERVES 'TIME-CRITICAL' IOT SYSTEMS

IOTECH

Edge XRT software platform for time-critical and resource-constrained applications at the IoT

Edge, simplifies the development of time-critical IoT systems at the Edge and enables application portability, improved supportability and faster time-to-market for new IoT edge applications. Product runs on commodity hardware, independent of silicon provider and operating system and has complete deployment flexibility, it can be deployed as a native application, containerized and/or into a virtualized environment.

www.iotechsys.com

SMART MULTI-SENSOR WIRELESS MODULE SERVES IOT DESIGNS

TDK CORP.

SmartBug MD-42688-P multi-sensor wireless module leverages firm's MEMS sensors and algorithms for a

wide range of IoT applications. Module combines six sensors, a powerful wireless (BLE) MCU, seven algorithm-driven features and a rechargeable battery, all in a small lady-bug enclosure. Device also comes with the option of an Add-On board that includes a Wi-Fi module, an SD card slot and an ultrasonic sensor from TDK. The integrated SHTC3 is a digital humidity and temperature sensor optimized for battery-driven applications and high-volume consumer electronics.

www.invensense.tdk.com/SmartBug

SECURITY SUITE FOR CRITICAL IOT DEVICE PROTECTION

SEQUITUR

EmSPARK Version 2.0 security software suite prevents high-value, embedded devices from being compromised and delivers security defenses that include protection of critical intellectual property (for example, AI/ML algorithms, Mutual authentication for secure chip-to-cloud integration, and secure OTA firmware updates. Software provides the firmware, tools and APIs needed to provide security features spanning device design, manufacturing, and product lifecycle.

www.sequiturlabs.com/iot-security-suite/iss-kit-descriptions/

www.sequiturlabs.com

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Proliferation of IoT drives greater diversity in sensors

Applications diversify with trends in health & safety, miniaturization, fusion & digitization, AI. **BY ROBBIE PAUL**

Laird Sentrius RS1xx industrial humidity sensor.

With the proliferation of IoT, the need for a greater diversity of sensors has exploded across all industries. Digi-Key has seen firsthand how this demand has skyrocketed. As a component distributor, the firm sells more than 60-million sensors each year, and has access to more than 130,000-part numbers. Temperature sensors are by far the most popular, followed by accelerometers, driven by the popularity of activity tracking IoT devices. Environmental sensors are third, focusing on sensors measuring pressure and humidity.

> ***As policies and procedures continue to evolve throughtout the COVID crisis, optical sensors will be more important than ever for monitoring and controlling for health and safety.***

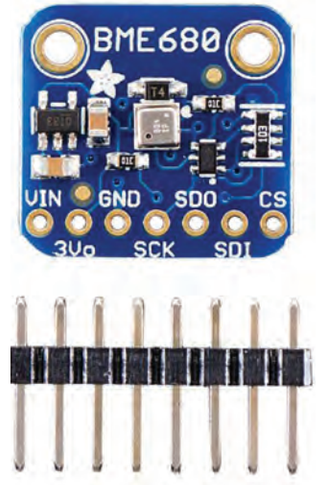
In addition to demand, we can expect sensor and sensor applications to continue to diversify, as new trends emerge in health and safety, miniaturization, fusion & digitization, and artificial intelligence & machine learning.

Health and safety trends

The COVID-19 crisis has brought several IoT solutions to the forefront. The overarching goal of these solutions is to assist in preventing the spread of the virus, which can be transmitted by air, as well as by touch or on surfaces. IoT solutions can mitigate some of these risks by monitoring and controlling key transmission modalities.

The EPA has reported that Americans are spending 90% of their time in buildings "where the concentrations of some pollutants are often two to five times higher than typical outdoor concentrations." IoT solutions for air quality monitoring include CO2 and particulate matter sensors, in addition to the more common sensors that measure temperature and humidity.

Creating a safe environment for customers and employees is essential to doing business. For many businesses, implementing social distancing solutions is now necessary to control the flow of customers through a store. This provides a unique opportunity for sensors, as there are several occupancy monitoring solutions available that make it easy to keep a constant, accurate count of the number of people in certain business environments. They can also provide a notification as full capacity is approached. As public life continues to reopen, optical sensors are a key piece of the occupancy monitoring solution and are being used in a novel way.



Adafruit BME680 temperature, humidity, pressure and gas sensor.

Sanitation is also essential to maintaining a safe and healthy work environment during the pandemic. Establishing a cleaning and sanitizing schedule is relatively easy, but maintaining and showing compliance to outside agencies without disrupting productivity can be a challenge. Even a simple system with high-visibility indicators that notify staff to begin scheduled cleaning processes can be coupled with automatic data recording and collection. These go a long way to ensuring compliance. Furthermore, with optical sensors, non-contact switching and activation can be enabled and used to control almost anything. As policies and procedures continue to evolve throughout the COVID crisis, optical sensors will be more important than ever for monitoring and controlling health and safety situations.

AI & machine learning for sensor deployment

Artificial intelligence and machine learning are starting to play greater roles in sensor deployment. One example of this is the Google Nest, which sets temperatures based on its surroundings, when people are coming and going, whether it's a weekday or weekend, etc. The Nest device is continually gathering data, analyzing it, and sending it to a cloud server to notify the user of its findings.

Not only does deep data analysis contribute to greater convenience for the user, but it also results in significant cost savings. A great example of this is some of the commercial applications for sensors that we've seen in the agriculture industry. Specifically, we're seeing a lot of farmers use moisture sensors to manage their irrigation systems. These sensors arm the farmers with rich data and automatically turn on the irrigation system if they detect the crops need moisture. As sensors continue to

Top: Source: Laird Connectivity / Below: Adafruit

progress, we expect that this intelligence and connectivity will be taken to a higher level. For example, tapping into the Weather Channel data, learning it is going to rain tomorrow, and determining not to activate the sensors. We'll also see the fusion trend here – combining temperature, humidity and pressure to give a more complete environmental picture.

The bottom line is we're using sensors today in a very rudimentary way. We take all of the data, but don't actively use a majority of it. Predictive maintenance like the commercial agriculture applications represent the proliferation of sensors and data – and how it can be utilized better. Artificial intelligence and machine learning will also be integral to helping us make data richer and more useful – and that will make all the difference in the world.

Other sensor trends

Miniaturization and sensor fusion are two interwoven trends that also continue to dominate. We're not only making sensors smaller, but also integrating multiple sensors into one single, small footprint. For example, temperature, pressure and humidity sensors can all be combined together in one package and used in compact environmental sensing applications.

We've also seen a greater move toward digitization in sensors as well. Typically, sensors have various analog output types, but by moving to digital outputs, integration is much smoother with other components like microprocessors. Whereas previously we had to convert from analog to digital, the widespread use of digital sensors is now enabling us to eliminate some components from sensor designs, further contributing to miniaturization.

Diversifying sensor applications

As IoT continues to grow on every front, and new sensor trends emerge, there's no question the applications for sensors continue to diversify as well. Sensors are moving up the value chain and becoming more like standalone finished devices. They are incorporating intelligence and connectivity and come in compact packages for indoor or outdoor use. This allows for these sensors to be deployed directly in the field by systems integrators and solutions providers since the engineering and development work has already been done by the OEM. With a little programming these versatile devices can be customized for any application.

As the applications for sensors diversify, we've noticed the types of customers coming to our sites has diversified along with it. The general trend we are seeing industry-wide is the move toward greater integration in all engineering applications. The proliferation of IoT has also driven some of the most innovative sensor technologies on the market.

We're seeing more and more boards that can be modified and used to create robust IoT systems and products, like the Adafruit BME680 breakout board, DFRobot breakout board, and BMI090L shuttle board. IoT continues to drive sensor technology and connectivity for what is ultimately a richer end-product. It's exciting to see all of the innovation happening in this space. **EP&T**

Robbie Paul *is the director of IoT business development at Digi-Key Electronics, one of the world's largest, full-service distributors of electronic components.*

Bringing touchless control to the industrial IoT

BY ALEXANDRA DOPPLINGER, P.ENG.

Many people use human machine interfaces (HMIs) with sleek glass touch screens and ubiquitous buttons daily, in homes, vehicles, workplaces, and public venues. The increasing spread and severity of the COVID-19 virus has heightened concern about touching the same buttons or screens as multiple other people. The pandemic has suddenly shifted the demand for alternative interfaces to reduce the need for physical contact.

It is not yet entirely understood how the virus spreads. However, a recent study suggests that SARS-CoV-2 may remain viable on surfaces such as glass, plastic, and steel for up to two or three days. This makes it even more important to implement touchless alternatives for humans to interact with machines in the workplace, retail, and hospital settings.

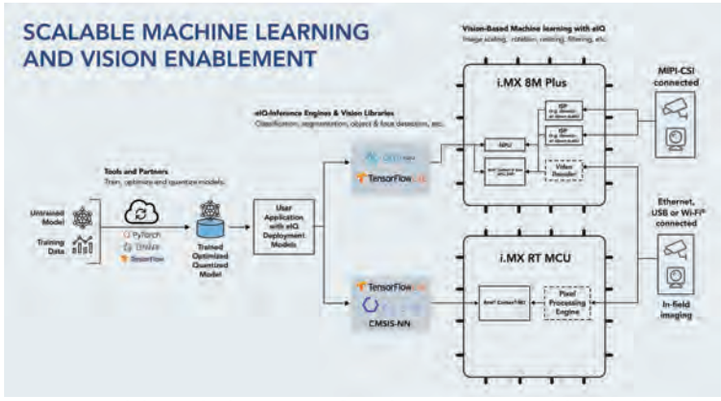


FIG. 1: NXP vision solutions range from i.MX RT MCUs, with a single Arm Cortex-M7 core, to the rich i.MX 8M Plus applications processor which integrates a neural processing unit with flexible interface options.

Reduce germ transmission

The Industrial Internet of Things (IIoT) automates manufacturing and smart machine communications, but there are still times when humans must interact with machines. To reduce germ and virus transmission, we need touchless alternatives to the traditional push-button or touchscreen controls.

Many users are familiar with voice assistants at home or in vehicles. However, this type of voice control is unreliable in noisy manufacturing facilities, active outdoor environments, or in large groups. For these cases, speech and gesture can be combined to give a more adaptable and robust multi-modal touchless interface.

With voice or vision-controlled systems, machines must quickly and reliably differentiate between deliberate user instructions and random or unintended inputs. For example, a machine should only turn on when the user intends this response, and not simply because a person is standing near it and talking. Machine vision systems can recognize gestures such as a hand movement, nod of a head, wave of a foot, and finger-pointing. Interpreting body language can become a more natural way for machines to respond to visible inputs from human operators.

Gesture-based solution

The first step to develop a gesture-based solution is to identify which gesture types the system must recognize and interpret. For example, will the user communicate using hands only, or by a full-body movement? Will finger movements be easier for the vision system to capture than a whole body, which could be partially obscured by clothing or other items being carried?

Gesture complexities are also important design parameters. For instance, opening a door might need only a single hand wave, but adjusting environmental controls or changing a production line might require a range of intricate gestures.

Finally, the speed of the movement and environmental conditions can play a significant role – for example, when lighting levels are low or too bright. Understanding all these factors help determine the number and type of camera sensors required, the field of view, the focal length, and the resolution required to detect and interpret the gesture.

It is also recommended to offer a back-up interface, such as voice control or a physical touch screen, in case the user cannot use the gesture method. For safety-critical functions in industrial environments, the application software may need a functional safety assessment and certification, such as IEC 61508 for industrial systems.

After the gesture, environment, and camera types are understood, we must acquire or build a gesture-recognition machine learning model. The left side of Figure 1 shows the steps needed to convert gesture examples into an inference engine – the algorithm which actually recognizes the gesture. TensorFlow, ONNX, and Pytorch are some commonly-used tools for this purpose.

Only now can we identify the appropriate hardware and software. Gesture recognition systems are typically built on industrial-grade embedded platforms ranging from a single, smart camera connected to a general-purpose computing core, to multiple camera sensors feeding multicore processors with highly-optimized vision and machine learning accelerators.

Figure 1 shows two such options for a gesture-recognition system, recommending i.MX RT microcontroller platform for simpler systems, and the NXP i.MX 8M Plus applications processor for more complex or faster-responding gesture and vision systems.

Stereo vision cameras can use either MIPI-CSI, USB, or Ethernet connections, together with audio inputs, to recognize speech and sound generators to provide audible user feedback. A display panel can also give visual instructions and feedback to the user and may incorporate back-up touchscreens in case the contactless control fails or will not be used.

The fastest way to get started is to leverage an existing embedded platform and toolkit, such as the Toradex Apalis i.MX8 Embedded Vision Starter Kit. The industrial-grade single-board solution is based on an NXP i.MX 8 applications processor, combined with an Allied Vision sensor, which leverages Amazon Web Services (AWS) development tools for the object recognition task.

Conclusion

Machine vision systems are set to surge in popularity as the demand for contactless user interfaces rises. This need may impact such applications as retail, smart building, healthcare, industrial, and entertainment.

Touchless controls will not only keep users safe but also improve the way we interact with machines in the industrial and manufacturing environments. **EP&T**

***Alexandra Dopplinger, P.Eng.**, is director product marketing, Building and Energy, for NXP's Edge Processing Business Line.*

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Disruptive innovation prepares Wi-Fi for massive IoT and 5G applications

After a long, post-COVID-19, day in the office, you return home. Your front door unlocks, and lights turn on as you approach. A blast of cool air is triggered by the high-efficient HVAC system controlled by an array of sensors. A day's worth of vitals and telemetry data downloads and is sent to your family doctor. And as you reach into your connected fridge taking your last favourite nutritious beverage, it automatically orders more.

We use so many devices on a signle lane WiFi highway today.

Welcome to the connected IoT world

"Hundreds of wireless devices in the home, seamlessly and wirelessly automating everything from the mundane daily tasks of turning on/off lights to enabling a new era of health and wellness," says Andrew Skaffel, CEO of Edgewater Wireless.

"In parallel, the new paradigm in the home will be eclipsed by the massive world of industrial IoT applications where – not 100's or 1,000's of wireless devices – potentially millions of wireless devices will enable factory automation and control. From lighting to temperature and environmental monitoring, the applications are as endless as the positive impacts," continues Skaffel.

Andrew Skaffel, CEO, Edgewater Wireless

According to sources at the Wireless Broadband Alliance (WBA), in 2018, there were 7-billion IoT devices. By 2019, the number of active IoT devices reached 26.6-billion, with industry experts estimating numbers to reach 31-billion IoT devices in 2020. Every second, 127 new IoT devices are connected to the internet.

Rapid growth in IoT applications

Couple the rapid growth in IoT applications with the transition to the new 5G mobile standards, and we are faced with our next technology revolution. The requirements to support a vast number of devices, combined with the demands of latency-sensitive applications, has created a transformative opportunity for application and equipment developers.

The bulk of IoT devices rely on Wi-Fi as the primary mechanism for connectivity – a sensible choice given the proliferation of Wi-Fi indoors (80% of internet traffic). As we move toward a 5G wireless world, Wi-Fi will be an integral part of the 5G solution, allowing network operators to leverage multiple technologies to deliver the capacity and low latency services. Known as 5G HetNet, heterogeneous networks supporting various technologies, including cellular and Wi-Fi, will be critical pieces of the new wireless paradigm.

The transformative opportunity facing developers and manufacturers is to shift Wi-Fi from a best-efforts, 'burst-rate' speed technology to an approach capable of delivering more capacity and lower latency. Relying solely on complex techniques, such as MU-MIMO, wider channels and homogeneous devices (i.e. all WiFi6) on a link which delivers increased 'burst rate', or higher association rates, no longer provides what's needed to move into the IoT age. Wi-Fi must evolve to tackle the densification of IoT and the low latency requirements of a wireless world. Wi-Fi must graduate to a more spectrally efficient standard.

Enter Wi-Fi Spectrum Slicing

"In-band Wi-Fi Spectrum Slicing optimizes performance for all devices in a coverage area. It enables the spectrum to be divided, allowing more radios to operate in a given area – in the same band," says Skaffel.

The challenge? Reduce interference so the radios can 'play nice' vs swamp one another out – the problem plaguing traditional Wi-Fi architecture.

A game-changing Wi-Fi innovation, Wi-Fi Spectrum Slicing can divide, or slice, both the 2.4 GHz ISM band and any of the three 5Ghz UNII bands into multiple concurrent channels.[1] Spectrum Slicing allows for multiple channels of bi-directional traffic both within the same band and within the same coverage area. Moreover, any Wi-Fi standards-compliant end device can take advantage of the technology, from 802.11a to 802.11ax. There is no need for the end devices in the network to have advanced Wi-Fi capabilities. With IoT applications, supporting multiple generations of Wi-Fi standards is critical given more robust protocols, such as 802.11 B, which are often used in industrial automation applications in particular.

Mitigating the performance degrading impacts of Adjacent Channel Interference (ACI) and Co-Channel Interference (CCI), Wi-Fi Spectrum Slicing offers a paradigm shift to reducing contention and providing the highest quality-of-service to the most users possible.

Designing and implementing ground-breaking new standards for Wi-Fi is critical for the success of massive IoT and 5G deployments targeting residential and industrial IoT opportunities. **EP&T**

*This article was supplied by **Edgeless Wireless Systems Inc.**, an industry leader in Wi-Fi Spectrum Slicing technology. www.EdgewaterWireless.com*

1. Wi-Fi Spectrum Slicing is applicable to all Wi-Fi bands, including the upcoming 6GHz band, as well as broader applications in other bands (i.e. 5G cellular).

Photo: Edgeless Wireless

Hiring amid Covid

Seven tips for attracting & retaining engineers during a pandemic. BY EVAN MELLOY

Photo: metamorworks - stock.adobe.com

Until recently, the demand for engineers has outpaced the number of qualified graduates. This created a job candidates' market in which high-performing engineering students had their pick of positions, and companies needed to act fast in order to snap up the best and the brightest.

This has changed somewhat in the era of COVID-19. According to one market study, more than half of electronics product launches have been postponed or canceled as a result of the pandemic—reducing the need for new hires. And, in some industries, such as automotive and aerospace, hiring has all but come to a halt.

At the same time, the demand for many engineers has strengthened as a result of the pandemic. Companies continue to hire systems engineers, software engineers, technical support engineers and others. The need for all types of engineers is sure to rebound once COVID-19 is behind us.

So, what should companies do today to attract the engineers they need both now and post-pandemic? Also, how can they tailor their hiring practices to ensure they continue to attract the most qualified engineers during this time of virtual hiring? Here are seven tips to consider based on our own COVID-19 hiring experience at Rohde & Schwarz:

Make the investment now. Don't put off your hiring needs until after the pandemic. Instead, consider taking advantage of the employers' market and the large supply of candidates that now exists. While hiring new engineers may not be perfect for your organization's bottom line today, COVID-19 will eventually be behind us and the demand for qualified engineers will once again outstrip the supply. Companies that hire now can differentiate themselves in the long run by ensuring they have the highest-quality engineers - now and into the future.

Adapt your hiring process. With the need for social distancing, it's unlikely you'll be able to adhere to all the same hiring processes you've used in the past. Yet, that shouldn't stop you from continuing to recruit. At Rohde & Schwarz, for example, we've been forced to eliminate the group project we've required of job applicants during in-person interviews. While that's made it harder to evaluate candidates' team leadership skills, one of the benefits of a virtual hiring process is that hiring managers can now record and directly compare interviews, which allows for a close evaluation of each job applicant.

Be decisive. Once you start the hiring process, it's important to carry it through without delay. Recent engineering graduates want immediate employment. The last thing they need is to go through a series of interviews only to learn that the hiring process has been postponed. A clear hiring process with a definitive timeline helps your company preserve its reputation, while equipping you with the top engineers you need for your success.

Look for good communicators and self-starters. While many companies prioritize innovation and technical expertise when hiring engineers, in today's at-home work environment, good communication skills are also a must. While communication is always a valuable skill, it's vital when engineers are working remotely. So, too, is the ability to self-motivate and to work well with other virtual team members. This is true for selling a company's products, as well as working to complete a project across multiple people.

Equip your hires with the right tools. To keep your engineers productive, it's important to provide them with the tools required to communicate and collaborate in a virtual environment. Videoconferencing software is essential, as engineers hold virtual meetings, collaborate on files and informally chat to stay connected throughout the workday. You'll also want to establish a centralized document management system to make it easy to store and access files, and project management software with clearly defined workflows and timelines.

Tailor your training programs for a virtual environment. Many companies offer training programs for new hires, and these, too, need to be adapted for a virtual setting. At Rohde & Schwarz, we've virtualized our in-person training sessions to include programs about our technical products and sales processes, as well as the history and internal resources of our company. Previously, new hires joined experienced sales engineers on a ride along, which allowed for job shadowing and in-person customer engagement. Today, assigning every new hire to work remotely with a manager on a special project can offer new engineers the 1:1 guidance they need to learn about a company's products and processes.

Stay connected. As you integrate new hires into the workplace, it's critical that you establish opportunities to connect, just as you would in the office. Weekly videoconferencing meetings can be a great way to share updates, discuss project roadblocks, and bond together as a team. And engaging with new hires 1:1 helps you establish a closer rapport, while creating a forum to address issues as they arise.

While COVID-19 has created business uncertainty, it's important to keep in mind that the crisis is temporary. Eventually, we'll be returning to business-as-usual, with many companies racing to fill the pent-up demand for engineers. With a proactive hiring process and the willingness to adapt, you can get ahead of the curve, differentiate your business, and ensure you attract and retain the highest-quality engineers both now and after the pandemic. EP&T

Evan Melloy *is a regional sales manager for Rohde and Schwarz, where he oversees a group of sales and application engineers.*
www.rohde-schwarz.com/us/career/overview/career_233504.html

TINY MULTILAYER CERAMIC CAPACITOR DELIVERS 1.0µF CAPACITANCE VALUE

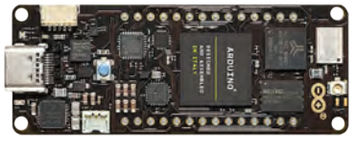
MURATA

GRM022R60G105M multilayer ceramic capacitor provides a capacitance value of 1.0µF in the 01005 inch size (0.4×0.2mm), with a rated voltage of 4Vdc. Mass production of GRM022R60J105M with a rated voltage of 6.3Vdc is scheduled to begin in 2021. Products have achieved approximately a 35% reduction in footprint and a 50% reduction in volume ratio compared to our existing product with the same capacitance value (015008 inch size).

www.murata.com/en-us/products/info/capacitor/

EMBEDDED MICROCONTROLLER BOARD SERVES PRO MAKER, INDUSTRIAL USERS

MOUSER ELECTRONICS



Arduino Portenta H7 first high-performance, industry-rated board from the Arduino Pro platform is based on a dual-core STMicroelectronics STM32H747 microcontroller that enables the board to simultaneously run high-level code along with real-time tasks. The STM32H747 processor's 480MHz Arm Cortex-M7 core and 240MHz Arm Cortex-M4 core communicate via a Remote Procedure Call mechanism that allows each processor to call functions on the other processor seamlessly. Both processors share all the in-chip peripherals and can run Arduino sketches on top of the Arm Mbed operating system, native Mbed applications, MicroPython and JavaScript (via an interpreter), and TensorFlow Lite.

www.mouser.com/new/arduino/arduino-portenta-h7

SPECTRUM ANALYZER EXTENDS FLEXIBILITY OF ULTRAREAL PLATFORM

RIGOL TECHNOLOGIES

RSA3000N and RSA5000N Spectrum Analyzer extends the flexibility and capability of the UltraReal platform with a new Vector Network Analyzer (VNA) measurement mode. Unit delivers the same performance specifications and feature set as the current RSA models but adds the VNA capability as a standard feature. With integrated Smith Charts, Polar Charts, Reflection Coefficient, Impedance, Insertion Loss, Frequency Response and a host of other measurements product becomes a fully functional VNA.

www.RIGOLna.com

UNIVERSAL MODULAR FUSE HANDLES UP TO 10A WITH VDE GRADE

SCHURTER

UMF 250 10 A Universal Modular Fuse has received VDE approval, according to IEC 60127-7/1. Offered with 15 rated currents, 500mA to 15A, the quick-acting SMD fuse was

previously approved by VDE up to 8A. The complete range is also cURus approved according to UL 248-14 and CSA22. An ideal alternative to traditional 5x20mm cartridge fuses, the compact 3 x 10.1mm device is rated for voltages up to 250Vac and 125Vdc, with a breaking capacity up to 200A depending on current rating.

www.schurter.com

I/O SYSTEM FIELD PROVIDES CABINET-FREE AUTOMATION

WAGO

I/O System Field meets the requirements of modern decentralized production facilities providing maximum performance and high level connectivity. System is IP67 rated and provides superior flexibility with two types of housings. Product comes with cast zinc housings with encapsulated electronics for harsh environments, as well as non-encapsulated plastic housings with low mass for mobile applications such as robots. Both types of modules are equipped with innovative load management.

www.wago.com/us/discover-io-systems/field

MINIATURE SMT FERRITES DELIVER TOP FILTER PROPERTIES

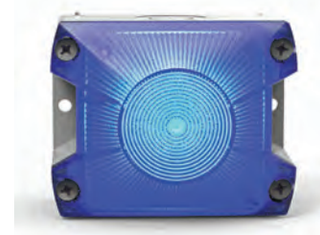
WÜRTH

WE-CBA SMT EMI Suppression Ferrite Bead product family include 0402, 0603, 0805, 1206, 1806 and 1812 packages. SMDs are AEC-Q200 qualified as part of firm's automotive electronics portfolio. Devices features Ni-Sn electrodes, high current carrying capacity up to 6A, and operating temperatures from -55 to +125°C. Ferrites are available in various specifications and are suitable as data line filters and for decoupling the supply voltage. The miniature devices in multilayer technology are soldered directly onto the pcb.

www.we-online.com

STEADY-ON/BLINKING COLOUR CHANGING LED DELIVERS VISUAL ALARM

X TRONICS



Pfannenberg PY L-S (UL Type 4/4x, IP 66) ultra bright colour changing or single colour LED comes with selectable signaling modes (continuous, blinking, flashing) and selectable colours (4 total). This Signaling Device provides a 180° x 360° visible field and operates in any climate. Can be surface or flush-panel mounted. Product can be used as a replacement to stack tower lights, easy to install. Alarm can be easily integrated with real time people flow control and thermal imaging camera systems. Available in grey housing with 10-year warranty.

www.xtronics.ca

MATING FACE COMMUNICATES ACROSS COMMON INDUSTRIAL ETHERNET PROTOCOLS

HARTING

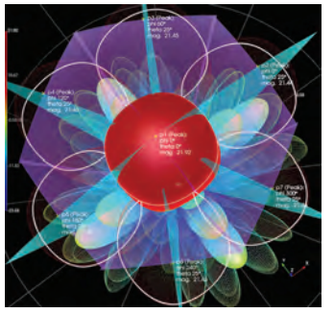
T1 Industrial connector delivers the standard mating face for Industrial Single Pair Ethernet and can accomplish communication across the common industrial Ethernet protocols (Ethernet/IP, Profinet, EtherCAT, and others) with a single twisted pair of wires instead of four or eight wires. Device utilizes power-over-data-line (PoDL) technology to bring communication,

voltage, and amperage needed to power the device. Device reduces the number of connections required, eliminating the need for an external power supply.

www.harting.com/SE/en-gb/single-pair-ethernet

SOFTWARE ACCELERATES 5G DESIGN, SIMULATION, VERIFICATION WORKFLOWS

KEYSIGHT TECHNOLOGIES



PathWave Design 2021 integrated software solution ensures design performance, improves accuracy and speeds time-to-market for end-to-end 5G workflows. Product is an open, scalable and predictable 5G and mmWave software solution that enables design and validation engineers to accelerate delivery of chip, board and system products by integrating device, circuit and system design with improved performance and accuracy. Higher frequencies coupled with the increasing design integration and complexity of 5G, require a unified, end-to-end approach to eliminate late stage design iterations and ensure first pass success.

www.keysight.com/find/pathwave-design2021-backgrounder

116-GBIT/S PAM4 ERROR DETECTOR BOOSTS FUNCTIONALITY

ANRITSU

MP1900A series is an 8-slot modular, high-performance BERT introduces Forward Error Correction (FEC) symbol capture and Bathtub test functionality for its 116-Gbit/s PAM4 Error Detector (ED) MU196040B in its Signal Quality Analyzer-R MP1900ABERTs. With the latest application software installed, unit conducts highly accurate bit error rate (BER) evaluations of 400GbE and 800GbE communications equipment and devices used in data centers servicing 5G networks. Firm developed each software package to support the growing demand for 400GbE/800GbE network elements.

www.anritsu.com

DUAL-CURING SEALANT SERVES AUTOMOTIVE ELECTRONICS

DELO

DUALBOND GE4918 light and humidity-curing sealant for connectors often used in vehicle control units or sensors, provides improved pin sealing properties, increases connector life, and allows efficient production. Product has been optimized for reliable sealing for silver coated connector pins. It adheres well to the mercaptan coating, and also adheres to the typical connector housing materials PA and PBT, even under the stringent conditions of the automotive sector. Sealant is flexible in the cured state.

www.delo-adhesives.com

250W CONVECTION COOLED RAILWAY POWER SUPPLY COMES WITH PFC-INPUT

ABSOPULSE ELECTRONICS

PFC 252R-HSA-F3 series dual-output railway quality power supplies deliver pure convection cooling. The 250W units employ active power factor correction (PFC) to convert a universal 95V to 264Vac input to two outputs. Output V1 provides any voltage 12V to 110Vdc/10A to 14A max; output V2 offers any voltage 5V to 24Vdc/8A to 2A. Both outputs are individually regulated, returns are common. Other input/output voltages are available on request. Product serves applications where pure convection cooling is feasible.

www.absopulse.com

30W DC-DC CONVERTER DELIVERS REGULATED OUTPUT

AIMTEC

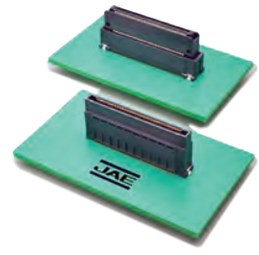
AM30CW-NZ high-power density 30W dc-dc converter in a compact 1x1 inch package features a wide 4:1 input voltage range of 18-75Vdc with an operating temperature range from -40°C to +85°C, suitable for a wide range of industrial applications. Devices can provide standard output voltages from 5,12,15 and 24Vdc and has been designed to meet the 62368-1 standard, which is the new safety standard for ICT and AV equipment. With an input/output isolation of 1500Vdc tested for 60 seconds, products can meet most system isolation and safety requirements. Features such as short circuit protection (OSCP), over-current protection (OCP), over-voltage protection (OVP), and under voltage lock-out (UVLO) come standard with the series.

www.aimtec.com

FLOATING BOARD-TO-BOARD CONNECTOR MORE FLEXIBILE THAN CONVENTIONAL UNITS

HEILIND

JAE Electronics AX01 series of high-speed floating type board-to-board connector features a floating structure, which allows movement of plus/minus 0.5 mm in the X and Y direction, as well as large mating guides, which can absorb positional shifts or misalignments that may occur during mounting and assembly.



Product's design allows increased flexibility over conventional rigid-type board-to-board connectors that often have difficulty with alignment when multiple connectors are mounted on the same board.

www.heilind.com

PUBLISHER'S PICK

ALL-NEW AXIAL HYBRID-POLYMER ELECTROLYTIC CAPACITORS

TDK's extended product offering of hybrid-polymer aluminum electrolytic capacitors include axial-lead and solder star versions. These new types are designed for voltages of 25V and 35V and capacitance values up to 2200 µF. Hybrid-polymer technology provides extremely low ESR values across wide temperature ranges of -55 degrees Celsius to +150 degrees Celsius.

Link for product info: www.tdk-electronics.tdk.com/en/electrolytic_capacitors

TDK ELECTRONICS INC.
732-906-4300
www.tdk-electronics.tdk.com

CURRENT LIMITING DIODE IS ADJUSTABLE

CENTRAL SEMICONDUCTOR

CMJA5050 adjustable current limiting 50V diode provides adjustable current regulation from 50mA to 80mA, and is packaged in the new DFN123F package. Device eliminates the need for using several individual CLDs in order to meet the required current regulation values. Product is suitable for any application requiring a space saving current regulating device, including LED lighting and test/measurement equipment.

www.centralsemi.com

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Design considerations with haptic technology

Actuators must have unrivalled performance in terms of acceleration, force and response time.

BY SONJA TAYLOR BROWN

Haptic feedback creates a tactile sensation through vibration or other mechanical motion. Haptic actuators are essential to use in environments where visible and audible feedback are not possible. High-definition haptic feedback significantly enhances the sensory experience of human machine interfaces by engaging the full range of human tactile sensitivity.

The haptic actuators used for these purposes often must be robust enough to operate in hostile, low-visibility and noise-filled environments. With integrated sensor functionality, these haptic actuators must have unrivalled performance in terms of acceleration, force and response time, and thus offers an unprecedented quality of haptic feedback.

Haptic feedback device technology provides that interactivity and tactile feedback. Conventional technologies including Linear Resonant Actuators (LRAs) and Eccentric Rotating Mass (ERM) are limited in the type of feedback provided, the amount of feedback provided, and the accelerated mass.

On the other hand, piezo haptic actuators are capable of accelerating large masses due to the high force and displacement characteristics Piezo haptic actuators are a reliable solution for high-resolution haptic feedback. All types of feedback from vibrations, to pulses, to button-like clicks are all possible with piezo haptic actuators.

Below are four design considerations for haptic technology.

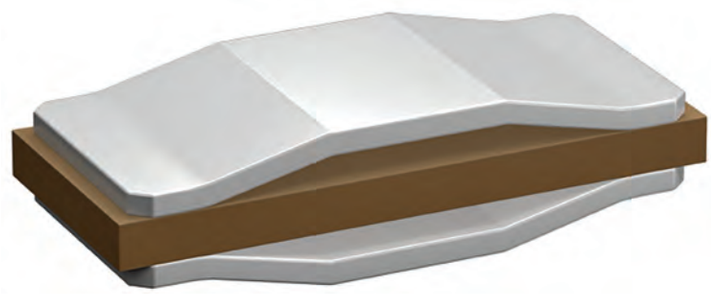

FIG. 1: TDK's PowerHap actuator has full functionality in a compact size.

1. Total available space

As devices become smaller, engineers must focus on shrinking the total solution, driver and haptics. Because the latter are the primary HMI for many devices, they must provide a seamless user experience, regardless of environment.

For nearly every project, the total available space is one of the first considerations an engineer evaluates. With haptic technology it is no different. Space is less of a concern when designing large industrial equipment or automotive displays, however, it is a significant concern with mobile and wearable devices.

Piezo technology can help shrink devices needing to provide haptic feedback. New devices such as monolithic piezo disks and multilayer piezos are thin, have a flexible wave design combined with sensing functionality. In addition, some piezo-based solutions use a multilayer design with ceramic PZT materials and cymbals to maximize force, displacement, and acceleration providing the user with a high-definition haptic feedback in a miniature package.

Understanding the application's size and space requirements will help determine if miniaturization is required.

2. Target feedback

Second, an engineer must understand what the target or goal for feedback/acceleration is desired based on the application, including how much mass needs to be moved. This feedback is what creates the tactile sensation when the user interacts with the application. As a result, engineers must understand the environment that the application will be used within as well as the sensing capabilities of the piezo device.

Piezo devices can sense the force applied and exchange voltage signals with an ASIC or microprocessor to provide haptic feedback. In a typical implementation of piezo devices, when the user touches the 'button' on a control panel, the touch is converted into a voltage based on the amount of force applied. This tactile feedback, based on voltage, vibrations and motion, feels like a button has been pushed.

In most automotive applications, engineers will need 6-8g of feedback acceleration. This is compared to a cell phone which only needs 2-4g of acceleration. An industrial keypad in a warehouse may need 10-12g or more depending on the application's operating environment and if users may be wearing protective clothing, including gloves. A single piezo actuator can move a mass of up to 1kg. Multiple piezo actuators can accelerate even heavier masses.

Closely associated with target feedback is the ability to sense pressure and provide haptic feedback through a material – such as the housing/frame of a mobile device. Target feedback is also dependent on the mass that will need to be moved to provide the feedback.

Actuators can altogether replace side buttons in hand-held devices while still providing the target feedback through a reinforced frame, enabling seamless dust and waterproof designs.

Piezo haptic actuators can detect a broad range of pressures up to 20 N, often rendering additional touch sensors unnecessary. For example, these actuators are able to provide different feedback depending on the force applied. This pressure sensing capability allows users to feel a virtual button before using a pre-defined amount of force in order to actuate. This provides the sensation that the user is working with a physical button without the actual physical presence of one. Pressure sensing ensures that the piezo device is not inadvertently or prematurely actuated.

By understanding the feedback/acceleration and pressure considerations, an engineer can determine the number of haptic components needed for the application.

PowerHap™ family	Driving Voltage		Actuator Thickness			Required Area (in mm)				Recommended weight				Automotive Qualification
	60V	120V	< 2 mm	2 < x < 5 mm	> 5mm	9 x 9 or smaller	13 x 13 - 20 x 20	26 x 26	60 x 5	<50g	50g - 250g	250g - 800g	>800g	
0909H011V060	X		X			X				X	X			
1313H018V120		X	X				X				X			
1919H021V120		X		X			X				X	X		X
2626H023V120		X		X				X				X	X	
0904H018V060	X		X			X				X	X			
1204H024V060	X			X		X				X	X			X
6005H070V120		X			X				X			X	X	
6005H090V120		X			X				X			X	X	

FIG. 2: Selection guides help user select the best actuator for the design.

Photo: TDK Corp.

3. Type of feedback

Next, an engineer must understand the type of feedback required for the application. While the end user will feel a button, a click, a bump, a vibration, or pulses there are actually millions of distinct responses that are achievable. These are made possible by the various signal forms made possible by the haptic device including sinus, square, sawtooth, trapezoidal and more.

Engineers should evaluate piezo devices based on the available signal forms. In addition, they should understand the duty cycle (or length of response), the pulse count and delay time possible from the piezo device. This feedback is what makes a good human-machine interface experience possible.

Tactile feedback is typically in the form of voltage and current pulses, with wave vibrations being the most common. In most applications, audible feedback is also needed to ensure the device operator understands that input was accepted. In some applications where significant audible noise is not desirable, the sound can be dampened by changing the waveform, voltage and frequency, as well as through electromechanical means. Engineers should often employ multiple types of feedback to reduce human error.

In the case of an automobile panel, the driver should be able to 'feel' the various buttons and options for selection on a menu when their hand moves down the panel to help with navigation of the various menus, without accidentally actuating the button. Then, when they actuate a virtual button, they should both feel and hear the feedback of the virtual button so they can be positive the system accepted their input. This not only provides a simple user experience, but improves overall safety in a moving vehicle where drivers can easily be distracted.

4. Power consumption?

Finally, power consumption should be taken into account. An engineer should understand if there are some low power constraints for a given application. Typically, if the device is battery-operated, such as a mobile phone or wearables – engineers should evaluate haptic devices with the least amount of energy consumption.

When the user interacts with a haptic device, the force of the touch is converted into an input voltage. Users then feel tactile feedback based on output voltage, vibrations, sound and motion that feels like a button has been pushed. This uses energy.

Piezo haptic actuators have extremely low power consumption compared with older haptic technology such as LRAs and other tactile engines. These technologies consume around 15mJ per click, and repeated actuation can drain a battery quickly. On the other hand, the power consumption of piezo haptic actuators is low, in some cases even lower than 1mJ per click, significantly reducing the amount of energy required, improving battery life.

Conclusion

The more questions an engineer can answer up front about the application, the better the solution that can be identified and put into place, improving device design, protecting against environmental conditions, improving user experience and safety. **EP&T**

Sonja Taylor Brown *is senior product manager of Piezo Products at TDK Electronics Inc.*
www.tdk-electronics.tdk.com

Source: Wenzel Group

DISTRIBUTION

WENZEL, NIKON METROLOGY ENTER DISTY PARTNERSHIP

Nikon Metrology Inc and Wenzel America reached a distribution partnership, making Wenzel an official Nikon Metrology partner for the sales distribution of Nikon Metrology laser scanning products in the North American market.

Wenzel's expertise and innovation in the CMM market, and Nikon Metrology's laser scanning technology will support the American customer base with tailored CMM laser scanning solutions to meet a wide variety of applications, industries and requirements.

Wenzel America has become an official distribution sales parnter of Nikon Metrology laser scanning products in North America

NEWARK LAUNCHES EBOOK ON CABLES FOR FACTORY AUTOMATION

Newark has launched an eBook that aims to guide engineers through the proper implementation of industrial-grade cables essential to a factory automation setting. The eBook provides users with cable solutions to avoid damages from commercial cable and ensure proper transfer of power, data and control signals within a machine, as well as from one machine to another.

Elements of this educational online tool include information on components of cables, a cable selection checklist, descriptions of cables for factory automation available from Newark and the necessary cable accessories to ensure optimal performance.

DIGI-KEY REACHES GLOBAL PARTNERSHIP WITH EAO

Digi-Key Electronics has expanded its tool offerings by signing a global partnership with EAO to provide its customers with a new Digital Product Selector (DPS) tool for emergency stop switches.

EAO's Digital Product Selector is an interactive and intuitive virtual configuration tool, enabling engineers and designers to easily configure products online to their specific needs. Exclusively offered by Digi-Key, the tool takes the guess work out of configuring emergency stop switches for engineers and designers, while offering an engaging user experience for customers to select emergency stop switches and configure them to their needs based on 3D photo realistic selections, as well as parametric input.

Customers can view 360-degree images, mounting depths, dimensional representations, illumination previews, and panel mounted views. Users can also download files such as data sheets designed for specific configuration, CAD drawings, launch installation videos and certifications.

TTI ADDS GOWANDA INDUCTORS, CHOKES

TTI Inc., a leading specialty distributor of electronic components, has reached an agreement to become an authorized distributor of Gowanda Electronics' inductors and chokes designed for RF, microwave and power applications.

For more than 50 years, Gowanda Electronics has been designing and manufacturing high performance components for demanding applications around the world. Product lines include off-the-shelf inductors for sensitive devices and equipment, broadband conicals for critical high frequency applications, and high reliability (Hi-Rel) products for demanding military, space and avionic applications.

Particular expertise in custom component design and manufacturing enables Gowanda to work closely with OEMs to develop solutions that address their unique application-specific requirements.

ACQUISITIONS

CIT RELAY ACQUIRES PICKER COMPONENTS

CIT Relay & Switch has enhanced its portfolio of electro-mechanical relays and switches by acquiring competitor Picker Components.

"This deal will generate value for our customers through a large choice of tailored solutions, a global network of services and expanded engineering expertise, says Jeff Hampton, president of CIT Relay & Switch. "It will magnify our value with a wider breath of product while at the same time extracting synergies"

With its state-of-the-art test lab, CIT provides custom or standard test requirements under a variety of conditions to validate most applications.

STANDEX ACQUIRES RENCO ELECTRONICS

Standex International Corp. has acquired privately-held, Florida-based Renco Electronics Inc., which designs and manufactures customized as well as standard magnetics components and products including transformers, inductors, chokes and coils for power and RF applications.

"We are very pleased to have acquired Renco Electronics, a great

strategic fit, deepening our significant engineering and technical expertise in end-markets supported by strong engineer-to-engineer relationships," says Standex president & CEO David Dunbar. "Renco's design and manufacturing cycle is extremely efficient, reinforced by a strong global network of proprietary supplier relationships."

Renco's products are used in consumer, industrial, military, and aerospace end markets.

WORK ENVIRONMENT

RITTAL SYSTEMS GETS NOD AS 'BEST' WORKPLACE

Rittal Systems Ltd. has been named to the 2020 list of best workplaces in manufacturing in Canada. The Mississauga-based office received this honour after a thorough and independent analysis conducted by Great Place to Work.

"Rittal is pleased to have achieved this, especially in these challenging times. This Award is a great testimony of how all the various teams at Rittal have come together to collaborate with true dedication and commitment," says Tim Rourke, president, Rittal Systems Ltd., Canada.

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AD INDEX

Canadian Women in Electronics

Exploring diversity through women in the Canadian electronics engineering and industry profession

Throughout 2020 EP&T explores the topic of diversity in the industry through a series of articles called Viewpoint; stories designed to get readers thinking about gender equity in the engineering profession, allowing others to maybe see their surroundings through a new lens.

Kristina Wheeler is senior manager of research & innovation at Veoneer Inc. in Markham Ontario, a world-wide leader in automotive technology. Headquartered in Stockholm Sweden, the firm designs, manufactures and sells state-of-the-art software, hardware and systems for occupant protection, advanced driving assistance systems, and collaborative and automated driving to vehicle manufacturers globally.

How did you first become interested and involved in engineering?
From a young age I enjoyed science and math and although I was not the tinkering type, I liked to observe how things worked. If my dad was repairing a car or my mom was working on a home improvement project, I was bursting with questions. Leading into post-secondary education I had doubts about going into Engineering, mainly because I tended to be more hands-off and book-smart. Fortunately, I mustered up the courage to apply and was accepted. Now, I am privileged to have enjoyed the last 22 years contributing to the electronics manufacturing industry.

How has your role or career path evolved over the years?
I started out as an intern in control system engineering. My first leadership role was to supervise a small group of test engineers and I have since had the opportunity to manageo operations, quality and maintenance departments. At Veoneer Canada Inc., I am currently responsible for research and innovation, focusing on industrialization strategies for emerging technologies. Located in Markham ON, we manufacture systems for preventing traffic accidents, as well as products that mitigate injury when crashes are unavoidable. Collaborative and autonomous driving is a challenging and fast-paced industry and Veoneer proves to be an exciting and dynamic workplace.

Q **Can you share an engineering workplace encounter you've experienced, or have been told about, that provides an example of unconscious bias based on gender or race?**
As a young engineer I was participating in an equipment design review abroad with several senior male engineers. Prior to departure, I was told by my manager to expect the representatives from the equipment integrator to look to my colleagues to confirm my assertions. "Why?" I asked. The response was gender related. This concept was foreign to me based on my life experiences. I had been encouraged by family, teachers, mentors, colleagues and managers throughout my life. Fortunately the promised gender bias didn't materialize, but I have since learned that right here in Canada many capable young women considering careers in STEM are discouraged to do so. It is certainly naïve, but this was surprising to me. Exposing young people to more diverse role models can help them to envision themselves in tech or leadership roles, and inspire them to overcome bias obstacles, gender or other, that may rear their ugly heads along the way.

Industry employers and associations have set some goals to achieve when it comes to equalization of genders within engineering circles. How do you think imposed gender initiatives will help women in their field?

A Imposed gender initiatives are counterproductive, and can lead to incremental gender bias in my opinion. Organizations should endeavor to find the best overall candidate, and should take decisive action to understand and eliminate gender bias in their recruiting pursuits. Initiating and supporting programs that motivate girls to pursue STEM courses in high school is key, and organizations can all contribute. The gender imbalance can be reduced by significantly increasing the quantity of skilled women candidates and eradicating bias in hiring practices.

What key words of advice do you have for employers seeking to create a supportive environment for women?
Employers should create a workplace that is highly collaborative, inspires innovation, promotes equal opportunities and strives to attract a diverse workforce.

An area for organizations to consider is how compatible is the expected work schedule with that of the working parent? Frequent early morning meetings and networking events that take place exclusively outside of working hours can be a disadvantage to people with kids.

Employers and employees alike can strive to be more self-aware when it comes to unconscious bias. Take a look around at the break table, at team meetings, at the tee blocks and the board room. Do you see people who look like yourself? If so it's time to identify ways to be more inclusive and to move outside your comfort zone.

*For more Women in Electronics, check out **ept.ca**.*

Photo: Veoneer Inc.

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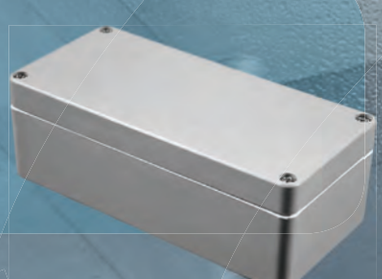

Industrial Wall-Mount Enclosures

Die-Cast Aluminum Enclosures

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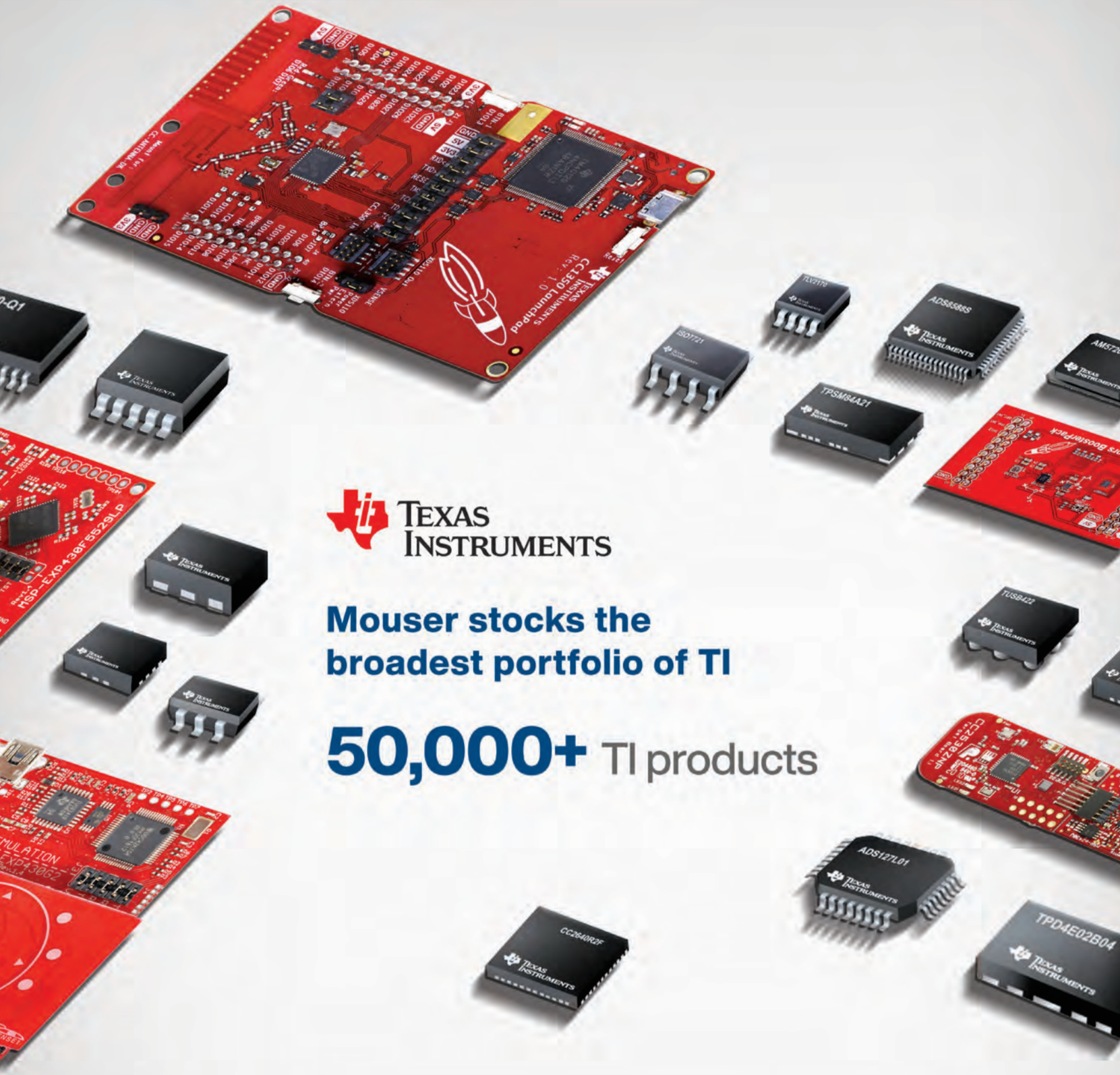

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