UMBRELLA
COMPETITION WINNERS

ABOUT UMBRELLA

UMBRELLA is a one-stop shop for your Internet of Things (IoT) development needs. It provides a large scale, multi-radio, open IoT testbed, connecting South Gloucestershire's main innovation hubs: Bristol & Bath Science Park, National Composites Centre, IAAPS at Emersons Green, the University of the West of England, Bristol Robotics Lab, and Future Space.

It covers two smaller testbeds - smart city sensing and robotics – which provide businesses, researchers, and ordinary citizens across the UK a platform to support the development of their products and test their IoT ideas across all industries, from manufacturing to hospitality.

▌Smart City Sensing and Wireless Testbed

Over 200 UMBRELLA nodes are mounted on lamp posts containing over 1,000 wireless radio nodes and over 1,500 sensors.

These provide a real-world platform for not only testing wireless algorithms and protocols but also smart city sensing, with the ability to collect data on temperature, air quality and even ambient noise levels along one of the busiest roads in South Gloucestershire.

▌Robotics Testbed and Digital Twin

The robotic testbed area, which has 20 robotic nodes, as well as several obstacles and platforms, allows the evaluation of communications protocols and swarm AI algorithms.

It also contains a state-of-the-art digital twin simulator that is accessible from anywhere and allows the testing of robot AI algorithms in a virtual arena before being implemented in the real-world robot arena.
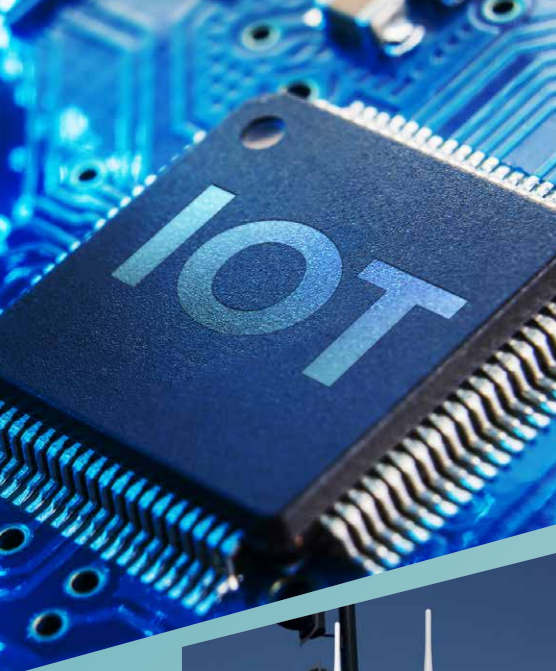
THE COMPETITION

UMBRELLA's aim is to accelerate the development of new technologies, solutions, and business models for the Internet of Things era.

It offers businesses a testing environment that allows them to **reduce testing costs**, **de-risk** product development, **collaborate** with others, and trial their products in a **real-world environment**.

The UMBRELLA competition aimed to support promising digital technology SMEs from across the UK to further develop their innovative products, by offering them financial and technical support to trial their solutions through the UMBRELLA network. This initiative was supported by funding from the UK Government through the UK Community Renewal Fund.

8 successful SMEs were supported to trial 9 use cases through the UMBRELLA testbed. This brochure highlights their achievements to inspire other businesses to take advantage of the UMBRELLA testbed.

▌ The Jury Panel

Stephen McCartney. Chief Engineer (Digital) at the National Composites Centre.

Barry Wyatt. Strategic Project Manager for Climate Emergency at South Gloucestershire Council.

Thomas Clapton. Group Technology Development Manager at Babcock International Group.

Madalina Nazare. Director of Collaborative R&D at Digital Catapult.

Joe McGeehan. CBE DEng FREng. Emeritus Professor of Communications Engineering at Bristol.

100 PERCENT IT LTD

Road-side network and k8s container hosting

Contact: Wessex House, 22 Oxford Rd, Newbury RG14 1PA

Website: www.cyberhive.com

UMBRELLA testbed functionality used:
Smart city wireless testbed (Road-side network and k8s container hosting)

"Access to technology testbeds such as the UMBRELLA IoT network provided by South Gloucestershire Council is invaluable to UK SMEs as it facilitates field testing that would otherwise be financially out of reach, and as such allows us to remain focused on product development and optimisation.

Our engagement in the UMBRELLA competition has been a catalyst for improvements to CyberHive Connect. Real world testing enabled the team to identify edge cases that were not apparent in lab environments but which with only modest effort have been overcome resulting in a significantly improved user experience.

Through our interaction with the UMBRELLA project team ahead of the deployment, the development team identified several enhancements which we believed would optimise performance. As a result of field testing these changes, we were able to validate them, and identify further possible improvements which now form the basis of the immediate roadmap for Connect."

Project goals & outcomes

CyberHive is the operating brand of 100 Percent IT Ltd, an organisation with over 2 decades experience providing cloud infrastructure and secure hosting to many of the UK's public sector organisations. Their product, CyberHive Connect, delivers low-latency network connectivity with Zero-Trust principles, and is future-proofed against attacks by Quantum Computers. 100 Percent IT Ltd works to develop technology that will future-proof the security of data transmitted between vehicles and infrastructure, which will help enable the future of sustainable, connected transport.

The UMBRELLA competition enabled them to "road test" how their product can maximise connectivity speed on all devices including low-power IoT endpoints.

The challenge

Whilst it is possible to simulate network conditions in the lab, one can never anticipate every subtlety and nuance of real-world operating conditions. Working with the UMBRELLA IoT network made it possible to carry out road-side field testing and to observe conditions which simply cannot be replicated in the lab.

Additionally, integrating the Connect software into the UMBRELLA roadside infrastructure and roaming client devices enabled the development team to deploy their code into real-world environments within a well-supported testbed prior to beta testing with end users.

Achievements

Through working with UMBRELLA, 100 Percent IT Ltd have been able to "flight qualify" the operation of CyberHive Connect in road-side environments. This relates to an increase from TRL6 to TRL8 in that context during the lifetime of the project.

Finessing the code base prior to the field test resulted in improvements to Connect making it able to operate in lossy throughput conditions of up to 97% packet loss. Classic IPsec VPNs fail to establish connectivity on networks with significantly less packet loss.

> "It was a tough job choosing between all of the submitted entries, I was impressed by the strength of the business cases and how innovative the ideas presented were. It also felt like the CRF was really going to help the SMEs develop their ideas in a way that they wouldn't be able to do without it and felt like a great use of the fund!
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> **Stephen McCartney.** Chief Engineer (Digital) at the National Composites Centre.
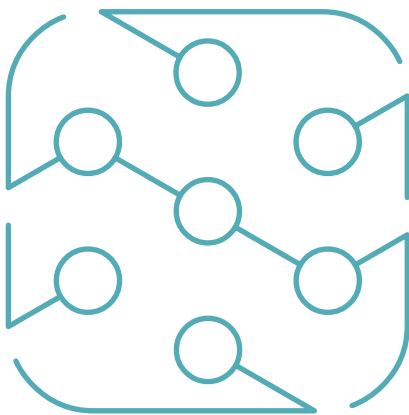
AWARE TECHNOLOGIES LIMITED

Digital Twinned, Building Performance Evaluation

Contact: Bristol and Bath Science Park, Dirac Crescent, Emersons Green, Bristol, BS16 7FR

Website: www.awaretag.com

UMBRELLA testbed functionality used:
Smart city wireless testbed (LoRaWAN Network)

awaretag®

" The stability of the network enabled us to gain confidence that the downlink features could be included in our device management design. The availability of CSV downloads and APIs to get the external environmental data, and the help from the team to get access to these resources was invaluable and helped us get to scalability decisions quickly.

The project allowed us to develop a service that could be used by a wider audience, including those who may not have or able to afford broadband connectivity. It has enabled us to go to all councils in the UK that have invested in LoRaWAN but have not yet found a business case.

On the back of this project, we have been invited by Sunderland Council to apply our technology on their LoRaWAN network and we intend to work with others. We are now planning recruitment of more permanent staff including marketing and data analytics. "
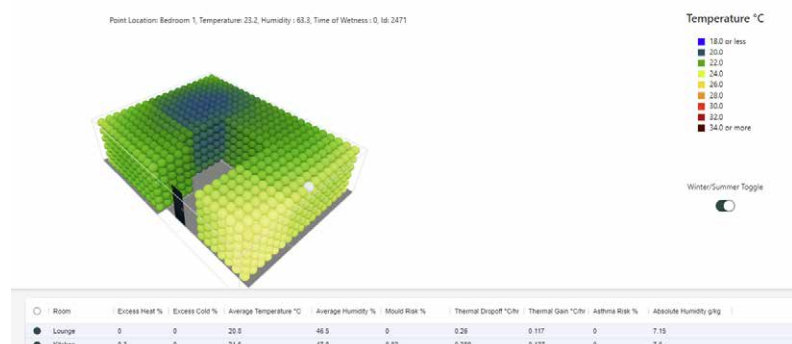
Project goals & outcomes

Aware Technologies Limited (Awaretag) are a sensor and AI company specialising in measuring how temperature, humidity, insulation, and ventilation affects every part of the home and where there are likely risk areas of mould, damp, excess cold and heat. They apply features about the home to improve the AI so that people can get personalised guidance on what actions they should take to improve comfort and efficiency. Awaretag aims to develop a solution that serves the most vulnerable in society and those with little digital inclusion who often need energy efficiency assistance the most.

They developed a product that measures the thermal performance of homes and buildings in 3D space and time (4D) whilst people are living there, whilst engaging occupants in the findings so that they can be part of their own net zero planning. Awaretag also validated the performance of their technology in a low bandwidth environment using the LoRaWAN network, achieving a true 'plug in and go' connectivity experience, reducing reliance on WiFi.

The challenge

The challenge was to speed up and scale up the measurement of the thermal performance of homes using the localised external atmospheric sensors on the UMBRELLA network, and to validate that the LoRaWAN network provided a 'no wires, no fuss, no engineer' reliable experience for consumers.

The team knew that the LoraWAN network supports a limited message size, sent at limited time intervals, and had to find a way to encode temperature and humidity for several rooms, combine them in one message to the network and then link that data to the external sensor data from the UMBRELLA platform. Being able to download the external environmental data to their server and having it at time intervals that matched their transmissions was perfect and helped them offload some of the processing to the server rather than all being at the edge.

Having the LoRaWAN network available at Bristol and Bath Science Park, UWE and the Stoke Gifford Retirement Village, allowed Awaretag to rapidly experiment with different encoding methods and observe what trends in the signal value would impact the reliability of data getting to the network.

Awaretag also explored how to manage their low power devices in the field using the downlink features of LoraWAN which have limits on packet size and ensure that the network can support remote configuration of edge devices.

Achievements

As a result of their engagement, Awaretag have reached TRL7 and have been invited by one of the regional Gas Distributors to propose a wider project in 300 homes to assess the impact of the quality of homes on health and wellbeing.

This new project marks a significant growth opportunity for the company, who are now able to start planning recruitment of staff who will be in the Bristol area.

ALTERED CARBON

Anomaly Detection with Graphene Gas Sensor Arrays

Contact: Future Space, North Gate, Filton Rd, Stoke Gifford, Bristol BS34 8RB

Website: https://altered-carbon.com

UMBRELLA testbed functionality used:
Smart city wireless testbed (LoRaWAN Network)

" This project has given us the opportunity to work on the physical deployment our of scent detection sensors and has provided the team with some very useful insight in terms of how systems can be physically deployed.

It has impacted some of the design choices in terms of the future form factor of our sensor itself and given us a clearer vision for deployment of this technology in very low power, wireless detection systems. The work undertaken in this project has overall strengthened our understanding of how best to deploy these sensors in wireless communication network. "

Project goals & outcomes

Altered Carbon is an advanced nanomaterial-based sensor company that develops a range of super low power gas sensors for a variety of applications. The Altered Carbon team developed a prototype system which allows their sensor array to monitor changes in crops and detect anomalies which could indicate issues such as disease.

During their trial, Altered Carbon developed test hardware and deployed their new gas sensor array in the wild, using the UMBRELLA LoRa network. This enabled a better understanding of how their sensors work in the field and supported the development of hardware that will allow sensors to be deployed in the future.

The challenge

The Altered Carbon sensor technology has been developed with new materials and techniques and as a results extensive testing is required to validate its performance. To prove that their scent detection technology is suitable for commercial applications, the team needed to fully understand how these devices perform over time and under different conditions.

The extensive LoRa network provided by UMBRELLA provided an opportunity to take sensors from their controlled lab conditions and bring them into the real world. The LoRa network provided by UMBRELLA on the UWE campus is an excellent testbed for experimentation as there are several different environments for sensor deployment across the campus. This testbed allowed the team not just to look at different environmental conditions for their sensors but also to evaluate other factors such as the effect of signal strength on battery life and where best to physically deploy nodes.

Achievements

Altered Carbon have been able to run their sensor arrays for anomaly detection at incredibly low power and using the UMBRELLA network and demonstrate the potential for 6-10 years battery life on a single thionyl chloride cell. This has given the SME the hardware backbone to engage with 2 large clients in the agritech industry and begin running larger scale field tests on actual products.
The data collected through the project helped give greater confidence in the baseline stability of each sensor device when exposed to ambient conditions.

By understanding how their sensor nodes perform in the UMBRELLA network, Altered Carbon improved their approach to sensors deployment, thus shortening the process of engaging with future clients by several weeks.

IOETEC LTD

Social Housing IoT

Contact: 3 Wilderhope House, Pountney Gardens, Belle Vue Road, Shrewsbury SY3 7LG

Website: https://ioetec.co.uk

UMBRELLA testbed functionality used:
Smart city wireless testbed (LoRaWAN Network)

"Access to the UMBRELLA system and funding support for the project were vital to proving that our technology can help address domestic energy challenges in Social Housing. The UMBRELLA Network provides LoRa Gateways to allow connection from Ioetec sensors and the infrastructure delivers this to a central point which in turn relays the collected data securely to the Ioetec Server where the data can be analysed.

Building upon our prior experience using the UMBRELLA platform, this competition facilitated the next stage in our product development. This engagement has pushed our company, which is actively exploring ways of supporting the UK Government's net zero carbon targets for social housing, a step closer to providing a cost-effective solution for monitoring the progress and success of measures taken by local authorities and housing associations. Our resulting demonstrator, which can be deployed securely at scale, will be capable of providing social and affordable landlords the trusted data sets upon which to base informed investments in their housing stock."

▌ Project goals & outcomes

There is an increasing importance being placed on efficient energy usage as part of meeting the Net-Zero targets of both National and Local Government. This is particularly important in the Social Housing sector with the aim of reducing energy costs. A significant requirement for achieving this is the measurement of existing and resultant energy usage after the adoption of reduction measures.

Through their project, Ioetec enhanced their range of experimental modular sensor units to support a variety of add-on components for measuring temperature, humidity, pressure, air quality and CO_2. The project also allowed them to develop an analytics portal, designed to display the data which has been relayed by the central UMBRELLA LoRaWAN servers.

▌ The challenge

Environmental monitoring in social housing requires a cost effective and secure collection and distribution platform which is independent of the occupier and can be provided without cost. The solution should be flexible, without vendor lock-in, so that it can be adjusted for the needs of diverse local authority clients. It is therefore necessary to build the relevant infrastructure to support the communications channels. Public LoRaWAN networks tend to be limited in terms of connectivity and available bandwidth and can be unreliable as they often include unmaintained gateways. The UMBRELLA network provides a unique solution to this challenge by offering a suitable and scalable wide area connectivity network.

▌ Achievements

Ioetec's aim in joining UMBRELLA was to prove their technology in a 'Smart City' environment which presents new challenges related to wide area usage and potentially uncontrolled user and physical access to the sensors and the gateways. By running their project with UMBRELLA, they are now much better placed to tender for other net-zero opportunities, having increased their readiness level TRL 4 to TRL 7 through their engagement.
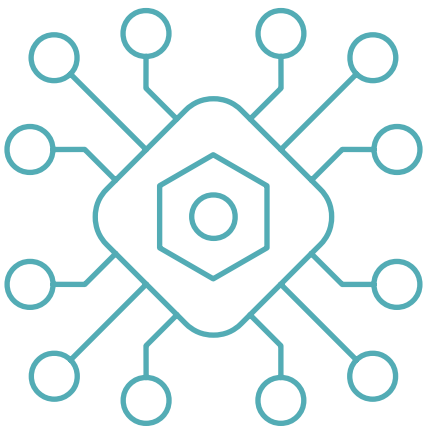
DIREK LTD

SIMS: Smart Indoor Management System

Contact: 184 Mulgrave Road, Cheam, Sutton SM2 6JT

Website: https://direk.io

UMBRELLA testbed functionality used:
Smart city wireless testbed (LoRaWAN Network)

"The CRF grant funding reduced the risk of additional R&D works and enabled us to focus our resources on resolving some of the most critical R&D issues that could hinder the commercial success of our product. We successfully integrated Direk's technology with the UMBRELLA node and implemented our sensors in the Bristol testbed. The implementation of the AI component on the UMBRELLA nodes allows for edge computing which was one of the prime objectives of the project.

This project helped us develop the essential components for improving scalability (edge computing), create new applications, and validate them with key partners.

SIMS helps building owners with their net-zero target, improves residents' well-being by reducing the risk of viral infections and manages energy consumption; all these services are in high demand, and we now have a window of opportunity to grow our offer."

Project goals & outcomes

Direk offers innovative AI-based localisation technologies for mobile tracking, asset tracking and indoor radar for nonintrusive monitoring. It aims to help building owners with their net-zero target, improve residents' well-being by reducing the risk of viral infections and managed energy consumption.

During their engagement, Direk focused on developing their Smart Indoor Management Systems (SIMS) to monitor occupants' activity and room density. SIMS can be used for space optimisation, energy management, hot-desking, sanitation alerts, and occupants' safety in emergency cases.

The challenge

Through their project, Direk aimed to demonstrate the application of their solution on smart building management using an indoor testing site.

In the first half of the project, Direk integrated their solution with the UMBRELLA platform to enable occupancy monitoring in indoor spaces and demonstrate its applications. Direk used UMBRELLA nodes as gateways for their sensors and developed data visualisation modules enabling a user-friendly reading of the data collected from the testing site.

In the second phase of their integration, Direk used UMBRELLA nodes as edge computing devices for their service, which gave them the ability to process the data in the node instead of sending it to their servers.

Achievements

Direk used their UMBRELLA testbed implementation to address challenges related to improving the scalability of their product, and the creation and validation of new occupancy monitoring applications. They developed an application for the UMBRELLA node to gather data packets from their sensors and created a customised system for detecting crossings and background removal. They successfully tested their occupancy monitoring algorithm in the Bristol testbed and developed data visualisation modules which were integrated with the Direk platform.

"It was intriguing to consider the bids through the lens of a changing climate and the wide-ranging challenges that this will bring to every aspect of our lives and to those that we care for.

Barry Wyatt. Strategic Project Manager for Climate Emergency at South Gloucestershire Council.

SERVICE ROBOTICS LTD

GenieConnect

Contact: Future Space, North Gate, Filton Rd, Stoke Gifford, Bristol BS34 8RB

Website: www.genieconnect.co.uk

UMBRELLA testbed functionality used:
Smart city wireless testbed (LoRaWAN Network)

" The grant enabled Service Robotics to evaluate the use of LoRaWan with the GenieConnect hardware, thus broadening the visibility of what embedding LoRaWAN into our product would require.

As a short project, it allowed Service Robotics to concentrate on a new technology that was not necessary sales driven but would provide a significant benefit to the overall business. It has allowed us to better understand and develop Use Cases for LoRaWAN in relation to the GenieConnect service and indicated where other technologies are better suited. This has been a valuable exercise for us in terms of product development. "

▍Project goals & outcomes

GenieConnect is a digital online service for Care Providers, providing audio/visual functions that require internet connection. With UK rural deployments, where internet infrastructure is poor, GenieConnect must be adaptive to the changing internet speeds.

With their engagement with UMBRELLA, GenieConnect trialled using LoRaWAN for always-on long-distance data to be sent to and from the Genie Companion robot, looking to overcome poor rural internet which impacts visibility of device status, user interaction, and hampers support – to identify where connections problems are located.

▍The challenge

The connectivity challenge was at the core of Genie Connect's engagement with the project. Using LoRaWAN with the GenieConnect robot provides a Long Range Low Powered WAN that allows the device to send status and debug information during internet outages.

In addition, GenieConnect's limited battery life pushed the team to look for connectivity technologies that are less power intensive in nature.

▍Achievements

Engagement with UMBRELLA allowed Genie Connect to test that their Proof-of-Concept IoT device has achieved connectivity to their backend server through the LoRaWAN network.

This has allowed data related to the battery power level, WiFi signal strength and last interaction dates and types to be reported through the system. Remote disablement and reset commands are currently being considered.

Resilience testing has been achieved for failover from WiFi to their LoRaWAN gateway – allowing a view of how the device will operate in real world conditions.

> I was fortunate to be invited to be part of the jury panel for the Community Renewal Funding programme. As a member of the jury I genuinely enjoyed reading through the proposals and was encouraged to see such a high level of ambition as well as a breadth and depth of innovative thinking from the SMEs. Crucially all submissions sought to put IoT technology to work in order to solve some of society's most immediate and complex challenges. In addition It was interesting to see the different ways in which the SMEs proposed to use the Umbrella Network to expedite the development cycle.
>
> **Thomas Clapton.** Group Technology Development Manager at Babcock International Group.

DILIGENSYS LTD

GENESIS IN DILIGENT SYSTEMS

DILIGENSYS LTD

VDI Smart Greenhouse and VDI NetZeroEnergy

**Contact:** C/O Cam & Co Accountancy Ltd, 10-12 Love Lane, Pinner, HA5 3EF

UMBRELLA testbed functionality used:
Smart city wireless testbed (UMBRELLA sensor nodes and historical data sets)

"The CRF Grant funding and access to the UMBRELLA network supported Diligensys to develop, test and validate two really exciting and relevant use cases. This enabled Diligensys to extend its technical capabilities into the IoT space, which will generate opportunities for entering the exciting and ever expanding IoT market. Without access to UMBRELLA facilities and funding, such a leap would have proven to be prohibitively expensive for a small-scale start-up like Diligensys.

The engagement with UMBRELLA enabled us to fast track our entry into the IoT space. The built-in sensors and data processing capabilities of UMBRELLA facilitated the implementation of a fully functional end-to-end proof of concept within a remarkably short period of time."
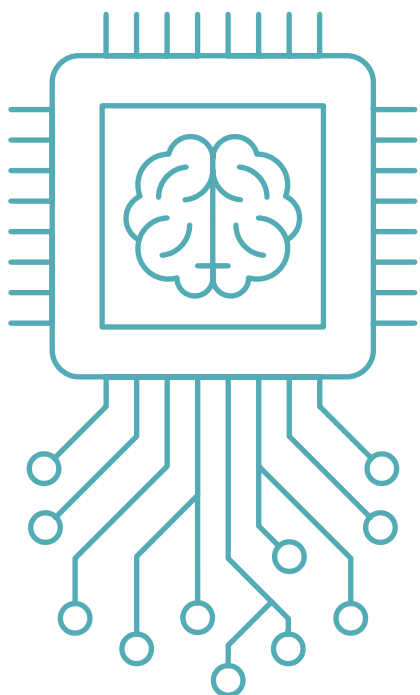
Project goals & outcomes

Diligensys is a data SME specialising in developing and delivering custom Artificial Intelligence (AI) and Machine Learning (ML) based data solutions to meet bespoke customer needs.

The engagement with UMBRELLA enabled Diligensys to broaden the scope of its technical expertise and capabilities into the IoT space. During their engagement, Diligensys piloted two complementary use cases, targeting the smart greenhouse and energy market verticals.

The aim of the Smart Greenhouse project was to develop a smart, self-learning solution to provide near real-time monitoring of key environmental parameters with IoT enabled sensor nodes.

The goal of the Net Zero Energy project was to deploy a network of energy monitoring sensors connected to the UMBRELLA platform and utilise them for development of an energy monitoring solution for residential, public, or commercial buildings. The solution aims to help optimise energy usage and contribute towards carbon neutrality.

The challenge

Deployment of an IoT sensor network is a time consuming, expensive and a challenging exercise for a SME like Diligensys. Further to that, any AI/ML analysis require a reasonably large data set. Both these challenges were addressed by utilising the already established UMBRELLA network.

The NetZeroEnergy project enabled Diligensys to identify and overcome challenges in building an IoT sensor network and integrate with cloud platforms such as UMBRELLA. Such a solution requires edge processing and existing UMBRELLA edge nodes enabled the team to test the performance of their AI/ML algorithms under limited computational constrains.

Achievements

Utilising the data and technical expertise from UMBRELLA, the Diligensys team managed to develop, trial and validate an end-to-end high TRL prototype of an IoT base Smart Farming solution. This solution utilises advanced AI/ML algorithms which will self-learn optimum environmental conditions and generate alerts when conditions deviate from a sensitivity threshold set by the customer.

Further, UMBRELLA funding has enabled Diligensys to build, configure and test a custom IoT network and a data streaming and visualisation pipeline to monitor energy consumption of commercial buildings. This will be a key step towards building a Smart Net Zero Energy monitoring solution.
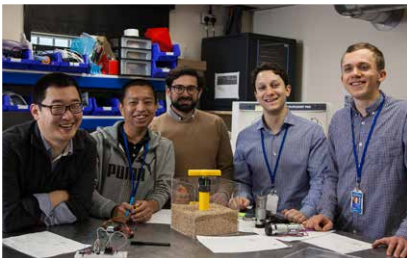
CROVER LTD

CROVER – Grain Storage Management

Contact: 15 Old Fishmarket Close, Edinburgh EH1 1AE

Website: www.crover.tech

UMBRELLA testbed functionality used:
Robotics Testbed

"The UMBRELLA funding and facilities at the Bristol Robotics Lab enabled our robotics engineers to focus on the localisation problem for a few months and allowed to access the BRL team's expertise in indoor localisation technologies and algorithms. This helped us identify the sources of errors and potential solutions much faster than we would have otherwise. The funding also allowed us to further develop the CROVER web app and to test the system at a new site, gathering vital data and feedback.

The engagement with UMBRELLA enabled us to fast track our entry into the IoT space. As an early-stage start-up with limited resources and finances, the project couldn't have happened without UMBRELLA competition's support. While there is still a lot to be improved for the system to be able to handle all automation scenarios that it needs to, we are much more confident now about achieving our mission to 'enable humanity to reach below the surface'. Because the early barriers are usually the hardest to overcome due to the limited resources at the beginning of the journey, we are forever grateful to the UMBRELLA team!"

Project goals & outcomes

CROVER is centred around the commercialisation of the first proprietary technology for locomotion in bulk solids (e.g., sand, grains, powders), through which the CROVER team has developed the world's first 'granular drone' (i.e., a CROVER), in the sense of a device able to move through bulk solids and powders. While potential applications of the CROVER range from the minerals industry to chemicals powders (as well as space!), CROVER's first product is a system for the monitoring and management of cereal grains stored in bulk (e.g., whole barley, paddy rice in sheds and silos).

Cereal grains are the basis of staple food, yet post-harvest losses during long-term storage are exceptionally high, above 20% in the UK and worldwide. The CROVER Grain Storage Management system autonomously scans and mixes grain in bulk storage (e.g. in grain bins and sheds), to provide early detection of potential spoilage. It allows grain storage operators to reduce losses and maintain quality, while improving the health and safety of grain storage operators, who will no longer require to physically 'walk' on dangerous grain bulks.

With their project, the team advance the capabilities of the CROVER robot and Storage Management system, to obtain more accurate positional accuracy, improve its automation capabilities, transfer and visualise the collected data effectively.

The challenge

Because most commercially available indoor localisation systems have been designed for tracking people and/or goods in offices and/or warehouses, they generally don't have good vertical accuracy, are designed to get through at most a couple of walls and aren't suited for harsh environments such as those where grain and other dry bulks are stored.

The CROVER team have been leveraging the UMBRELLA network and the Bristol Robotics Lab's facilities and the team's expertise in indoor localisation to deliver better localisation and motion tracking of the CROVER robot.

Achievements

Through their engagement with UMBRELLA, the technology readiness level of the CROVER Grain Storage Monitoring system increased to TRL7. The team is planning to launch their first commercial version of the system in the months after the project end.

Thanks to the support received, the CROVER team grew to 14 full-time, which has been a key driver of their success.

Do you want to test your innovation through **UMBRELLA**? Get on board now!

Sign in or Register on the **UMBRELLA** portal:
🌐 www.umbrellaiot.com

UMBRELLA is a partnership between South Gloucestershire Council and Toshiba, with the Funding from West of England Local Enterprise Partnership through the Local Growth Fund, administered by the West of England Combined Authority.

South Gloucestershire Council
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University of BRISTOL

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