T H E E L E C T R O N

N E W S L E T T E R O F T H E I N S T I T U T I O N O F E L E C T R O N I C S

Issue 43: Autumn 2019

MED-TECH INNOVATION EXPO

Med-tech Innovation Expo, the UK and Ireland's leading showcase for medical design and manufacturing, opened its doors at Birmingham's National Exhibition Centre on 15th and 16th May. Around 250 organisations exhibited, whilst the conference featured some 55 presentations. Topics of interest to electronics professionals included '3D Printing and Bioprinting and its relevance to the Medical Device Sector' (University of Newcastle), 'Swimming with Whales - growing a Digital Start-up in the Healthcare Industry' (Forward), 'Solutions for powering next-generation Implantable Devices' (Ilika Technologies), 'Disrupting Disability with 3D Technologies' (AMFORI Consulting), 'Glaze Prosthetics - new Frontier in the Revolution of Prosthetics' (Glaze Prosthetics), 'How to identify and minimise Cyber Security Risks when developing Medical Devices' (Lorit Consultancy), '3D Printed Medicines - A Digital Pharmacy Era' (FabRx), 'Building a connected Devices Ecosystem for Digital Medicines' (Aptar Pharma), 'Cyber Security: Addressing Risk in the IoT connected World (Intertek), 'Towards a ubiquitous connected Healthcare System' (Datalink Electronics), 'Digital Light Synthesis - unlocking the Future in Medical Design and Manufacturing' (Paragon Rapid Technologies), 'How 3D printed Conductive Inks are being used to improve Medical Device Design' (Iterate Design),

'Developing Simulation to tackle real-time Packaging Issues' (Nelipak Healthcare Packaging), and 'Using Simulation to validate Performance of Drug Delivery Systems' (Wilde Analysis).

For this issue of The Electron we therefore focus on some of the major topics and developments in this area of electronics.

RISE OF AI CREATES CHALLENGES FOR INTELLECTUAL PROPERTY

The rise of artificial intelligence and machine learning is transforming how many industries plan and operate, and healthcare is no exception, but in this field there are some profound implications, especially in the area of intellectual property rights, as the commercial feature 'Rise of AI set to create unique IP Challenges' in *Intellectual Property*, 19th. March 2019, explains.

Particular attention is drawn to the interaction between users of AI-based solutions and their suppliers, and the fact that most standard software agreements fail to cover a lot of the complex areas of AI.

Tom Lingard, Partner and Head of Intellectual Property at UK law firm Stevens and Bolton, is quoted as follows:

"The big difference is that with software you can explain to a developer what you want to do and they will create a piece of software to achieve that, which can be clearly identified, but with AI that isn't the case. Fully understanding what constitutes an AI solution and distinguishing it from the customer's own data is a much more complicated process."

It follows that unlike wit traditional software it can be very difficult to delineate between which aspects of the trained AI are brought by the developer and which are specific to the customer, as well as the extent to which each should be owned by either party. The result is a legal minefield.

The article states:

'Once the AI system is up and running, a wide-ranging conversation around which party is providing the data and training the AI needs to happen, alongside to what extent data and analytics can be extracted or taken away if the collaboration comes to an end.

There is also a risk in terms of where the data for AI is coming from. Some AI solutions may make use of data mining to uncover relevant data from third-party sources, which may not have given permission for that work to be copied.

As the AI system itself cannot incur liability, the parties involved in its creation and use must be clear about who would be liable for IP infringements as they surface.

Businesses will need advice on everything from how correctly to ascertain IP ownership to defining liability conditions and discerning which party is responsible for AI actions that are not 100 per cent controlled by direct human input.'

Stevens and Bolton are specialists in the development of comprehensive IP strategies for AI platforms and may be contacted through www.stevens-bolton.com

MOTION CONTROL TECHNOLOGY ENABLES ROBOTIC NEUROSURGERY

Neurosurgery is a very exacting science where an error of just a few hundred microns can result in catastrophic and irreversible brain damage. For this reason surgeons have increasingly sought to apply minimally invasive surgery and robotics has played a major role in this.

The article 'How Motion Control enabled Neurosurgery' in *Med-Tech Innovation* journal (Issue 41, March-April 2019, p.25) describes the EU-funded EDEN2020 project in which researchers are developing a robotically steered catheter that can precisely deliver anti-cancer drugs to a brain tumour in-situ. This system, however, is only as good as its ability to position the needle exactly as commanded, and this has led to a focus on motion control:

'When it came time to specify the motion controller and drives for the four-axis robotic system that steered the catheter, researchers wanted compact, low EMI, high performance components.

The EDEN2020 system is based on the Programmable Bevel-tip Needle (PBN), a flexible needle that is capable of advancing through the brain along a precisely defined route that minimises tissue damage. The goal is for the robotic motion system to reference preoperative MRI scans and intraoperative ultrasound imagery during the procedure to generate path commands.

The PBN consists of four interlocking plastic segments nested together each of which incorporates a drug delivery channel. The channel also contains a fibre-optic cable used for shape sensing. Each segment is driven at its distal end by an ironless motor. By pushing one segment or another forward so that it slides over the others, the system can cause the tip of the needle to curve by a specific amount. This process enables the needle to be gently navigated through the structures of the brain to reach even deeply embedded tumours.'

At the low level control range the system needs to operate with an accuracy of 10 µm:

'The PBN features four motors each of which requires a drive. In addition, the overall system requires a high-performance motion controller to perform path planning based on closed-loop feedback and an input from the MRI and ultrasound units.

For a drive, the Imperial College team selected the Elmo Gold-Twitter servo-drive. Just 35 mm x 30mm, the compact Gold-Twitter drive is essential for minimising the overall footprint of the portable surgery station. In addition, the servo-drive's extremely low EMI, resulting from a highly efficient pulse-width modulation switching process, proved vital in this critical medical application.

In an environment in which safety is a primary concern, the Gold-Twitter, the smallest STO (SIL-3) certified drive available on the market, offers a huge advantage. Guiding the PBN requires the system to analyse the MRI and ultrasound data, then independently drive the four segments of the needle to direct the payload to the tumour.'

For a controller solution the Imperial College team selected the Platinum Maestro multi-axis motion controller:

'The Platinum Maestro incorporates a multi-core processor and advanced multi-axis features, making it effective for highly synchronised systems. It includes a library of motion algorithms to simplify the implementation and control of machines and robots that need to be both fast and accurate. The Platinum Maestro features enhanced fieldbus support, including EtherCat, cycling at a rate of 250µs in the Imperial Project.'

GRAPHENE BIOSENSOR AIDS LUNG CANCER DETECTION

Early detection is crucial for the treatment of lung cancer, but the biomarkers for the early stages of the disease are difficult to pick up. Currently electronic noses are used to analyse compounds in the vapour of a patient's breath, combining electronic sensors with mechanisms for pattern recognition such as neural networks. Improved electronic sensitivity leads to stronger patterns for the neural networks to analyse, which in turn leads to better detection of the cancer biomarkers.

In order to take this theory a stage further, researchers at the University of Exeter have used multi-layered graphene to create electrodes for a biosensor with enhanced sensitivity capabilities for three of the most common lung cancer biomarkers, namely ethanol, isopropanol and acetone.

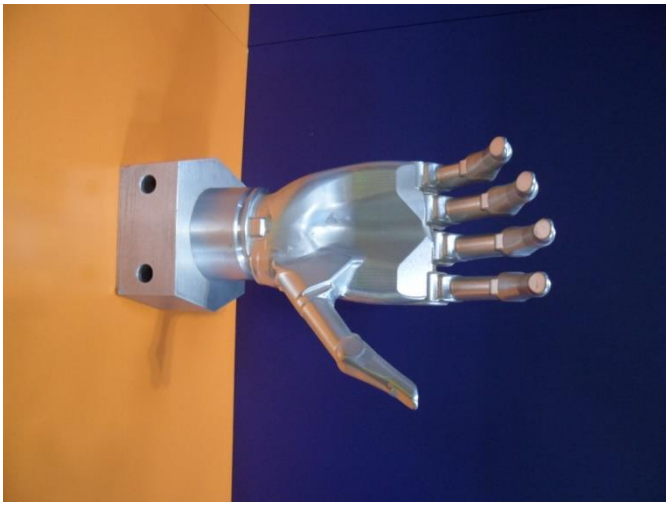
The article 'Lung Cancer Detection could receive Graphene Boost' in *The Engineer*, March 2019, p40, quotes study co-author from the University of Exeter Ben Hogan, as follows:

"The new biosensors that we have developed show that graphene has significant potential for use as an electrode in e-nose devices.

For the first time we have shown that, with suitable patterning, graphene can be used as a specific, selective and sensitive detector for biomarkers.

We believe that with further development of our devices, a cheap, reusable and accurate breath test for early-stage detection of lung cancer can become a reality."

FIRST PROSTHETIC HAND WITH TACTILE SENSATIONS



Researchers at the University of Essex have played a key role in a pioneering surgical operation undertaken at Sahlgrenska University Hospital in Gothenburg, Sweden, which, for the first time, has allowed a patient to receive what is described as 'the first clinically viable dexterous and sentient prosthetic hand'.

In the procedure titanium implants were placed in the patient's two forearm bones, from which electrodes to nerves and muscle were extended to extract signals to control a robotic hand and provide tactile sensations.

The Essex team contributed to the development of algorithms that can decode and understand the neuro-muscular signals from the patient's brain and subsequently send those commands to the robotic control of the hand.

Conventional prosthetic hands rely on electrodes placed over the skin to extract control signals from the underlying stump muscles. These superficial electrodes deliver limited and unreliable signals that only allow control of simple movements such as opening and closing the hand. The new device delivers richer and more reliable information by implanting electrodes in all remaining muscle in the stump. In this case sixteen electrodes were implanted in the patient. Tactile sensations are enabled where the patient previously could only rely on vision.

[Reference: 'First Prosthetic Hand with Tactile Sensations successfully implanted', *The Engineer*, March 2019, p.40]

MORPHING MICROROBOTS: A BREED APART

Researchers in Switzerland have developed a new breed of microrobot that can automatically change its shape in order to navigate different environments, which is envisaged to have major implications for medical applications.

The microrobots are constructed out of hydrogel composites and contain magnetic nanoparticles that allow them to be directed from outside the human body. This flexibility allows the microrobots to change shape autonomously according to their surroundings. Changes in viscosity, for example, can prompt them to form more efficient shapes so as to maintain momentum. This ability enables them to pass through, for example, narrow blood vessels with no loss of speed or flexibility.

The article 'Morphing Microrobots change Shape according to Environment' in *The Engineer*, March 2019, p.41, quotes Assistant Professor Mahmut Selman Sakar of the Ecole Polytechnique Federale de Lausanne as follows:

"Our robots have a special composition and structure that allows them to adapt to the characteristics of the fluid they are moving through. For instance, if they encounter a change in viscosity or osmotic concentration, they modify their shape to maintain their speed and manoeuvrability without losing control of the direction of motion."

KINETIC ENERGY FROM HEART HELPS POWER IMPLANTED DEVICES

Engineers at the Thayer School of Engineering at Dartmouth College, New Hampshire, USA, have developed a device about the size of a modern 5p piece that is designed to harness and convert kinetic energy from the heart to power a range of medically implanted devices.

Traditionally implantable biomedical devices are powered by batteries, which require replacement every five to ten years, necessitating surgery that can be costly and create risks of complications and

infection. The new device, however, combines thin-film energy conversion materials with a minimally invasive mechanical design that effectively makes it self-charging.

The team proposes to modify pacemakers to harness the kinetic energy of the lead wire attached to the heart so as to convert it into electricity that will continually charge the batteries.

The added material is PVDF, a type of thin polymer piezoelectric film. When designed with porous structures, either an array of small buckle beams or a flexible cantilever, it can convert mechanical energy into electrical energy. The same modules could potentially also be used as sensors to enable data collection for real-time monitoring of patients.

The self-charging pacemaker is envisaged to be around five years from commercialisation.

[Reference: 'Kinetic Energy from the Human Heart could power Implantable Medical Devices', *The Engineer*, March 2019, p.41].

SNIFFPHONE ENABLES EARLY DIAGNOSIS OF GASTRIC CANCER

VTT, a visionary research, development and innovation organisation, has, in collaboration with nine other partners, helped to pioneer a small sensor device known as a SniffPhone, which can be attached to a smartphone and used for cancer screening.

The patient exhales onto the device which then measures the contained Volatile Organic Compounds using highly sensitive nanotechnology-based chemical sensors. The measurements are then sent by Bluetooth through the smartphone to a dedicated cloud platform for analysis by medical professionals.

VTT had the role of implementing the platform for transferring the data from the smartphone to the cloud-based storage space, and has also built analysis tools for recognising high-risk patients. VTT has additionally developed a mobile application that guides the patient in giving a breath sample and provides the user with a preliminary analysis of the sample.

The SniffPhone project is part of the EU's Horizon 2020 Funding Programme and won the European Commission's 2018 Award for Most Innovative Project.

[Reference: 'SniffPhone Prototype enables the Diagnosis of Early Stage Gastric Cancer', Medical Plastics News, Issue 47, March-April 2019, p9.]

ADDITIVE MANUFACTURING FOR REMOVABLE PARTIAL DENTURES

Med-Tech Expo exhibitors Renishaw have been working with Yorkshire-based Egan Dental Laboratory in the application of additive manufacturing to the production of Removable Partial Dentures, also known as chromes.

Previously the Egan Laboratory had used the so-called lost wax technique, a manual process whereby a wax pattern is created of the framework, which is then sprued, invested and turned into a mould. The metal is then cast, desprued, finished and polished to produce the chrome. It took technicians two hours to complete each cast chrome framework and the process was highly error-prone.

One source of error was the fact that when casting metal by hand, the cobalt chrome material shrinks on cooling. This requires the technician to use expansion liquid such that when the metal shrinks during casting, the resulting RPD still fits.

A second source of error arises through limitations in the manufacturing process that make it difficult to achieve a thin cross section. Attempting to do so then results in deformation of the framework.

Further errors are introduced if the molten metal does not enter the mould cleanly, in which case the frames become incomplete. There is also a risk of porosity if the molten metal is overheated, and this in turn can result in the introduction of excessive carbon which can cause structural weaknesses.

Egan therefore partnered with AM experts Renishaw to develop an alternative digital process in which a technician draws on a master model by hand and uses a scanner (such as 3Shape, DOF or Medit) to commence Computer Aided Design. Renishaw's additive manufacturing techniques are then deployed such that the denture is built using laser powder bed fusion. A high-powered ytterbium fibre laser beam is focused onto the powder bed selectively melting 40-micron layers of cobalt chrome powder until the complete component has been constructed.

The new process involves just forty minutes of manual work, enabling Egan's laboratory to double productivity. There is now no risk of carbon or miscasting and the risk of porosity is substantially reduced. The RPDs themselves are lighter, stronger and more flexible than the old hand-cast ones, resulting in a more comfortable fit for the patient, whilst dentists have reported fewer instances of

fracturing of the clasp. When patients return for check-ups the RPDs have been found to hold their shape and the clasp does not require tightening.

STREAMLINING ADDITIVE MANUFACTURING FOR SPINAL IMPLANTS

Another pioneering project spearheaded by Renishaw is the application of additive manufacturing to the production of lightweight spinal implants that mimic the mechanical properties of bone.

In this project Renishaw worked with Irish Manufacturing Research, based in Dublin, who designed and manufactured a series of representative spinal implants using software from nTopology, an industry leading generative design company based in New York that has developed next-generation design engineering software for advanced manufacturing.

The nTopology platform enables engineering workflows, manufacturing processes and knowledge to be captured within the software to enable users to create custom workflows to meet their exact requirements. With it advanced designs can be created in minutes rather than hours or days.

Spinal implants are needed to restore intervertebral height in patients with a range of medical conditions such as degenerative disc disease, herniated disc, spondylolisthesis, spinal stenosis and osteoporosis.

Conventional manufacturing techniques are unable to produce spinal implants with a lattice structure, which offers a high surface area to encourage migration of osteoblasts into the implant and the ability to optimise the mechanical properties of a porous volume to meet the required loading conditions.

Renishaw, IMR and nTopology therefore joined forces to develop implants for the cervical spine, or c-spine, that incorporate lattice structures using additive manufacturing, under the project heading of Anterior, Cervical, Interbody Device (ACID).

First IMR created a design envelope to identify the unique opportunities offered by additive manufacturing to improve patient outcomes, whilst nTopology provided software that would design the complex geometry of the implants. Renishaw then produced the implants using its RenAM 500 machine.

IMR conducted extensive research to identify the appropriate dimensions for the specified case and the loading conditions that the implants would have to withstand in day-to-day life, as well as extreme conditions such as running or jumping. This data was combined with the known material properties of bone in patients with diseases known to create the need for a spinal implant.

Renishaw state:

'IMR used the RenAM 500M to produce prototypes from grade 23 titanium (TI 6AI-4V ELI). The company performed a series of tests to demonstrate the device met the most relevant elements of the standard specifications required by the FDA. Chemical properties were tested to ensure they met ASTM F136 and ASTM F3302, the standard specification for wrought grade 23 titanium to be used in orthopaedic implants and the standard specification for the additive manufacturing of titanium alloys by powder bed fusion respectively. The mechanical properties of the porous structure were characterised per ISO 13314, a test method used to determine the compressive properties and failure mode of a porous metallic material. Finally, testing ensured compliance with ASTM 1104 and ASTM 1147, standard test methods to demonstrate that porous structures do not delaminate from the solid faces of the device.'

Further Information

More information on these projects may be obtained from Renishaw plc, New Mills, Wotton-under-Edge, Gloucestershire GL12 8JR. Telephone: 01453 524 524. Email: uk@renishaw.com

PROJECT BRAINBOOK

Brain surgeons at St. Bartholomew's Hospital in London have launched Project Brainbook, a library of 360-degree Virtual Reality (VR) films of brain surgery.

A combination of 360-degree cameras show the operating theatre as if the viewer is the patient entering the operating theatre. Head-mounted HD cameras show the operation from the view of the surgeon.

The medical team worked with Fundamental VR, a UK-based VR simulation company that specialises in clinical training, whose Fundamental Surgery software as a service is likened to 'a flight simulator for surgery'. This combines VR images of tissue with haptic feedback for orthopaedic surgeons and with the procedure recorded in this way Fundamental VR can recreate the surgery in a VR simulation.

The article 'Creating a "Flight Simulator" for Brain Surgeons' in *Engineering and Technology*, Vol.14, Issue 3, April 2019, p.68, quotes Co-Founder of Fundamental VR Chris Scattergood, as follows:

"Trainee surgeons can practise the key stages of the procedure in a safe virtual operating room and actually feel in their hands the textures of all the different tissue types using FeelReal VR [for haptic feedback]."

The system works with HTC Vive and Oculus Rift headsets and a PC or tablet.

RAILTEX 2019

Also taking place at the NEC from 14th. to 16th. May was the 14th. Railtex exhibition and conference with some 420 exhibitors from 22 countries.

New for 2019 was the Future Focus Conference in which the Digital Railway featured prominently with a Keynote Presentation from its Programme Director Michael Flynn. Elsewhere in the Seminar Theatre papers were presented on 'How can we digitalise the Journey to benefit the Customer?' (Mike Hewitt, Chief Technical Officer, AD Comms), 'Trust- How Cyber Secure are you?' (Steve Little, Cyber Lead, Frazer Nash), 'Rolling Stock and Digital Systems Delivery for the UK' (Nick Hughes, Sales Director, Hitachi Rail), 'Optimising Lifetime Asset Costs using the Digital Railway' (Dr. Mark Aston, Chief Technology Officer, LB Foster), and 'Devolution and the Digital Railway' (Stuart Calvert, Managing Director, Group Digital Railway, Network Rail).

Below we feature just a few recent electronic developments in the rail sector.

INTRODUCING THE VIRTUAL STATION

As in the medical sector, Virtual Reality inroads into the rail sector, most notably in the field of training, and in 'The Real Benefits' (*Railway Strategies*, Spring 2019, p.46-47) Andy King, Finance Director for MTR Crossrail, explains how the 'Virtual Station' has been deployed in advance of the scheduled opening of the Elizabeth Line in December.

With 41 stations and 200 million passenger journeys expected per year a large amount of recruitment and training has to be undertaken and for this a fully immersive Virtual Station has been developed to help overcome the problem of how to re-create dangerous situations without having to take any risks or cause any disruption in real stations.

The author states:

'Many organisations have introduced gamification and virtual environments, a "VR Room" which involves large screens in a room to mimic a different environment. The difference with the VR station approach comes with using the HTC Vive equipment, where staff are immersed in situations - not just watching a screen - and need to interact with the virtual world, using a headset and a controller that's operated by movement and gestures.'

An initial trial was carried out to develop a tool focused on making employees more vigilant in identifying and reporting various KPI faults at their station, increasing passenger satisfaction and improving service:

'The environment encourages staff to explore and monitor the complete station world, just as they would in their day-to-day role, creating a stronger sense of real situations and pressures rather than contrived, tick-box exercises. Users are able to physically walk around as well as see and touch things in a station environment along the actual Elizabeth Line route. The 50 different scenarios range from reporting faults on critical station equipment, applying safety protocols for unattended luggage and dealing with a potential safety hazard such as a broken window. The users can then navigate the environment and make decisions using the gesture-controlled system'.

So far the training has been rolled out to over 150 customer experience employees since the end of 2017, with plans for the VR station to be used as a mainstay of induction for new staff and meeting changing needs.

ROBOTIC APPLICATIONS IN THE RAIL SECTOR

Robots have been used in manufacturing for over forty years, but are a rarity in the rail sector. This, however, is set to change as Simon Jarrett, Engineering Assurance and Development Manager for railway operating company Chiltern Railways, explains in his article 'Is there a Place for Robotics in the Future of Train Maintenance?' in *Global Railway Review*, Issue 2, April 2019, p.50-52.

In 2018 Brunel University London, working with TBG Solutions, won funding through the Department of Transport through Innovate UK to investigate the feasibility of using robots in the area of fluid servicing, including testing of port interfaces between train and robot:

'A test rig has been constructed and is now dynamically testing the existing train connections in common use across the UK network. TBG Solutions has developed concept designs for a fluid servicing maintenance road using commercially available six-axis robots. We have determined that the ability to dedicate one or two traversing robots to each vehicle in a train means that typical servicing times for a fuel point exam can be reduced from 30 to 10 minutes or less with the fuel flow rate and fuel tank size likely to be the limiting factors.'

At the same time Cranfield University has been working with Garrandale to develop a prototype cab front cleaning robot, which may be combined with the above to form a single robot depot servicing road concept.

The author concludes:

'Our intention as a next stage is to construct a full-size single-vehicle prototype to really demonstrate the potential of this technology before progressing to hopefully construct the world's first robot depot servicing road.'

Garrandale Rail was an exhibitor at Railtex and is based at Dartmouth House, Bawtry Road, Wickersley, Rotherham, South Yorkshire S66 2BL, www.gbr-rail.com

NEW SPEED PROTECTION SYSTEM FOR LONDON'S TRAMS

In November 2016 an accident on the Croydon tram network left seven people dead and many others injured. The subsequent Rail Accident Investigation Branch report recommended that an overspeed protection system needed to be developed in order to prevent a similar accident from happening again. The detail of the system was not specified and it was left to industry to provide a solution that was cost effective and offered an appropriate level of safety integrity.

On main line railways this would usually need to conform to Safety Integrity Level 4 (SIL 4) with full failsafe status and active monitoring of the safety integrity and functionality. For a tramway, however, the expense of this would be difficult to justify and a SIL 2 solution was thus specified as one of the functional requirements.

In response to the report Transport for London (TfL) let a contract to Deutsche Bahn's UK subsidiary ESG Rail to provide the required system for London's trams, with components to be supplied by Stockport-based Railtex exhibitor Sella Controls.

The article 'Tram Speed Protection' by Clive Kessell in *Rail Engineer* Issue 173, April 2019, p.24-27, describes Sella Controls' solution, known as Tracklink III:

'Sella Controls have developed, over the years, a track-to-train communication link originally developed for selective door opening (SDO). This consists of a sealed track or lineside mounted beacon that is powered from the radio signal of the train interrogator unit. The beacon is coded with data for the specific location and the information exchange between beacon and interrogator can be used for a number of applications.

For SDO, 18 fleets of UK trains are now equipped with the system. The radio link is in the 865.7 to 867.9 MHz unlicensed band and power levels of around 200 MW give a range of around one metre.

Although when used in SDO mode, trains are normally stopped at a station, tests showed that Tracklink III could get an acceptable number of "reads" at speeds of over 70 mph.

The Sella Controls system has three basic component parts - firstly the track beacons mounted traversely between the running rails, secondly, the underfloor beacon readers mounted on the underside of each tram and, thirdly, an on-board controller unit that monitors all the beacon "reads" and which is linked to a 4G public cellular radio connection or Wi-Fi for reporting back to a workstation in the control room.

On the approach to any significant curve, a series of beacons (up to four) will be positioned some distance in advance of the curve. Each beacon will be programmed with the maximum permitted speed at a specific point ahead which represents the start of a slowing down zone, thus a four beacon arrangement would signify four zones.

The train odometry then measures the distance to the start of the first zone, this zone being typically 150 metres in length. The speed at that point is likely to be line speed, which is already set at a maximum of 70 km/h. If that speed is exceeded, the system trips in and a full service-brake application is made.

The second beacon would similarly give a speed and distance for the start of the second zone, the zone distance being shorter (typically 30 metres) with, say, a maximum speed of 60 km/h, as the tram should be slowing down for the curve.

Similarly, the third beacon would give a speed for the start of the third zone at, for example, 40 km/h and the fourth beacon indicates the speed near the start of the curve - typically 20 km/h.

Under normal driving conditions the speed at the beginning of each zone should be well under the maximum speed permitted but, if the tram exceeds this then a trip occurs and a service-brake application is made, bringing the tram to a stop.

The exact distance from the beacon to the zone start is not critical but will be around 60 metres. The zones are "virtual" and are not marked in any way. Each beacon will be programmed with the distance to zone commencement, zone length and maximum tram speed within that zone. The four-beacon arrangement is such that the combination of all four can be positioned before the commencement of the first zone, so the tram odometry equipment is vitally important in monitoring

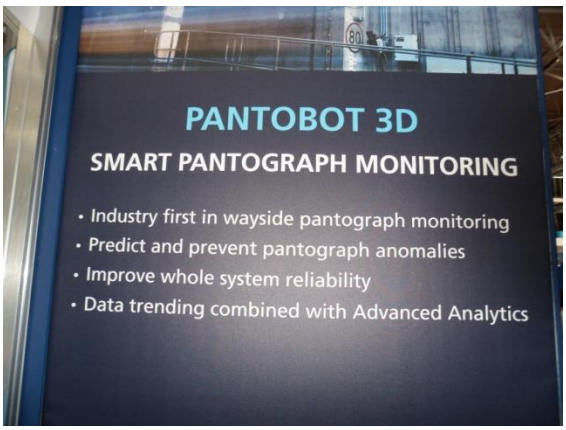
the slowing down process as it has to measure the distance to the start of the different zones simultaneously.

If the curve is not so tight and thus the speed is higher, it is likely that fewer beacons will be required, but, there will always be a minimum of two.'

There are currently 36 trams, of which there are two types in the London fleet. These are already fitted with speed sensors and odometers. ESG Rail is now delivering the integration design of the system to the vehicles, and is retro-fitting the trams with the reader and controller equipment, including interfacing these to the brake and odometry circuits. Completion of the project is expected by the end of 2019.

Sella Controls Limited are based at Carrington Field Street, Stockport, Cheshire SK1 3JN.
www.sellacontrols.com

AUTOMATED PANTOGRAPH MONITORING



Damaged pantographs on trains have the potential to tear down the overhead power line of a railway and subsequently cause considerable service disruption. Typical examples of pantograph anomalies are excess chipping, increased wear and cracking of the carbon strips.

Traditional pantograph inspection has relied on a two-dimensional subjective assessment by a skilled railway engineer. Railtex exhibitor Camlin Rail, however, has recently released a 3D real-time fully

automated inspection system that allows the network operator to make real-time decisions based on a true pantograph condition.

The system, known as Pantobot 3D, represents a step change in the image capture, processing and analysis of train pantographs, providing the ability to detect pantograph anomalies to less than a millimetre with no loss of image resolution.

When a train passes Pantobot 3D is triggered via a laser to detect the top of the pan head. This allows the LED illuminators to activate and the cameras to capture a single shot of the pantograph with train speeds possible up to 300 km/h. For ease of installation the Pantobot 3D is mounted on a vertical structure similar to the catenary support system, rather than a conventional portal system.

Advanced image processing software is utilised to automatically create a 3D reconstruction of the train's pantograph whilst powerful diagnostics determine its overall condition. E-mail notifications are generated automatically should a pantograph be outside of its normal limits.

A web-based interface allows the user to access Pantobot 3D via a secure device connected to the internet. Users can define the operating limits of each pantograph model and set alarm thresholds accordingly. Pantograph images can also be viewed for further analysis.

Machine learning algorithms trend individual pantograph models to predict when the pantograph is approaching end of life so that maintenance schedules can be fully optimised.

The system is able to:

* Recognise and classify the pantograph model.

* Classify the material on the contact strips (e.g. graphite or copper).

* Analyse the degree of wear, chipping and cracking on every axis (X,Y,Z) to millimetric level.

* Evaluate the level of roll, pitch and yaw (X,Y,Z) of the individual contact strips and complete pan head to within one degree.

* Detect if the pantograph horns are bent, damaged or missing.

* Measure the degree of uplift exerted by the pantograph (vertical displacement).

* Measure the degree of uplift of a passing pantograph (contact wire displacement).

* Match the train to the damaged pantograph either by RFID or machine vision.

Camlin Rail was an exhibitor at Railtex and is based at Camlin Power, 31 Ferguson Drive, Knockmore Hill Industrial Park, Lisburn BT28 2EX, Northern Ireland. Telephone: 028 9262 6989. www.camlingroup.com

UC EXPO

UC Expo, Europe's largest unified communications and collaboration event, took place at London's ExCel exhibition centre on 15th. and 16th. May. There were just over 110 exhibitors and 86 conference presentations.

The presentations were spread across eight theatres, namely UC Keynote, Cloud, Video and Collaboration, Microsoft Technologies, Network Modernisation and Security, The Future of Work, Customer Contact X (new for 2019) and Customer Contact Technologies.

Papers included 'How Cloud Communication is powering Digital Transformation in the Enterprise' (Ring Central), 'Microsoft Teams with Third-party Video Conferencing: What it means for the Enterprise' (Pexip), 'Transition from Skype to Microsoft Teams' (Microsoft), 'The Future Impact of AI on Cyber Crime' (Darktrace), 'Cloud Networking: SD WAN, Landscape and EMEA Managed Services' (Cavell Group), 'How do we avoid the common Pitfalls of UC Deployment' (Spink Telecom Consultants Limited), 'Bringing Business and Communication Apps together with Bots for increased Productivity' (Zoho), 'Reading the Room: How and why IoT Sensors improve Collaboration and Wellness in Meetings' (Sharp Electronics and Workplace Unlimited), 'AI's Role in the Future of Work' (Dialpad), 'First Class for All: Bringing Enterprise Class AI and Collaboration to Everyone' (LogMeIn), 'AI enable the Contact Centre: Improve Customer Experience and drive Operational Efficiency' (Amazon Web Services Keynote), 'How AI is shaping the Future of Contact Centres' (Cisco), 'Global SIP Trunking: The Gateway to Enterprise Cloud Telephony' (BICS), 'The Impact of Chatbots and AI on the Customer Journey' (LogMeIn), 'Understanding AI in Communications today and tomorrow' (ZK Research), 'The Human Factor of Cybersecurity' (Defence Works), 'Intelligent Meetings' (Microsoft), 'Contact Centre of the Future tomorrow - or today?' (EE and Associates, LLC), 'The Future of Contact Centres using AI (Google), 'The Impact of Telecommunications fraud in in Cloud Communications (BICS), and 'How Digital Transformation reduces Costs and improves Customer Experience' (Britannic Technologies).

With all of this, and more from the Microsoft Tech Hub and the Cisco Collaboration Zone, it was easy to become swamped by electronics, so we have selected just a few topical subjects.

ADAPTIVE LEARNING AT LEEDS UNIVERSITY

Many universities are currently investigating the use of flexible spaces as the traditional transmissive model of teaching is gradually giving way to collaborative active learning in technology-enabled spaces, typically equipped with large displays and the ability to connect and share data [Reference: Reynolds, L, 'Active Learning is defining HE Frameworks, *AV Magazine*, May 2019, p.26].

In line with this trend Leeds University has set a number of requirements for two new teaching spaces in its business school that "would break the traditional mould of lecture spaces" [Reference: Webb, R, 'Adaptive Learning', *Inavate*, May 2019, p.41].

Universal AV Services, a UK-based integrator which has built up a strong relationship with Leeds University over the last 25 years, were engaged to design the facilities, each with thirty seats. One is a fixed collaborative space, the other a flexible collaborative space.

Reece Webb's article states:

'One room, a G.07 collaboration suite, was designed to host collaborative tables with fixed displays, while the additional collaboration room features fixed interactive screens with an informal seating cluster to promote the use of touch technology. Both rooms also feature a traditional podium at the front at the request of academic feedback'.

A Clevertouch screen system was deployed, using Clevertouch 15465PRO 65 - in pro IR touch screens to meet the university's required levels of functionality, with control provided by an Extron control system:

'The fixed collaborative space has Panasonic 48-in displays on a Top-Tec table with five seats, which allows for bi-directional collaboration.

Audio-Technica failsafe ceiling mics were installed with a Univox induction loop system alongside a Beyerdynamic MPR 21 boundary microphone, Extron SM28 speakers and FF2201 speakers.

In the second space self-seating was used rather than fixed furniture allowing for a more flexible approach.

Universal AV took a flexible approach to the mounting of the displays it installed, allowing the Clevertouch units to be wall mounted on Clevertouch height adjustable mounts. This allows the room to be adapted for different purposes, unlike a traditional lecture space.'

UNIVERSITY OF ST.ANDREWS AWARDED £1.5M FOR SAFEPOD NETWORK

The Economic and Social Research Council (ESRC) has awarded the University of St. Andrews £1.5 million to create and manage a new SafePod network.

Designed and developed by St. Andrews University, the SafePod replicates a traditional safe setting and includes security features such as a door control access system, CCTV and secure storage areas

for IT equipment. These SafePods are thus designed to support, strengthen and widen remote access to research datasets held by data centres.

No datasets are kept within a SafePod. Instead a secure connection links it to a data centre for researchers to access, view and analyse their project datasets. The SafePods are compact, enabling them to be placed easily in organisations where space is an issue, with researchers able to have local remote access to project datasets without the need for long distance travel to a dedicated safe setting provided by the data centre.

In the April 2019 issue of *Networking*, Darren Lightfoot, SPN Manager at the University of St. Andrews, is quoted as follows:

"For a participating data centre, SPN provides a low-cost secure platform to widen access to their datasets across the UK for research purposes. As a SafePod design and policies are standardised, a single accreditation for use of a SafePod by a data centre is all that is required for them to accredit the full network of SafePods."

Eligible organisations can apply for a SafePod and be part of the SafePod Network (SPN) via the ESRC website www.esrc.utri.org

X2O MEDIA LAUNCHES VIRTUAL COLLABORATION ROOM

UC Expo exhibitors X2O Media launched their virtual collaboration room in the UK on May 15th. 2019 following a successful launch in Canada.

According to X2O Media the virtual collaboration room represents "the future of remote collaboration", combining the benefits of live meetings and collaborative sessions with the power and flexibility of a cloud-based virtual platform which extends across multiple meeting rooms or from participants' own desktops.

The virtual collaboration room supports up to five rooms and 16 remote participants that appear on dedicated avatar displays with directional audio in each room. Attendees experience a unique interactive meeting environment between the remote participants and the in-room attendees. The solution supports SAML based single sign-on for one-click access for enterprise users.

The collaboration room features ultra-high quality bi-directional audio/visual communication with intelligent multi-camera views, including a unique perspective view of the selected room for each remote participant. This enables the same level of engagement for everyone in the meeting, local or remote.

The company states:

'Moderators can add documents, set the seating chart, start a session or control content such as chat functionality and polls from the operator's view. Using the X2O Desktop application, a meeting organiser with the proper credentials can simply add a new collaboration session through the UI.

Remote participants join by using the X2O Desktop application or Chrome browser, and the only hardware required is a standard headset and webcam. All remote participants can annotate in colour on specific pages or slides without losing the markups already made. This applies to any content being shared - presentations, images, videos or simply a whiteboard. Attendees can also share content and interact as a group and as individuals.

Remote executives, engineers, analysts and designers experience and participate with local attendees in everything that is taking place in multiple live meeting rooms - ultimately enhancing team productivity across the globe.'

The Virtual Classroom

X2O Media has also pioneered the development of the virtual classroom through which universities and corporate learning centres can offer a unique learning experience to remote students and employees alike.

Remote students are able to experience and participate in everything that is taking place in the live classroom and, as with the virtual collaboration room, combines the benefits of live, instructor or moderator-led training with the power and flexibility of a cloud-based virtual platform.

The virtual classroom supports up to 90 remote participants that appear on dedicated avatar displays with directional audio.

More information is available at www.X2Omedia.com

THE FUTURE NETWORKS LAB

The anticipated benefits of 5G rollout to the UK economy are well known, but realisation has been hindered by a general accessibility to infrastructure. As with low power wide area networks (LPWAN), on which IoT technologies are run, other countries, especially the USA and China, have been investing heavily to stay ahead, hence there is concern that a widening gap in future networks technologies infrastructure could leave UK enterprises that are looking to develop IoT or 5G-based products at a disadvantage.

In order to try to redress this Digital Catapult, in partnership with BT and others, has recently launched the Future Networks Lab, one of the first facilities in Europe to be specifically designed with a focus on IoT, 5G and LPWAN technologies.

Based in London, the Future Networks Lab will provide access to the latest LPWAN networks (LoRaWAN, Sigfox, NB-IoT, and LTE-M) as well as a 5G node which is interconnected to other 5G testbeds. It will also provide a space for UK start-ups, corporations and network platform providers to collaborate and develop the services and applications required to support UK businesses and take advantage of the latest network solutions.

A key feature of the Future Networks Lab is its ability to bring both UK start-ups and larger organisations together to collaborate, experiment and test. By combining the wider experience and resources of larger corporates with the innovations and agility of start-ups it is hoped that the chances of making breakthroughs in the use of new state-of-the-art networking technologies will be

significantly improved. This in turn will help to realise the full potential of Industry 4.0. New network technologies such as IoT and 5G should also help to bring leading edge technologies out of university labs and onto the market.

[Reference: Silver, J., 'The Future Networks Revolution', *Network Computing*, Vol.27, No.2, March/April 2019].

ROBOT SPEEDS UP MOBILE PHONE TESTING

Technology Recycle Group has invented a robotic arm that has made a fivefold increase in the speed of testing of mobile phones.

The specialised robot arm works in tandem with TRG's in-house diagnostic software to carry out such functions as testing phone buttons. It has currently only been configured with iOS devices.

Mobile News, Issue 687, April 24, 2019, p.6, quotes TRG Managing Director Sam Hargreaves as follows:

"Where a competitor might process 1,000 devices in a week, we could process up to 5,000 with the same human resources but with better tech to allow us to do it.

The plan is that rather than having one tester at a desk with lots of phones in front of them, they are in front of five robotic arms and feeding them with phones in time with our diagnostic software."

The High Wycombe-based recycler serves around 6,000 second-habd retailers across the UK and EU and recently launched an auctioning platform that allows clients to bid for batches of devices by software and level of functionality.

USING BLOCKCHAIN FOR SMART CONTRACTS

Smart contracts are designed to automate deals from the signing of the contract to its implementation and the enabling technology is blockchain, which theoretically removes the need for solicitors and even trust between the contracting parties.

The article 'Chip off the old Block' by Eric Johansson in *Elite Business*, Issue 50, April 2019, p.60-61, quotes Julian Zegelman, Founder of TMT Blockchain Fund, as follows:

"Smart contracts are self-executing meaning they allow the performance of contractual transactions without third party involvement."

Every transaction must be compliant with the previous block of data to be accepted, creating a new block in the chain. Once the parties agree on a deal, what should be in it and what the different parties should do to fulfil their part of the transaction, the deal will run through a blockchain platform such as Ethereum.

The article continues:

'This means that half of the computers - or nodes - in the decentralised network must agree that the deal is sound before it goes through. This procedure results in there being no other party involved in the process, no centralised authority, other than the two parties making the deal. Moreover, this automation means that, once triggered, no parties can back out of the deal.'

Andy Bryant, Chief Operating Officer for bitFlyer Europe (the bitcoin marketplace) is then quoted:

"One of the biggest advantages for small businesses using smart contracts is that they're able to trust unknown transaction counter-parties over long distances or different legal jurisdictions. The use of blockchain allows the processes to be automated which in turn saves a huge amount of time whilst eliminating the need for third party involvement. They allow businesses to essentially streamline various complicated processes into one automated process."

Emma Stevens, associate solicitor for law firm Coffin Mew, however, presents a contrasting viewpoint:

"Due to the complexities of computer coding, it's not yet possible to accurately use smart contracts in all scenarios - many ideas for where smart contracts could be or ideally would be used aren't currently possible to implement.

By their very nature smart contracts are unequivocal due to computer coding trends and the need to be black and white to avoid uncertainty so they can execute instructions. They're therefore only as good as the data they receive and, as they're programmed and reliant on human data input, there is always the potential for human error."

In addition, security is also an issue, which the article highlights with reference to a breach in the Decentralised Autonomous Organisation (a digital organisation):

'The DAO allowed users to contribute the cryptocurrency ether to a pool that would be invested in proposed projects based on a vote, which would be proportional to how much ether each person had invested. When the DAO launched its tokens on Ethereum's blockchain in May 2016 it attracted 14 per cent of all ether created at that point. However, in June someone exploited a flaw in the code.'

Andy Bryant is then quoted again:

"It essentially allowed for an attacker to keep interrupting a transfer at the moment between sending and receiving funds, tricking the receiver into repeating the same transfer a large number of times and accumulating ill-gotten gains."

The $50 million that was stolen was eventually able to be returned to its owners, but the breach served to illustrate the vulnerability of both blockchain and smart contracts. Thus, whilst there may be substantial benefits available in the long-term, there are still risks and potentially a long way to go before this technology can be signed off as sound.