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Issue 33: Spring 2017

THE UK DRONE SHOW

Drone technology is one of the fastest growing fields in electronics today and on 3rd. and 4th. December 2016 The National Exhibition Centre in Birmingham hosted the second UK Drone Show. It can be noted that, unlike all previous events reported in The Electron, the event was held over a weekend, reflecting the fact that drone technology is a field of interest that is just as important for amateurs and hobbyists as it is for commercial operators.

The event featured 72 exhibitors and 22 workshop presentations, and incorporated an impressive 'Innovation Zone', Radio Controlled Car Race Track Zone with Drone Demonstration, and the showpiece Flight Zone, which occupied a complete hall of the NEC in itself and served as a stage for some spectacular indoor drone racing around a specially constructed obstacle course. With all of this the Show has notably become Europe's largest drone event.

In introducing the Show the UK Drone Show Team described the year of 2016 as having been "a great one for the consumer drone market in the UK" as well as "the breakthrough year for drone racing".

The Team states:

"British talent has been flying the flag around the world, starting with Luke Bannister being crowned the World Drone Prix Champion, and UK pilots have been featuring right at the top of the leaderboards in international competitions. The racing scene is thriving in the UK, and The UK Drone Show has been at the forefront of innovating the next step - indoor drone racing. In partnership with GAME plc and Insomnia Gaming Festivals, The UK Drone Show has launched 'iSeries Drone Racing', with a full card of events for 2017. We're also pleased to announce a joint venture with UK Drone Store to bring the UK's first dedicated indoor drone racing centre, which will be hosting qualifying events for the iSeries throughout the year."

ProSight HD Digital Cup Challenge

The principal highlight of The UK Drone Show was undoubtedly the ProSight HD Digital Cup Challenge where some of the world's top drone pilots competed in the first ever all-digital race.

The breakthrough all-digital HD vision system from Amimon was featured alongside the Connex family of digital wireless transmission systems and the pioneering ProSight HD system that has been specifically tailored to the fast-growing First-Person View (FPV) drone racing market.

Twelve pilots, including 16-year-old Luke Bannister, who won the $250,000 first prize at The World Drone Prix Championships, competed using drones that had been fitted with the ProSight system, which brought unparalleled clarity and precision to the pilots as well as an unrivalled spectacle for the audience.

Qualifying rounds were held on the Saturday afternoon with the semi-finals and final taking place on the Sunday.

The European Rotor Sports Association has also now sanctioned digital technology for use at all of its events as HD Vision is beginning to transform the drone industry.

The UK UAV Challenge

The UK Drone Show also saw the launch of the UK UAV Challenge, a new project for sixth form, college and university students with an interest in aviation and engineering. The Challenge aims to encourage students to design, develop and race custom aircraft and a two-day final is planned for The UK Drone Show 2017.

The UK Drone Show Team states:

"The Challenge shares the focus not just on racing, but emphasising engineering skill to improve the performance of their aircraft, with static components such as strength for weight comparisons, and dynamic components such as durability testing."

The Launch of UKDS Racing

UK Drone Store Limited is very excited to announce the launch of UKDS Racing, which will be undertaken on new UKDS purpose-built FPV Drone Racing Circuits.

These Race Circuits are based on the quarter kilometre iSeries format with the layout being reconfigured every month. In addition there will also be a circuit for beginners where expert staff will provide tuition both on a one-to-one basis and for groups.

Each Circuit will include a UK Drone Store retail area showcasing the latest entry level and expert racing drones, plus a wide selection of leisure products, batteries and spare parts. There will also be a workshop where racers will be able to learn how to customise and repair drones.

The first iSeries qualifier is scheduled for March 2017 and anyone with an interest is invited to log on to www.ukdronestore.com or www.ukdsracing.com

REVIEW OF EXHIBITORS

As previously stated there were 72 exhibitors at The UK Drone Show 2016. These reflected a considerable amount of innovative and pioneering work and a review of some of this is presented below, beginning with one of the exhibition highlights, The Innovation Zone.

Innovation Zone

The Innovation Zone featured four specialist exhibitors, namely Atmos VR, Sea Drone, Extreme Flyers and Tetra Drone.

Atmos VR Limited provides an immersive 360-degree, 4K live streaming service whereby users can experience what they have potentially missed. As well as concerts and festivals, drone racing events are covered to either live stream or record for later viewing. Platforms include the EXO 360 Drone from Queen B Robotics, which provides a full 360-degree live stream facility. Atmos VR Limited has successfully attended the Civil Aviation Authority permission course provided by RUSTA. More information is available on 0845 565 1783 or www.atmosvr.co.uk

The innovation from Sea Drone comes in the form of a modular aquatic drone through which the underwater world can be observed and investigated. This pioneering drone makes it possible to both take pictures and videos and to retrieve different items from the seabed. A very wide variety of applications is envisaged, for example in shipbuilding, policing and various offshore industries. More information is available from Mr. Ronald van Dijk, Sea Drone, Mijnbouwstraat 120, 2628 RX Delft, Holland. Telephone: +31 6425 71184. Email: info@seadrone.nl

Extreme Flyers have designed and built the Micro Drone, a ground-breaking new type of drone that is constructed around the user's needs. The latest version, Micro Drone 3.0, has an HD streaming WiFi camera, FPV Mode, flight speeds of up to 45 mph, and a completely modular design.

Tetra Drone is an innovation developed by three designers from The University of Lincoln that deploys a submersible multi-rotor that can function both above and below water, with the added benefits of an autopilot system.

Tetra Drone states:

'Tetra is not just a submersible drone with autonomous features, it is a hub for exploration. Designed to be taken on holiday in carry-on luggage, Tetra allows you to capture breathtaking photography. Thrust vectoring provides efficient and stable flight preventing the aircraft from pitching violently, which also benefits aerodynamics.'

Further information is available from www.tetradrones.co.uk

Airborne Drones

Airborne Drones have developed what is described as "the world's number one drone" through a market leading combination of telemetry distance 35km+, unchallenged 94 minutes of flight time, and optical/thermal/sensing capabilities.

This drone was designed with feature interchangeabilityto meet all sectors from enthusiasts to demanding commercial applications. The drone can be configured to clients' specific and 'special' needs.

Cinemizer OLED

Cinemizer OLED, immersive multimedia goggle, combines the quality of an optical system designed by Carl Zeiss with the sharp and colourful image offered by Microoled displays. Whether they are

used for racing, leisure or professional applications, the Cinemizer OLED is recognised by a number of pilots as a reference in terms of visual experience.

In support of the product Carl Zeiss explains how the Cinemizer OLED may be used for the application of checking power lines:

'Heat is generated on defective isolators as a result of electricity - aircraft equipped with thermal cameras make it possible to identify such isolators without endangering the welfare of people. Furthermore users can ideally configure the viewing direction and distance through the video glasses to prevent any distraction through ambient lighting.'

Another key application, with FPV, is the documenting of accident damage from the air:

'You don't have to be anywhere near the accident site. By using the Cinemizer OLED with FPV, you will not be distracted through events in your direct vicinity. You can fully concentrate on the image and your work and thus recognise every tiny detail. At the same time the video glasses allow you to find the optimal position for photo and video recordings - regardless of the time of day or lighting. On a traditional monitor your view would be considerably impaired, for example through sunshine.'

The company summarises the potential of the Cinemizer OLED as follows:

'The Cinemizer OLED, the latest video glasses from Carl Zeiss, opens up entirely new possibilities for FPV flights that far exceed a simple new perspective for hobby users. For fire and police rescue squads, insurance appraisers, real estate specialists and even professional cameramen for various TV formats, FPV transforms the Cinemizer OLED into a watchful aerial monitor in any situation.'

Further information may be obtained from Carl Zeiss, Carl Zeiss Strasse 22, 73447 Oberkochen, Germany. www.zeiss.com/cinemizer

EHang Ghostdrone

The EHang Ghostdrone 2.0 VR is the first 'ready-to-fly' virtual reality drone complete with professional FPV goggles that allows the viewer to see exactly what the drone sees. The goggles also control the on-board camera - look up or down and the camera follows.

The company states:

'Featuring smart and simple control by EHang Play APP, unique AVATAR flight mode and immersive aerial filming experience, GHOSTDRONE 2.0 brings the joy of flying to the masses.'

EHang is the world's leading tech company for intelligent aerial vehicles and has its headquarters in Guangzhou with branches in Beijing, Shanghai, Dusseldorf and California.

Connex by Amimon

Amimon is the market leader in latency-free wireless HD video solutions. Its CONNEX all-digital solutions are enabling unmanned aerial vehicles (UAVs) and first-person view (FPV) drones to achieve unmatched vision performance. Amimon's flexible CONNEX systems utilise its core technology to set a new standard in creating, transmitting and viewing content on remote devices.

Amimon is headquartered in San Jose, California, with branches in Tokyo, Taiwan and Herzlia (Israel).

Information on CONNEX products may be obtained from connex.amimon.com. For the CONNEX ProSight product line contact www.connexhd.com

THE UNMANNED AIRLINE

The Speaker Zone, sponsored by Panasonic, Cifi, Parrot and EHang, featured a number of interesting and informative presentations and one of these was 'The Unmanned Airline' by Michael Surcombe of drone consultancy firm ConsortiQ.

In his presentation he noted particularly the trend of the drone industry of following the evolutionary pattern formerly set by manned aviators in the early twentieth century:

"Self-build led to manufacturer-built machines. Systems then came in to improve regulations to make it safer. Fewer, bigger operators then emerged with small operators frequently joining together."

This type of evolution, he said, "needs a departure from a system that relies on individuals". An agreed way of working was therefore required, and it was predicted that insurance providers "would gain in dominance."

A notable recent development was that of telemetry uploading logs on drones such that "drones now effectively have a 'black box' containing lots of data".

In larger organisations people can download, for example, how many take-offs have been conducted with less than 40 per cent capacity. With this flights can be audited and this kind of service is now available, along with flight planning services backed by a rising trend in automation.

At the end of the presentation Mr. Surcombe was asked whether pilots were flying a requisite number of flights and in reply he said that "a model was going forward".

About ConsortiQ

ConsortiQ Limited is a drone consultancy firm that focuses on guiding businesses as they integrate drones into their operations.

Based in Southampton, the company offers training and consultancy to organisations across the globe, and is actively engaged in designing courses for special branches of industry. Theory, instruction and flight training is provided over five days.

The company has been certified by The Civil Aviation Authority and has been granted National Qualified Entity (NQE) status.

Further information may be obtained on 0208 0450 322 or email: info@consortiq.com

FIRST SAR SPECIFIC ACCREDITED DRONE TRAINING COURSE LAUNCHED

Drone training and consultancy provider ConsortiQ has collaborated with Surrey Search and Rescue (SURSAR) to create the UK's first Search and Rescue (SAR) specific accredited drone training course.

The course combines content from ConsortiQ's Unmanned Aircraft Qualification (UAQ) with specific modular delivery and SAR relevant scenarios so as to enable SAR professionals to fly a drone safely and legally in order to improve emergency response efforts.

Simon Green, Director of Air Operations - Lowland Rescue, states:

"We are elated to be working with ConsortiQ and anticipate that our training will step up a notch because of it. Their expertise in drone technology coupled with our experience in UK SAR will cultivate the development of a niche curriculum that arms personnel with the skills and equipment to save more lives."

ConsortiQ states:

'For SAR teams it will represent reduced training costs with savings that can be channelled back into their life-saving charity accounts. As well as a new emphasis on SAR, the UAQ course will also address a range of bolt-on CPD (continuing professional development) modules. These include search techniques, water rescue and night operations.'

It is planned that this course will be offered nationwide so as to provide consistency in skills and training for SAR teams across the country.

Contact details as above.

THE INTERNET OF FLYING THINGS

Another interesting presentation at The UK Drone Show was 'The Internet of Flying Things' by Richard Parker of Altitude Angel.

This presentation focused on connectivity between digital flying machines in order to create "a next generation drone management system" and the speaker pointed out the fact that "technology is changing very fast in this area".

A key development has been the creation of autonomous air traffic control systems for drones whereby invisible airspace information is gathered and made available through a system known as Guardian UTM.

This uses revolutionary cloud technologies to provide secure and robust Unmanned Aerial System Traffic Management (UTM) capabilities to any drone, anywhere and at any time. It supports recreational and commercial drone applications under VLOS, BVLOS, human operated, autonomous scenarios and is built for internet-scale operations.

Guardian UTM uniquely incorporates dynamic airspace management to provide safe integration for all airspace users, and does not require the advanced filing of flight plans. It is modular and extensible, supporting local requirements and dynamic, personalised geo-fencing.

Guardian UTM incorporates terrain models, 3D city maps, aeronautical and regulatory data, live air traffic monitoring, declarative and responsive drone flights, hyper-local weather and urban congestion data, with the option of drone and operator identity management that allows everyone to be able to see personalised data.

Key Capabilities and Features

Key capabilities and features of Guardian UTM include the following:

* Mitigation of the risk of collision between manned and unmanned traffic

* Support for VLOS, BVLOS and Fully Autonomous scenarios

* Support for drone operators, authorities, ANSPs, regulators and citizens

* Fully audited status secured with cryptographic assurance

* Rules-based airspace management

* Digital representation of current regulations

* Integration with existing ATM infrastructure and aviation traffic

* Efficient and dynamic management of airspace

* Supportive towards planned drone operations as well as operations without flight plans

The company states:

'Businesses and social causes around the world are lining up to use drones, but, in almost every country today, a human must be present when flying the drone and must keep it within visual line of sight. This restriction severely limits the potential of drone technology, but in the majority of cases it is absolutely necessary because drones, while powerful machines, are just not smart.

It is our mission to provide data and services to enable drones to be "connected" to their environment (physical, logical and regulatory), providing them with the tools they need to operate safely, integrating with and automatically complying with local laws.'

In his presentation Mr. Parker highlighted the fact that a lot of manned aviation is not visible, yet it still needs to be tracked, and a feature called 'Fly Now' is augmenting Guardian UTM:

"This is going to connect to a system of manned aviation so that operators can track and check to see if anything is coming towards them. It will then give an 'airspace alert' to the operator. It will include weather and temporary flight restrictions, and will use text communication as this is more reliable than the internet for doing this."

More information is available from altitudeangel.com

LEGISLATION AND REGULATION

This subject was aptly covered by Jonathan Nicholson of The Civil Aviation Authority, who emphasised the fact that drones were now "a vital part of the aviation industry", and as such the CAA "wants drones to be successful".

He pointed to first time research into public opinion concerning drone use, which suggested that 61 per cent of people welcomed the use of drones for good purposes, but also showed that 45 per cent of respondents associated the word "dangerous" with them.

Mr. Nicholson emphasised the fact that "even recreational fliers are pilots" who therefore are "equal airspace users with responsibilities" and "must behave like airspace users".

He said that he wanted drones "to fulfil their potential", particularly for applications such as transplant organ transportation between hospitals.

Following the presentation a number of questions were asked, beginning with the CAA's stance on the issue of flying drones in parks, which is currently being debated by local authorities.

The speaker replied as follows:

"The CAA will talk with anyone, but will target people looking to employ commercial operators. The police will enforce against dangerous use. The CAA cannot go to a local authority and tell them who can and cannot use its land, but it is an ongoing process just like dog fouling in parks."

He was then asked about licensing requirements for drones and explained that for commercial users licensing was mandatory, but not, as yet, for recreational users.

The Dronecode and 400ft Britain

In his presentation Mr. Nicholson mentioned the Dronecode that has recently been launched on dronesafe uk, pointing out its key requirements i.e. stay below 400ft and avoid built-up areas and airports.

In the UK Drone Show Show Guide a special feature is included entitled 'The Dronecode and 400ft Britain' , which adds:

'This Code was established to remind everyone to adopt a responsible attitude toward drone flight and usage, in order that safe drone flying is encouraged and the wider sector opportunities (mainly through commercial potential) are not stunted by legislation brought about by reckless, risky use early on in the adoption curve.

To celebrate the best of what drones can do, we have launched 400ft Britain, a drone photography and videography competition in partnership with VisitEngland. The campaign aims to raise awareness of the Dronecode and highlight that fantastic images can be captured within the rules of the Code.'

Panel Discussion

The three-man panel consisting of Paul Rigby of ConsortiQ, Elliott Corke of The Aerial Academy and ARPAS, and Mike Gadd of The Civil Aviation Authority, invited questions from the audience on the issue of legislation and regulation.

The first question asked 'what problem is legislation trying to solve?' and the answer was "not any particular one". The panel emphasised the principle that all airspace needs to be shared safely with rules that are "consistent and standardised", whether thia be for leisure or commercial purposes.

The panel stressed the need to be clear about what actually constitutes 'regulated airspace' and called for more clarity. It was noted that airspace itself is not owned, but rather broken down into categories with, for example, a farmer owning a field but not the airspace above it - a concept that was established in a court ruling in 1977. What counts as trespass or nuisance in the case of drones, however, is currently "uncharted territory".

Other questions focused on aspects such as 'how are we going to regulate?' and 'what are we going to control?'. The panel's response was that this "still wasn't clear", with the CAA currently not distinguishing between recreational and commercial use when it comes to regulation.

Another key regulatory body is the European Aviation Safety Agency (EASA), which is currently drafting regulations that will include everyone, but EASA at present cannot regulate machines under 150kg and in any case these rules are likely to take at least a year to implement. It was also noted that EASA has not up to now distinguished between drones and model aircraft.

The panel was asked about whether Britain's departure from the European Union would have any relevance, for example if some European rules may not apply in the UK. In reply the panel was united in saying that "there would potentially be no benefits if the UK was not part of this system" because "economically this is a global industry that we need to be part of". It was also stated that the UK Government was about to consult on drone regulation particularly with regard to training, registration and identification, which will have an emphasis on distinguishing between registration and identification.

Elliott Corke explained a little more about regulation as it stands, including the need to maintain a direct line of sight under an Air Navigation Order that was amended in August 2016, and the authority of the CAA to allow things to be written into the permission that they grant. He commented that "often it is people's perception of the law that is a bigger problem than the law itself".

He was then asked about the number of mechanical failures that he was aware of having occurred as a result of "small oversights" and said that he had known of just two in five years, both of which had been due to pilot error. He pointed out that he had not known of any equipment failures, although he had feared it. In the two failures to which he referred he explained how the first had been due to an inadvertent failure to plug in a second battery in an agricultural survey drone. The second case was a controlled flight on a training course in which a fast and low fly accidentally impacted with a raised patch of ground.

The audience was reminded that there are CAA regulations governing the need for occurrence reporting, that is to say anything that could potentially cause an incident. This is mandatory and provides data to the CAA that can be used to identify trends and recurring dangerous themes, but it was emphasised that the CAA does have a "no blame culture" and that the information is used solely to inform the industry.

As of October 2016 Mr. Corke's company, The Aerial Academy, can provide the practical and theoretical competency assessments required by the CAA for the issue of a Permission for Commercial Operations (PFCO) and more information on this may be obtained on 01603 881 985 or by email at office@theaerialacademy.co.uk

DRONE PUBLICATIONS

The UK's first drone and multirotor magazine is *RC Flight Camera Action* edited by Kevin Crozier and published by Traplet Publications.

In Issue 6 (July/August 2016) John Stennard introduces the Parrot Minidrone, and explains how Parrot has extended the use of the word 'drone' to include the concept of the 'Minidrone', incorporating Jumping Night Drones, Jumping Race Drones, Airborne Night Drones, Airborne Cargo Drones and the Hydrofoil Drone:

"All the Parrot Minidrones are controlled via a smartphone or a tablet. The Airborne Night Drones and Hydrofoil all use a Bluetooth 4.0 link, while the Jumping Night and Race Drones use a WiFi link. All the models use the same free 'Freeflight 3' app that can be downloaded from the iOS/App Store or Google Play."

Wayne Andrews then begins a series entitled 'Quad on a Shoestring' in which he takes the reader through the process of building an FPV racing quad on a budget, from assembly through to testing, calibration and tweaking.

Later on in the Issue Andrew James describes the CL-84 Dynavert, a hybrid model that is part drone and part plane:

"This interesting model encompasses several recent developments in radio control equipment; specifically, the brushless motor mixing technology that is commonly used in multirotors, combined with 3-axis gyro stabilisation that is now fitted to many model aircraft - drones and planes alike. Based on the Canadair CL-84 'Dynavert' experimental aircraft, it is able to take off vertically like a helicopter or drone and then transition into forward flight where it flies like a standard R/C aeroplane.

The heart of this model is the 'Electronic Board' that takes inputs from the receiver channels and outputs them with 3-axis stabilisation. It also splits the throttle channel into outputs for the right and left hand motors and mixes in the rear motor. The long leads that feed from the wing tilt mechanism are connected to the bank of output pins while short extension leads connect the receiver channels to

the input side of the board. All the leads are supplied and are clearly marked to show which pins on the board they need to be connected to.

As this is a Hobbico product I decided to use my trusty Tactic six-channel transmitter. The Tactic TTX650 radio set comes with a TR624 receiver with a single short aerial. The CL-84 instructions recommend the twin aerial TR625, which the Editor kindly arranged for Hobbico in the UK to supply for this review. Initial hovering trials were conducted with the TR624 while I waited for the TR625 to arrive and I am sure it would have worked fine in aeroplane mode."

James Crozier follows with a description of the UDI Discovery WiFi, which evolved from the original UDI Discovery, but has added features such as smartphone-based FPV and Aerial Photography, as well as a modified transmitter to allow for mounting of the smartphone.

Rod Boswell explains how thermal imaging is about to go mainstream before James Crozier returns for an explanation of FPV simulation using Liftoff, which is being developed by Belgian developers LuGus Studios in collaboration with ImmersionRC and FatShark:

"A lot of traditional simulators use 'billboard' style photo-realistic backgrounds to give the illusion of depth, but Liftoff (as well as the other two simulations in this article) uses a fully 3D modelled environment. This means that there are a lot of little locations that you can find and play around in."

In Issue 7 (September/October 2016) there is more on EHang's Ghostdrone 2.0VR and Extreme Flyers' Micro Drone 3.0 before David Bright provides a guide to the recently launched Typhoon H from Yuneec:

"At the front of the H are the 'eyes' - its sonar sensor. This gives the H the ability to automatically avoid a collision. It is important to note that this is NOT the much publicised and anticipated Intel RealSense system, which is yet to be released. This is the basic low-speed, short range system that comes built into the base (advanced) model. When the obstacle avoidance system is switched on, the H automatically reduces its speed. If it detects an obstacle in front of it as it flies forward, it will stop a few feet away and refuse to move any further. If it is in a stationary hover and you walk towards it, it will back away, which can be highly amusing (for a couple of minutes).

The Intel RealSense system, when it is released, is a much more sophisticated system, working at faster speeds and longer range. It will enable the H to build a 3D model of its environment so it can not only avoid flying into an obstacle, but can plot a path around that obstacle and continue its flight path. The RealSense system should be available soon as a plug-and-play add-on module to the current Typhoon H."

The ST16 controller incorporates an integrated, fully functional Intel powered 7-inch Android tablet and the LCD screen displays the live video feed in HD 720P.

Saving the Salton Sea

Issue 8 (November/December 2016)contains an interesting case study in drone applications entitled 'Saving the Salton Sea' by Eric Hanscom.

He describes the Salton Sea as "the biggest unknown disaster waiting to happen in the United States". It consists of a shallow lakebed that has been filled several times over thousands of years, most recently in 1905 when a canal was overwhelmed by the Colorado River and river water flowed in for over two years before the breach was stopped. Unfortunately water then entered in the form of runoff from fields, which contained fertiliser and pesticides, and the Salton Sea gradually became much more salty:

"As time passed the salinity and pollutants killed off all the fish species other than the hardy Tilapia, but over 400 birds began to either live at the Salton Sea or use it as a resting stop during their migration. Thus, the Salton Sea began to head toward a breaking point, with many scientists and environmental groups worrying publicly that unless the Salton Sea was fixed quickly it would be beyond repair. Because much of the water that used to reach the Salton Sea was being cut off, the water level at the Sea began to fall, thereby increasing both the salinity and the amount of the exposed lakebed."

The author explains how drone technology is now being applied as part of a rescue mission for the area:

"In March 2017 I will be hauling my drone on a 120 mile hike from the Sea of Cortez to the Salton Sea, along a possible path for seawater to be pumped to keep the Salton Sea full. The State of California has been working with me to shoot drone video of the rivers running into the Salton Sea to monitor the quality of the water in the river. Ecomedia Compass and Agess Labs are just two of the groups working on the use of mangroves and floating islands to remove the toxic compounds from the Salton Sea."

Unmanned Warrior 16

Another important drone publication is *Drone Magazine* and in the December 2016 Issue an article entitled 'Military Intelligence' by Ian Collen reports on the inaugural Unmanned Warrior 16 event which brought together naval forces from around the world for a series of exercises and evaluations of unmanned and autonomous craft.

The author quotes Admiral Sir Philip Jones, First Sea Lord and Chief of Naval Staff as follows:

"Unmanned Warrior is driven by the Royal Navy's belief that unmanned and autonomous systems have the power to revolutionise naval operations. We're eager to explore what we can do with this innovative technology in a realistic scenario, and we want to help industry understand how the latest equipment fares when put to the test by a top-tier navy."

The author emphasises the fact that the Royal Navy is not seeking to use unmanned craft to directly replace any human element, but rather to establish potential uses for autonomous craft that can radically alter the way in which the Navy operates and quotes Unmanned Warrior 16 Project Leader Admiral Paul Bennett as follows:

"If you have the opportunity to put an air vehicle ahead of a Naval force, or supporting a static Naval force, to provide a wider area surveillance for literally days, and your alternative is to put up a whole series of manned helicopters, then we have to be doing the former. This is not about reducing the requirements of people. This is about putting people into places where they have real value and to allow these systems to do what they do best."

The most damage that an autonomous craft can do by itself is, according to the author, "to crash into a buoy" as there will always be a person overseeing things.

In the second half of the article the author focuses on a specific element of Unmanned Warrior, namely Mine Counter Measures.

The author states:

'The oceans contain millions of square miles of water, much of it uncharted in any great detail, so being able to send out a fleet of USVs - rather than a series of ships or aerial craft that wouldn't be able to see much beyond the surface - is clearly a healthy option in terms of time and some serious data gathering potential.

What's especially impressive is how several of these systems can be linked together and be able to respond to each other. For example, if you have a fleet of six boats or submersibles, carrying out an automated search of a target area and one of the craft breaks down, the other five will automatically recalibrate their own pre-programmed routes to pick up the slack and ensure that the entire area is still checked. They, in turn, can bounce their data through an overseeing aerial drone to a control centre on board the mothership. In theory it's not too complex, but in practice it's a hugely impressive achievement.'

Further Information

RC Flight Camera Action is edited by James Crozier and is published by Traplet Publications, Willow End Park, Blackmore Park Road, Malvern, Worcestershire WR13 6NN. Telephone: 01684 588 500. Email: james.crozier@traplet.com

Drone Magazine is edited by Ian Collen and offers a three issue trial subscription for £10, a six issue subscription for £25 and a yearly subscription for £50. It is published by Uncooked Media Limited, P.O. Box 6337, Bournemouth, Dorset BH1 9EH. Telephone: 01202 586 035. Email: dronemaguk@gmail.com

In addition to the above, *Drone Monthly Magazine* is an e-magazine that is compiled by a team of dedicated and passionate pilots whose aim is "to captivate the drone industry in a positive light while creating a vital link between industry innovation and consumers". The publication is designed to offer "a fully interactive experience". Anyone with an interest is invited to log in to the *Drone Monthly Magazine* website or download the pages to any device. It is also possible to experience the content on a fully interactive multimedia platform.

AROUND THE JOURNALS

At this point The Institution of Electronics would like to thank all of the publishers that have provided complimentary subscriptions of their journals to us over the last year.

A selection of articles from these is reviewed below, grouped under the headings of robotics, 3D printing, data centre management and the Digital Railway.

GIVING A ROBOT EYES

The article with the above title by Neil Sandhu in the June 2016 issue of *Industrial Technology* explains how the latest vision technology is enabling robots to achieve the reliable identification of parts and objects in more unstructured and flexible arrangements, which has long been a challenge.

The author explains how, whilst robots can outperform people in terms of strength, speed, stamina, accuracy and repeatability, they have, until recently, been somewhat limited by their powers of vision:

'Advances in machine vision such as CMOS, smart cameras, time-of-flight laser sensing and LED lighting are now showing new potential for stereo vision and 3D sensing. At the same time industry has demanded that the vision technology becomes quicker and easier to install and commission on the factory floor without the need for the system integrator or OEM to undertake complex programming, or even to use a separate PC.'

The author traces the development of robotics from the traditional "pick and place" where the robot needed parts or products to be fixed in the same position and orientation, often on a conveyor:

'For a human, distinguishing between a pile of different objects in a container, then picking out the uppermost one is easy. For a robot, this remained for some time a challenge for vision technology to accomplish reliably. The limitations of 2D vision made it difficult for a robot system to avoid picking occluded objects, or to distinguish between similar colours or backgrounds, and most importantly to accurately calculate the depth and 3D profile of the object so it can be safely gripped. Components with curved or complex profiles prove particularly difficult.

Now, 3D vision applications are beginning to be integrated with robots to solve these previously problematic applications reliably.'

Mr. Sandhu, who is National Product Manager for Imaging, Measurement and Ranging for Sick UK, then introduces the SICK PLB500 guidance system, explaining how it is able to recognise the correct part profile, calculate which is uppermost and most accessible for selection, and then find the optimum gripping point and place it exactly where required without collisions. It will then select the next part at another angle and repeat the task at high speeds:

'The PLB robot guidance system incorporates Sick's ScanningRuler 3D vision solution which combines 2D and 3D image processing and a built-in light source in a single unit. Its fixed laser with a rotating mirror captures a sequence of laser line profiles across the scanned area, from which a 3D image is built up using the process of triangulation.

An accurate 2D overlay across the ranged image then enables part identification against known profiles. The software correlates the CAD data of the parts with the position and orientation information captured by the camera, as well as CAD data of the gripper, for the verification and collision-free gripping of the parts. This enables very precise and at the same time flexible visual guidance of the robots.'

The author then explains how another common problem, that of picking large parts from racks, often when hanging in slightly different positions and orientations, has also been addressed:

'The system works by taking a first picture of the part, looking for contrasting features such as drill holes, for example. It then projects a laser cross onto a flat area of the part and takes a second image. The resulting data enables the correct distance and any pitch, roll or yaw of the part to be calculated in the system and the information communicated so that the robot can safely grip it.'

TEACHING ROBOTS TO READ

This article, by Dr. Rainer Pausch in the November 2016 issue of *Industrial Technology*, describes how Optical Character Recognition (OCR) systems can use sophisticated text recognition in order to provide "reading" capabilities to machine vision systems such that text-based information printed on labels, displayed on control panels or visible on computer screens can be captured, interpreted and processed:

'With integrated data capture technologies robotics, computer vision and quality control systems can process the extracted data and compare it with entries in the database to initiate the system to take the appropriate action. Converted information can be exported to applications and systems in the form of XML data and plain text. With these new capabilities, robotics can conduct a range of completely new tasks.

By implementing sophisticated technologies for text recognition, such as OCR, hand print extraction (ICR), barcode recognition (OBR) and optical mark recognition (OMR), independent software vendors and hardware providers for manufacturing industry can significantly extend the functionality of machine vision systems.'

A key application area is the testing of touch panels and user interfaces in devices such as washing machines, dishwashers, microwave ovens and car infotainment systems:

'During the screening process of the touch-enabled device, the individual areas of the screen are activated by the robotic platform and response messages are captured. The extracted text is automatically validated by a computer with integrated OCR technology.'

USING ROBOTICS TO TEST LIVING CELLS

The article entitled 'UCB Life Scientists use Robots to test Cells by the Billion' in the May 2016 issue of *Industrial Technology* describes an automated primary antibody screening workcell for the early stage development of potential new treatments for central nervous system and immunology disorders that uses a Mitsubishi Electric robot to speed up the process of antibody discovery by allowing the screening of billions of antibody-producing B cells.

The article states:

'To become a therapeutic candidate an antibody is required to have many desirable properties. As more is understood about the biochemical and biophysical properties of antibodies, so the list of desirable properties becomes longer. This quest for desirable properties produces more challenges for the area of antibody discovery; more antibodies need to be screened, tested and assessed to allow the selection of the most suitable antibodies to progress.

The workcell operates by combining high-throughput cell culture screening and identification with the isolation of single antigen specific B cells using a proprietary technique known as the "fluorescent foci" method.

The robot facilitates extremely efficient interrogation of the natural antibody repertoire. In a typical early stage screening campaign, a billion antibody-producing B cells can be screened to find the ones with some of the desirable properties, a number that would be all but unimaginable if manual techniques were used.'

The robot is a Mitsubishi model RV7-FLM-D1-S15, a unit that is popular for a range of applications from life sciences and precision assembly to manufacturing and materials handling and is rated to IP67 confirming capability to work in demanding environments.

The article quotes Dr. Malcolm Crook of Farnborough-based Peak Analysis and Automation, who designed and built the facility, as follows:

"The robot has to manipulate microplates containing the cells between several work stations, each time using a multi axis movement. It also has to synchronise its movements with other functions within the workcell."

The dramatic reduction in time required to identify potential candidate antibodies compared with manual methods provides useful starting points from which to allow subsequent discovery of therapies and treatments in the downstream antibody discovery process far faster than was previously possible, and the fact that multiple projects can be conducted in parallel allows for a broad spectrum of disease mediators to be addressed:

'With the workcell, the robot is then used to seed the cells into barcoded 96-well tissue culture plates at a density of between 500 and 5000 cells per well. A typical experiment may use up to 500 plates. The robot then moves the filled plates to an incubator station where the cells divide and produce antibody. After a week's incubation the plates are moved by the robot onto the conveyor so that they can be transferred onto a screening workcell.

In the screening workcell the cell culture supernatant is sampled and transferred to an assay plated by the robot. A carefully designed homogeneous, plate-based, fluorescent screen assay is used to identify wells containing an antibody specific to the target protein.

The plates are then transferred in to the picking workcell where the positive well, cell culture supernatants are cherry-picked by the robot and consolidated onto a barcoded master plate. Freezing media is added to the picked wells and the plate containing the cells is frozen down to -80 degrees Centigrade. Further highly detailed analyses follow, at which stage it is possible to collect the genes of the best individual antibodies and go on to discover and develop therapies for specific diseases.'

3D PRINTING BUILDS SUCCESS FOR RENISHAW SPONSORED MOTORBIKE

This article in the September 2016 issue of *Industrial Technology* publicises the first victory of the French Moto2 team TransFIORmers at the CEV Repsol European Championships in Barcelona in June 2016, and the revolutionary front suspension system that incorporated a 3D printed titanium wishbone produced using Renishaw's cutting edge AM250 manufacturing system.

The TransFIORmers team worked in partnership with I3D Concept to design and manufacture a unique front suspension system inspired by maverick race bike designer Claude Fior:

'The system uses a design radically different from any other suspension system used in Moto2. The system bypasses the traditional weight transfer phenomenon and the problems created by "brake dive". Key components of the front suspension are the wishbones - components that attach the fork to the motorbike chassis, enabling movement of the forks. The original upper wishbone component was handmade and assembled using twelve individually machined and welded parts.

I3D Concept topologically optimised the shape of the part using CAD software. The new design reduced assembly time, decreased the weight by a factor of 40 per cent, but, as importantly, reduced the unsprung mass of the bike. This improved the suspension in terms of vibration management and responsiveness to braking and acceleration.

The optimal control system of Renishaw's AM250 additive manufacturing system enabled accurate control of laser steering, which enhanced precision, definition of features and surface finish.

The TransFIORmers team considers itself the first in the Moto2 championship to use additive manufacturing in a structural, functional component.'

More about the Renishaw AM250 is explained by Robin Weston in the January 2016 issue of *Industrial Technology*:

'Renishaw specialises in metal bed powder fusion, a metal 3D printing process capable of producing fully dense parts directly from 3D computer aided designs.The laser melting process uses a high powered ytterbium fibre laser to fuse fine metallic powders together and form three dimensional parts. The beam is focused to less than the diameter of a human hair, creating temperatures high enough to fully weld the materials.

Renishaw's AM250 machine is already used in medical applications, including orthopaedics and dental, aerospace and industrial part production. Currently, the most common use of additive manufacturing are prototype creation, the manufacturing of complex geometries and low volume manufacturing of elaborate metal parts in specialist materials.'

3D LASER WRITING REVOLUTION IN OPTICS

The article entitled '3D Printing enables the smallest Complex Micro Objectives' in the October 2016 issue of *Commercial Micro Manufacturing* describes how researchers at the University of Stuttgart have pioneered the use of ultra short laser pulses in combination with optical photoresist to create optical lenses that are barely larger than a human hair.

The femtosecond laser, with pulse durations of under 100 femtoseconds, is focused in a microscope into liquid photoresist, which rests on a glass substrate or optical fibre:

'Two photons of the red laser beam with a wavelength of 785nm are being absorbed simultaneously in the focus and expose the photoresist. This crosslinks the polymer and hardens it. The laser beam is directed with a scanner or by moving the substrate over the substrate. After exposure the unexposed photoresist is washed away with a solvent. Only the hardened transparent polymer remains and forms the optical element.

Using this method, optical free form surfaces can be created with sub-micrometer accuracy. The precision of the 3D laser writing allows not only for the construction of common spherical lenses, but also the more ideal surfaces such as paraboloids or aspheres of higher order are possible. Optical lens systems with two or more lenses can be realised for the first time with this method. This opens the door to aberration correction and micro optical imaging systems with unprecedented quality.'

The article also describes the work of PhD student Timo Gissibi, which involved the printing of micro objectives with a diameter and height of just 125 micrometres, even on optical fibres, which allows for the construction of novel and extremely small endoscopes that are suited for the smallest body openings or machine parts that can be inspected:

'Timo Gissibi also printed optical free form surfaces and miniature objectives directly onto CMOS chips, which thus create an extremely compact sensor. Using such optics, smallest cameras from drones that are no larger than a bee are possible. Also, smallest sensors for autonomous cars and robots are conceivable. Even smallest body sensors and surround-cameras for cellphones could be realised.

The researchers were also able to combine their optics with illumination systems. The optics on an LED which concentrates light in a certain direction can thus be extremely small. Additionally, illumination of ring-shaped areas, triangles or elongated rectangles can be realised with such miniature free-form optics.'

The article concludes with the following quote from Timo Gissibi's professor, Harold Giessen:

"The time from the idea, the optics design, a CAD model, to the finished, 3D printed micro objectives is going to be less than a day. We are going to open potentials just like computer-aided design and computer-integrated manufacturing did in mechanical engineering a few years ago."

EDGE COMPUTING

This subject is covered by Dr. Peter Koch, VP Solutions, Emerson Network Power, in the December 2016 issue of *Electrical Review*, and relates to the trend of organisations toward moving computing power away from core data centres and deploying it at the edge of the network:

'This structure is putting performance IT and networking infrastructure closer to where the customers' digital interactions are taking place, resulting in better operational connectivity and enabling devices to access far more data-intensive content, especially to mobile users.'

The backdrop to this is the enormous strain that has been placed on current data management and storage systems stemming from the recent explosion of data from mobile devices, and benefits are highlighted in areas such as security (data contained in-house where a company can have total control over security procedures), improvements in response times, better availability for customers, and easier working of IoT-connected machines with a local source of computing power. The retail sector is highlighted as being particularly well-suited to edge computing:

'The retail landscape is rapidly changing; a few years ago bricks and mortar retail stores were stand-alone environments , but this is no longer the case. A retail store is now a complex IT environment, made up of a myriad of devices such as PC-based POS [point of sale] terminals, handhelds, RFID readers, manager work stations, local hosts and local database servers. This expanding array of devices at the edge plays a critical role in enhancing the customer experience but brings its own set of challenges. Moreover, it all needs to continually operate at peak efficiency. Relying on a central data centre to support all of these devices is not enough. A comprehensive IT management infrastructure in which all the resources can be managed, regardless of where or what these resources are, is key and edge computing could become a useful part of this.'

Edge Computing and the Internet of Things

Under this sub-heading the author states that the Internet of Things (IoT) is dependent on edge computing:

'Without local data processing power, connected devices will not reach their full potential. Edge computing will be instrumental in creating a future where IoT is mainstream in smart homes, smart cities and industry. However, this does not mean an all or nothing approach. Data centres will continue to provide most of computing, but they will more and more be supported by facilities on the edge of the network, providing rapid information for fast data processing for IoT networks and low latency applications for consumers.'

LITHIUM-ION CHEMISTRY TRANSFORMING THE FUTURE FOR UPS TECHNOLOGY

This article, by Victor Avelar, Director and Senior Research Analyst at Schneider Electric's Data Center Science Center, in the September 2016 issue of *Electrical Review*, reports on the growing use of Lithium-ion chemistry to dramatically reduce the footprint and cooling requirements of data centres:

'The last few years have seen prices for Lithium-ion battery decrease rapidly, meaning that the technology has fast become a viable option for data centre power.

A recent research paper published by Schneider Electric, White Paper 229, "Battery Technology for Data Centres: VRLA vs Li-ion", identifies a 10-year total cost of ownership (TCO) analysis, showing Li-ion costs 39 per cent less than VRLA, despite their capital cost premium.'

Several benefits of Li-ion over VRLA for UPS technology are identified:

(i) Fewer battery replacements during the lifetime of the UPS, reducing the risk of downtime through battery replacement.

(ii) They weigh a third less, yet provide the same amount of energy.

(iii) They deliver up to ten times or more discharge cycles, depending on the battery chemistry and technology deployed, the surrounding ambient temperature and the depth of discharge required.

(iv) Ability to recharge four or more times faster and discharge four times slower when not in use.

These benefits are compared with the disadvantages:

(a) A requirement for about two to three times more capex for the same amount of energy.

(b) Stricter transportation regulations.

The author then distinguishes between a power cell (designed to provide a large amount of power in a short amount of time while using nearly all of the battery's energy capacity), and an energy cell (designed to provide a relatively small amount of power over a set period of time).

Li-ion batteries can be designed as power cells or energy cells, but VRLA battery chemistry and technology are noted to limit their design solely to energy cells. The service life of VRLA batteries (3 to 6 years) is also compared with that of Li-ion batteries (upwards of ten years).

The article concludes:

'In the case of Li-ion, certain chemistries and technologies present a favourable TCO over a 10 to 15 year period when compared to VRLA batteries. This happens to be the typical life span range of a UPS before replacement is needed.

Large UPS systems utilising Li-ion batteries will address all the disadvantages of traditional batteries, namely footprint, lifetime maintenance and cooling requirements. And we expect the performance of Li-ion batteries to improve and costs to steadily decrease.'

ARTIFICIAL INTELLIGENCE ENABLES 40 PER CENT COOLING SAVINGS AT GOOGLE

The article 'DeepMind AI: From Atari Games to Climate Change via 40 per cent Cooling Savings at Google' by Brendan Coyne in the December 2016 issue of *Mission Critical* Power, provides an interesting data centre case study where artificial intelligence that learned to "think" by playing classic Atari video games enabled a 40 per cent reduction in cooling costs as well as a 15 per cent improvement in Power Usage Effectiveness (PUE).

The article features DeepMind co-founder Mustafa Suleyman, who explains to the author the background.

The author states:

'Data centres consume around 3 per cent of the firm's power and the firm [DeepMind] aims to sell its Artificial Intelligence learning as a service to more of them - and into other power-intensive business sectors.

Earlier this year, the DeepMind AlphaGo programme beat Lee Sedol, 18 times world champion of the ancient Chinese game of Go, four games to one in a televised event watched by 250 million people.

Now the firm aims to launch its optimisation engine as a service platform to other data centre operators and to power-intensive sectors more broadly.'

Central to this project was maximising PUE by removing the heat from incoming compute load as efficiently as possible while respecting known temperature and safety constraints.

State data (such as sensor and meter data that describe the physical behaviour of the utility) and action data (such as how many cooling towers are turned on, how many chillers are active at any given moment, and what the set points are of various pressure and temperature valves) were combined:

'That threw up about 1,200 different state variables, and for each of those variables were about 20 actions. Those were aggregated into around 120 state representations combined with a series of actions, both continuous and discrete, that would throw up suggested actions to optimise the PUE within the safe operating constraints.'

Mr. Suleyman is quoted as follows:

"Essentially [it is] a very general framework to solve data centre prediction. There's a bunch of state inputs, a bunch of actions, and just like we did with Atari and AlphaGo, we are learning to correlate state with rewarding behaviour."

Mr. Suleyman then goes on to say how' conventional wisdom' was defied:

"If you spread out load really thinly over lots of bits of kit and run them all at a lower level of capacity you can learn really interesting linear versus exponential power efficiency curves that were very surprisingly and intuitive to the human operators that had been running the system for some time.

A lot of the engineers believed that they should be concentrating flow through the chiller a great deal, but if we put less flow through the chiller it turns out that.........the global energy consumed across the system was actually much more efficient.

Finally, the ability to shift loads to different parts of the system given the type of incoming compute demand and the temperature, actually allowed a much more flexible and fast adaptive response to the kind of conditions that the data centre team were seeing at any given moment."

THE DIGITAL RAILWAY

The Digital Railway forms a major theme in the December 2016 - January 2017 issue of *RTM Magazine*, the independent trade journal for the UK rail industry, with a series of articles beginning with 'A Digital Railway for a Modern Britain' by David Waboso CBE, Managing Director of Group Digital Railway.

He says:

'Introducing digital technology as part of a package with conventional system upgrades is the best option to address the capacity and performance challenges on key pinch points on the network.

Digital technology will also allow us to manage and control trains better and enhance the way we maintain the rail network by enabling a "predict and prevent" regime to improve our asset management.'

Nick Hughes, Sales Director for Hitachi Rail Europe adds in his article 'A Modern Solution to Overcrowding: Embrace Digital':

'Digital solutions have the potential to transform rail services in the UK without needing new trains or track. Traffic management and digital signalling systems enable trains to run closer together, therefore creating more services.

Digital in-cab signalling systems, or on-board ETCS as it's known in the industry, enables trains to run closer together meaning frequency of services can increase. Hitachi has ensured its new rolling stock includes such technology and, in 2016, we became the first UK train manufacturer to have its on-board ETCS approved to run on UK passenger services.

Implementing ETCS will allow new rolling stock to run at its full potential. Therefore, train manufacturers like Hitachi would welcome a greater focus on modernising track-side receivers.

Traffic management systems powered by big data can ensure busy routes operate efficiently and help mitigate the impact of disruption. From next year Hitachi's traffic management system will run on the Thameslink core, allowing up to 24 trains per hour.'

Challenges and Opportunities for Big Data

Dr. John Easton and Dr. Shruti Kohli from the University of Birmingham explain further the role of big data in transforming railway operations.

In their article 'Challenges and Opportunities for Big Data in the Digital Railway' they state:

'At first glance, it is easy to assume that the digitisation of the railway is all about train control. However, the challenge that new digitally-enabled infrastructure and systems present to the railway industry is about far more than in-cab signals. It's about creating a virtually-connected "system of railway systems", where the timely provision and analysis of data on the state of the network enables smoother running, increased flexibility, and, critically, greater use of the physical capacity available.

By combining large volumes of data from different fleets across the network, big data analytics approaches will enable the industry to identify patterns that represent best practice in operation and maintenance and, perhaps more importantly, show how day-to-day activities can be improved on poorly-performing routes.

The potential application of big data techniques within the industry will not be limited to the physical assets it owns and operates. Understanding the movements of passengers around station buildings, for example, will become increasingly important as headways decrease and station dwell times become more critical.'

The digitisation of the railway is also described as a "game changer" for cyber security, and the authors highlight the need to avoid the assumption that railway ICT will be protected simply because it runs on closed networks. They stress the need for new systems to be "secure by design".