Department for Transport

Transport-Technology
RESEARCH INNOVATION GRANTS
Department for Transport

Transport-Technology Research and Innovation Grants (T-TRIG)

2019 Project Outcomes

23rd March 2021

Department for Transport
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This publication is also available on our website at www.gov.uk/government/organisations/department-for-transport

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Foreword

This T-TRIG funding call was launched in September 2019 and the world was a very different place back then: transport, people and, in fact, almost every aspect of life seems to have changed greatly in this time. The Covid-19 pandemic has raised many challenges to our society but it has also highlighted the importance of research and innovation (R&I) in developing solutions to tackle them. R&I is at the heart of our post-pandemic recovery, the decarbonisation of our transport system and our strategy for maximising the benefits of leaving the EU.

As I near the end of my six years as DfT's CSA, I look back at the T-TRIG Programme with pride. In January we made our 199th grant offer; since 2014, we invested around £6m in innovation support, primarily to SMEs and start-ups. The 2019 cohort of T-TRIG projects demonstrated once again the depth of ingenuity and breadth of imagination of UK innovators and featured a highly diverse spread of projects, covering all transport modes, and with a strong focus on DfT's biggest strategic technology priorities. Since this 2019 call, we've launched a subsequent T-TRIG call focusing on decarbonisation and Covid-19 resilience, and three novel sister calls: A-TRIG funding accessible transport innovations, S-TRIG supporting developments in transport security, and D-TRIG focusing on drone progression.

The 2019 call was the first time we had delivered T-TRIG with the active support of the Connected Places Catapult (CPC). I am delighted to be partnering with them as it allows us to join up DfT's policy needs and expertise with the CPC's understanding of SMEs to target specific innovation priorities. It also allows us to provide broader support to innovators in commercialising their new products and services – so that funding can go further and lead to significant impact on the ground.

The impact of the programme is clear from my discussions with T-TRIG alumni over the past years. I have seen successful businesses develop and thrive since their involvement with T-TRIG – and some have also actively supported the Department with data to understand the impact of Covid-19 on the transport system. T-TRIG's streamlined programme has led to its mechanisms being adopted across DfT and by other government departments.

I look forward to seeing the 2019 cohort take their next steps in their innovation journey and to the next cohort of projects in 2020 as they take their first steps in the programme.

Professor Phil Blythe FREng FIET CEng

Chief Scientific Adviser, Department for Transport

Introduction

Transport – Technology Research Innovation Grants (T-TRIG) is a programme that enables the Department for Transport (DfT) to fully fund proof-of-concept research projects in support of innovative ideas or concepts that facilitate a better transport system. T-TRIG aims to:

- Foster innovation to improve UK transport
- Generate growth in the transport sector
- Build links between policy teams in DfT and innovators.

First launched in 2014, DfT launched the 2019 call with its joint delivery partner the Connected Places Catapult (CPC) in September 2019. It provided £900k to fund 30 six-month projects, across four themes:

- Decarbonising the Transport System (13 projects)
- Open Call (8 projects)
- Age-friendly and Accessible Transport (6 projects)[1]
- Potholes and Resilient Infrastructure (3 projects)

This compendium compiles the 1-page summaries prepared by the 2019 awardees, summarising their aims, their activities and the impact they achieved.

You can find out more about T-TRIG - including its 2020 cohort - through the T-TRIG GOV.UK page, or by getting in contact with the T-TRIG mailbox.

[1] Many projects encountered difficulties as a result of the emergence of Covid-19. One project within the Age-friendly and Accessible Transoprt theme was terminated early by mutual agreement. Other projects agreed time extensions to manage the impact of the pandemic on their operations.

Decarbonising the Transport System

QuokkaGo

Agile Charging

Impact: *QuokkaGo will enable realistic trials of fleet electrification, speeding up deployment and decarbonization.*

Implementation Pathway: *We have been accepted onto the APC Technology Developer Accelerator Programme and hope to build a prototype by June 2021.*

Issue

The market for electric vehicles (EVs) is set to grow rapidly, from 300k+ vehicles on UK roads today to an estimated 3m by 2025 (National Grid, 2019). However, the biggest barrier to roll-out is the failure of chargepoint installations to keep pace with demand. This is due to uncertainty around operating profiles and optimum locations, which are heightened by the inability of fleets to trial EVs realistically (i.e. using fast charging) without sinking capital expenditure into fixed charging infrastructure.

Concept

To address this "chicken-and-egg" challenge of chargepoint installation uncertainty, Agile Charging is developing a portable EV fast charger ("QuokkaGo") with 20kWh of integrated lithium ion batteries, two 7kW Type 2 EV connectors and standard mains connectivity. Onboard battery storage allows for faster charging than often otherwise possible without a local power supply upgrade. The unit's portability and 'plug-and-play' functionality reduces deployment cost and risk, which allows for short-term use cases such as facilitating EV trials, chargepoint location testing, and provision of temporary EV charging at public events.

Activity

Agile Charging worked with the Centre for Power Transmission and Motion Control at the University of Bath to explore the feasibility of offering a trailer-mounted version of Agile's EV fast charger. A model was developed to simulate and assess the likely vehicle dynamics of transporting a portable chargepoint on UK roads. This allowed Agile to assess the implications of the necessary anti-vibration strategy on the design, in addition to incorporating regulatory compliance considerations, and input from initial market conversations.

Conceptual design of QuokkaGo: a trailer-mounted battery-enabled Electric Vehicle (EV) chargepoint

Outcomes

An initial configuration was designed based on a Bateson Trailers 720 four-wheel trailer and the feasibility of the design was shown at a high level. Further work must be done to identify the appropriate battery chemistry and perform detailed operational modelling.

Initial desireability testing was positive, with encouraging feedback from a vehicle OEM, a Local Authority, a District Network Operator (DNO) and a car rental company. The price will need to be extremely competitive (no more than £25k-£30k), as a probable utilisation factor of around 30% for a lease business model could make the economics unfavourable.

We are in the early stages of discussions for equity investment from the CIIF and others and have recently won support from the APC's TDAP program. With further funding, Agile will be able to develop and test a prototype. This technology will help catalyse the EV rollout in the UK and beyond, helping to create and secure green jobs in our supply chain and R&D ecosystem

Agile Charging
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Carbon Policy & Monitoring Tool

City Science & Somerset County Council

Impact:
The Tool supports Local Authorities to develop transport decarbonisation strategies and engage stakeholders.

Implementation Pathway:
A web-based application is available at ***https://decarbonisation.cityscience.com/.*** *Local Authorities wis the tool can request their data to be added for use using the email address below.*

Issue

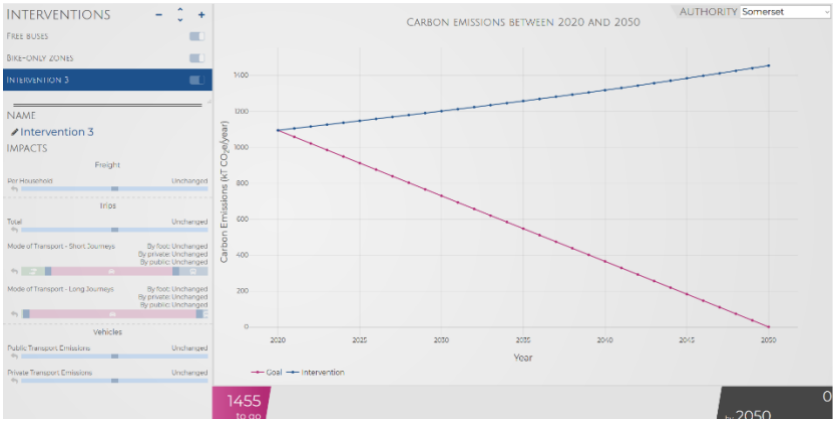
Transport is the largest contributor to carbon emissions in the UK and a critical challenge for global decarbonisation. With 322 Local Authorities having declared a climate emergency, there is now a huge desire at a local level to do more. As we emerge from COVID-19, many local authorities are asking how they can build in interventions that support social distancing in the short-term, and also make progress towards their net zero targets over the longer-term.

Concept

Working with Somerset County Council, City Science has developed and tested a flexible, web-based forecasting tool to track carbon emission from transport and support local authorities in developing decarbonisation strategies, reconciling to national datasets.

Activity

The project developed a methodology and tool to track and understand the impact of carbon reducing policies within transport. Similar methodologies have been shown to have a significant impact on decarbonisation strategies within the energy sector. Working with a range of users including Somerset County Council, the team developed and implemented a live version of the decarbonisation tool that can be accessed by Local Authority users to support the development and testing of decarbonisation strategies.



Decarbonisation Tool Live Site

Outcomes

The project developed a highly flexible methodology and web-based tool linked to national datasets to help Local Authorities develop and evidence strategies for transport decarbonisation. The tool can also be used to engage and inform stakeholders raising awareness around the benefits and costs of different approaches to decarbonisation. The prototype tool has been tested with a number of users and has received positive feedback and identified a series of future enhancements that would provide further benefits.

The UK can become a leader in healthy, sustainable and clean transport. This tool can be used today to help develop place-based strategies for transport decarbonisation. With further funding the tool could be further enhanced to provide tracking and sharing of strategies between regions, helping to coordinate the UK's decarbonisation activities.

City Science
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P2P EV Charging

Cranfield University

Impact:
P2P EV charging will bring extra EV charging points at drivers' convenience, reduce EV running costs and facilitate EV uptake.

Implementation Pathway:
We will partner with Power Transition Ltd and Electric Corby CIC to deliver other elements of P2P EV charging and hope to have a demonstration site in 2025.

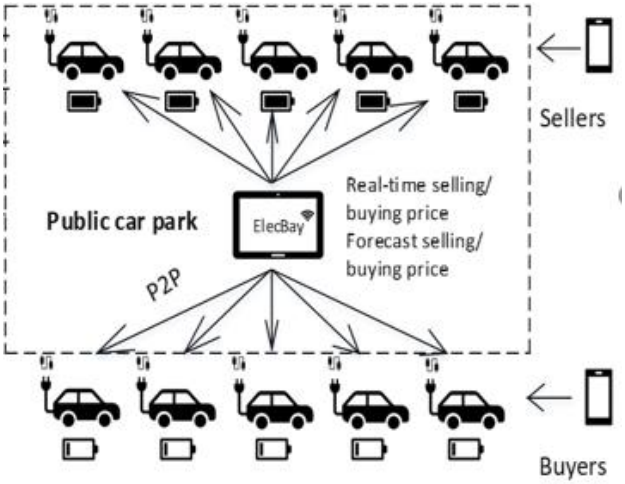
Issue

The most significant barriers to the growth of the UK's electric vehicle (EV) market are: cost, lack of charging infrastructure and range anxiety. Peer to peer (P2P) EV charging could bring extra charging points at drivers' convenience and reduce running costs of EVs, facilitating uptake levels of EVs across the UK and the globe.

Concept

Electrified road transport is one of the most credible technologies currently available to deliver carbon emission reductions in the transport sector. EVs will potentially bring 20% extra electricity demand, potentially challenging the capacity of electricity networks. So far, the conventional vehicle to grid (V2G) technology has challenges, due to economic viability, standard and regulation concerns. A P2P energy trading platform, which allows EVs who have surplus energy to share and trade with other EVs, is as an attractive option.

There are several key milestones to the realisation of this vision, and the foremost important steps are to develop a P2P EV charging platform and to validate the economic viabilily of conducting P2P energy trading between EVs.



P2P EV charing at a public carpark

Activity

At the Energy and Power group of Cranfield University, we used a T-TRIG grant to develop a P2P energy trading platform enabling EV energy trading. A double auction mechanism is used to calculate trading prices between EV energy buyers and sellers. The mechanism incorporates EV drivers' individual preferences and resource characteristics, allowing mutually beneficial energy transactions to be negotiated, at the same time providing drivers with security, privacy and freedom of negotiations. A P2P EV charging Smartphone App was developed. The functions of the app include interfaces allowing EV energy sellers and buyers to provide information - e.g. where, when, kWh and prices to trade with each other - and a platform to settle the mid-market prices between buyers and sellers. .

Outcomes

Cranfield Energy and Power Group have had good success in adapting existing techniques to develop the trading platform, realising the platform in a Smartphone App and demonstrating the economic viability of the concept. The Group is seeking further funding.

A number of key stakeholders have shown strong interest including Power Transition Ltd. Cranfield University have encouraged Power Transition Ltd to bid into the *Innovate UK 2020* Sustainable Innovation Fund (SBRI) phase 1 funding call to develop a demonstration project of P2P EV charging at a solar car park. This project was not selected by the funder, but we will develop further opportunities to best use the findings and outcomes from T-TRIG funding work.

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Aircraft to Grid (A2G): Hybrid and Smart Charging for Electric Aircraft

Impact:
The A2G will support the viable future of electric aircraft by providing charging infrastructure.

Implementation Pathway:
We will partner with IPFT Fuels Ltd and Airbus to develop an experimental integration of a modular and autonomous charging system for electric aircraft.

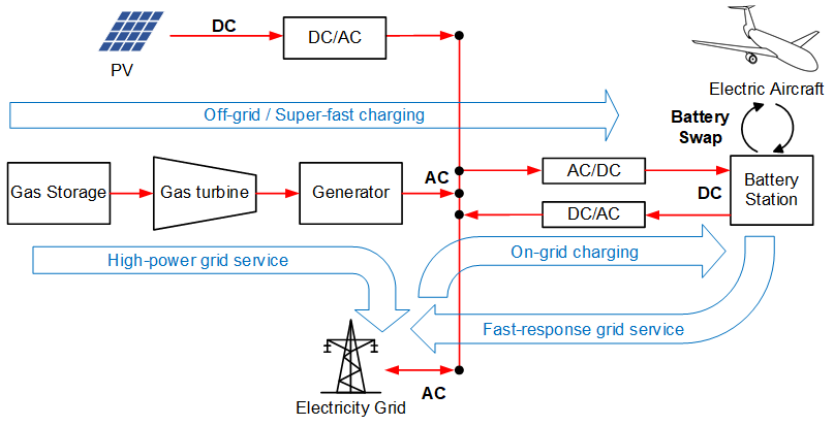
Cranfield University

Issue

To achieve sustainable targets in air transport, innovation design of electrically powered aircraft has advanced rapidly. This presents a key challenge for the charging of electric aircraft: 1. Lack of charging infrastructure; 2. Slow charging; 3. Expensive grid expansion for charging.

Concept

This project proposes a conceptual design of a hybrid and smart charging system 'Aircraft to Grid (A2G)'. The A2G system is capable to provide: 1. On-grid and off-grid charging; 2. Super-fast and hybrid charging; 3. Optimal charging scheme, 4. Grid ancillary services.



Conceptual design of the A2G hybrid and smart charging system

Activity

In the Centre for Energy Systems and Strategy at Cranfield University, we used a T-TRIG grant to fund the conceptual design of the A2G as a hybrid and smart charging system. The approach for A2G system design includes: 1. design A2G system infrastructure, 2. develop smart charging management scheme; 3. conduct case studies of A2G system in airports.

Smart A2G charging system with battery swap is developed to meet electric aircraft charging requirements based on flight schedules. A novel A2G energy control strategy is proposed for aircraft charging and grid services. The hourly energy dispatch strategy is produced to minimise charging costs. Case studies are conducted in 8 UK airports assuming all domestic flights will be electrified.

Outcomes

The project findings show that 8GWh daily energy consumption is required for electric aircraft charging in 8 UK airports. A2G system can cover 50% off-grid charging to relieve energy requirements from the grid. 20% of charging energy is supplied by renewable energy sources. Battery swap with combined gas turbine, PV and grid can supply super-fast charging to meet busy flight schedules, so that each electric aircraft can complete charging within 50 minutes.

The A2G system can provide effective grid ancillary services across the 8 UK airports, with response power of 1,000 to 1,400 MW overnight and 200 to 600 MW during daytime. Annual A2G charging costs are estimated at £230 million, while it's grid ancillary services can generate £45 million revenue for airports.

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Electric MOLE

IPFT Fuels Limited

Impact:
The Electric Mole will transform electric vehicle charging across transport modes.

Implementation Pathway:
During Q3 & Q4 2020 we plan to build more prototypes, and execute live, fully functional trials with fleet operators and local authorities during 2021.

Issue

Problems with existing electric vehicle charging infrastructure limit uptake of EVs and the wider benefits this brings. The Electric MOLE, IPFT's autonomous, hands-free charger for EVs, is future-proof and makes charging more efficient, safe, and scalable. The technology benefits vehicle owners, charging companies, local authorities, and fleet operators.

Concept

Robotics and artificial intelligence are used for a hands-free charger that transfers power through conduction, as opposed to induction used by wireless chargers. The solution involves an ACDU (Automatic Connection Device for vehicle Underbody) and consists of a plug on a robotic arm, which connects to a vehicle parked over the unit. The plug aligns itself with the receiving vehicle connector.

Benefits of an ACDU include enabling more reliable connections for V2G and mission critical environments (fire engines, ambulances, commercial fleets), no disease transmission risks post Covid-19 (as it is hands-free), and reduced clutter in the sidewalk, garage, or depot. Energy efficiency and low-cost build make it ideal for the on-street charging use case and charging commercial fleets (cars, LCVs, HGVs, RCVs).

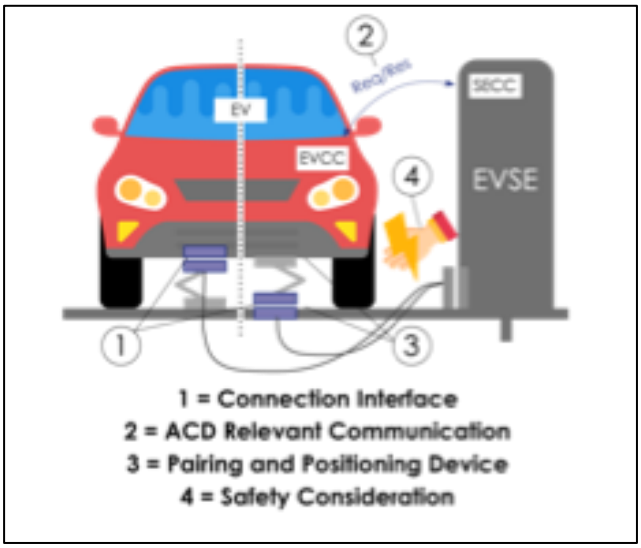
Activity

IPFT used the T-TRIG grant to fund product design, prototype development, and software development. Supply chain studies for manufacturability and customer development were also conducted alongside product development. IPFT is the only British start-up developing ACDU.

Outcomes

The outcomes of the project has been a versatile prototype for testing. The prototype was built, and preliminary testing of the core functions carried out with good results. Despite delays due to Covid-19 the project made considerable progress and achieved the milestones planned. During Q3 and Q4 2020, IPFT plans to build more prototypes and execute fully functioning, live trials with local authorities and fleet operators starting in early 2021. A number of key stakeholders have shown strong interest both for the final product and to host trials of the technology. We expect a large global demand for autonomous charging solutions. IPFT is at the forefront of this market, helping the UK stay at the cutting edge and create high-quality manufacturing jobs in the green economy.

Overview of ACDU Charging System



IPFT Fuels Limited
www.mole.energy
information@mole.energy

The Liftshare and AppyWay integration

Liftshare

Impact:
The integration will facilitate better utilization of carpark space by filling empty seats in cars with more people.

Implementation Pathway:
After pilot sites staff return to offices post COVID-19 we will rollout integration and app amongst staff. We will also explore alternative pilot sites.

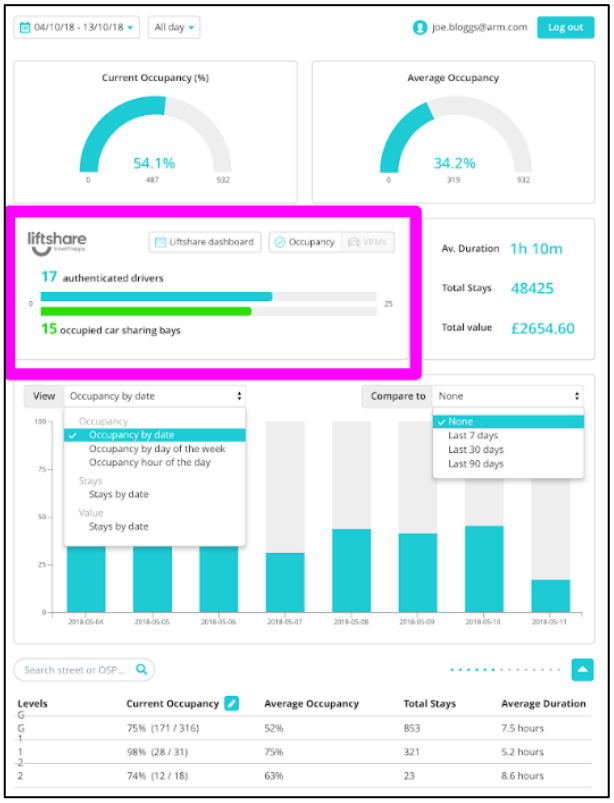
Issue

The latency available in Single Occupancy Vehicles operating at peak commuting times represents a huge opportunity to capitalise on shared mobility and ultimately remove vehicles from the network - with sizable economic and environmental gains.

Organisations struggle with the management and policing of car-sharing and dedicated car-sharing bays, as well as the monitoring of when they should expand due to over-occupancy. For certain locations, use of the vehicle for commuting and access to jobs cannot be avoided due to a lack of public transport or alternatives. Vehicle ownership is in itself expensive and represents a barrier to entry for some of the potential employee market. Integration, will not only reduce congestion and emissions, but will enable access to employment without dependency on private vehicles.

Concept

We are proposing technology that makes the monitoring of carshare bays a simple process. We want to encourage employers to dedicate more parking spaces to be car-share-only, and therefore encourage more cars to be taken off the roads as employees understand if they carshare, they get a guaranteed space to park. The software shows the organisation when the car-share bays are full, and encourages them to expand to allow for more sharers as adoption of car-sharing increases. It also provides number plates for those that are sharing, enabling the client to police the bays and discipline those parking in dedicated bays without sharing.



Screenshot of the AppyWay dashboard with Liftshare Trip Authentication data embdedded

Activity

The technology will help employers better monitor the utilization of dedicated car sharing bays from their desk by giving them monitoring access to track that their employees are sharing their commute to work and parking in the assigned car sharing bays once on site, with ease. We understand their employees need a process that is easy and safe, that incentivizes them to Liftshare and directs them to the quickest, readily available space.

Outcomes

Liftshare and AppyWay have started to collaborate on a shared pipeline of clients who may take the solution in future. Joint engagement is helping to draw out the integration benefits and some tangible numerical gains to be had from the combined system. The aim is to build a shared introduction brochure of the system, complete with use cases and testimonials from the pilot site for use in both the public and private sector.

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Electric Vehicle Easy Readiness Switch Over (EVERSO)

Miralis Data

Impact: *Reduced transport emissions by facilitating the transition to ULEVs by optimising whole fleet makeup to include them.*

Implementation Pathway: We have developed an API to show organisations how ULEV can be integrated into their fleet. This is available for use in existing platforms or can develop new products and tools.

Issue

Currently people and organisations are offered limited support in transitioning from traditional internal combustion engine (ICE) vehicles to ultra-low emission vehicles (ULEV). The support that exists is often; biased- provided by vehicle salespeople, expensive- a consultancy-based approach, or limited- only considering direct like for like vehicle swap outs.

Concept

The EVERSO feasibility study is designed to determine whether the need for a systemised, objective tool exists and if the creation of it is technically and commercially feasible. The study will extend existing algorithms, determine data requirements, and test the impact of generalised assumptions. Commercially, it will explore different models for how the tool could be exploited.

The EVERSO tool is a systematic approach that holistically explores the make-up and usage of any fleet (including single vehicles), exploring the trade-off in operational complexities, with potential economic and environmental savings delivered by including ULEV.

Route	Stops	Miles	Conversions To Renault Kangoo (106 range)
Green	10	195	Not- possible
Red	7	73	Possible
Blue	5	108	Not- possible
Yellow	10	146	Not- possible

API output showing ULEV optimised

Activity

Miralis Data have used T-TRIG grant to extend existing algorithms and build a fully documented API that shows how ULEVs can be introduced into a fleet and the impact that this will have in terms of cost and emissions. This API is ready to be integrated with existing platforms or to be developed into its own standalone system.

We have conducted research, both to determine the need and market for such a tool through focus groups, competitor analysis and persona development, and to realise what the product might look like by developing user stories.

We have also explored a number of different commercialisation options and produced a business model canvas that captures some potential next steps.

Outcomes

While the project has faced major disruption through Covid-19, we have been able to prove the technical feasibility of what we set out to do, as well as identifying several potential routes to market and next steps. This includes organisations that we have made connections with through the project.

While migration to ULEV may not be the priority of organisations at the present moment, as we move past Covid-19, market forces and decisions may force businesses to start thinking about how they integrate ULEV in an affordable way. We will be well placed to assist and help contribute to a potential Green (post-Covid-19) Recovery.

Miralis Data Ltd.
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hello@miralis.co.uk

Elmo MVP

Nova Drive Limited

Impact:
The elmo platform will assist electric vehicles becoming viable transport solution for the mass market in the UK.

Implementation Pathway:
This project has helped elmo become a commercially viable product which is ready to scale.

Issue

Electric cars are a key part of the UK's decarbonisation strategy and their uptake is crucial to achieve CO2 as well as air quality targets. In their current form, they are not yet suitable to the mass market due to high upfront costs and the perceived user complexity.

Concept

Elmo is proposing an all-inclusive electric vehicle subscription. This will directly solve the cost and complexity issues surrounding electric cars by:

1. Removing all upfront costs- Including running costs which are significantly cheaper than traditional vehicles.
2. Simplifying the consumer offer to provide all an electric vehicle driver needs in a single monthly payment.
3. Providing a low commitment introduction to electric vehicles for drivers not sure if going electric will suit their lifestyle.

Elmo believes that flexible and affordable electric vehicle 'usership' is the future of the automotive industry.

Activity

Nova Drive Limited used the T-TRIG funding to develop the first version of the elmo platform. This includes a full vehicle subscription platform with billing, fleet management, and user account tools. It also included integration with a number of partners to deliver a 'Total Cost of Ownership' vehicle solution. This was used to pilot the product with a small volume of vehicles for elmo's soft launch.

30kWh Nissan Leaf - elmodrive.com

Outcomes

Nova Drive Limited were successful in delivering a fully functioning electric vehicle subscription platform. By the end of the project, 11 customers had received a car on completely flexible contracts all managed through the elmo software. This included integration with So Energy so that user's home charging was paid for through their vehicle subscription – we believe this is a world first. The one key objective not met was providing an all-inclusive subscription product. A number of partnerships were finalised during the product to provide vehicle supply, home energy, home charge point, and public charging access but including insurance in the product was not possible. This was due to the early nature of the business and lack of volume not allowing competitive prices to be achieved.

The elmo platform is now in a very good position to scale the service to achieve its mission of enabling 10,000 drivers to go electric.

Nova Drive Limited
https://elmodrive.com/
hello@elmodrive.com

Pelation REBO

Pelation Ltd

Impact:
REBO will enable safer road behavior and the collection of previously unavailable near miss footage and data.

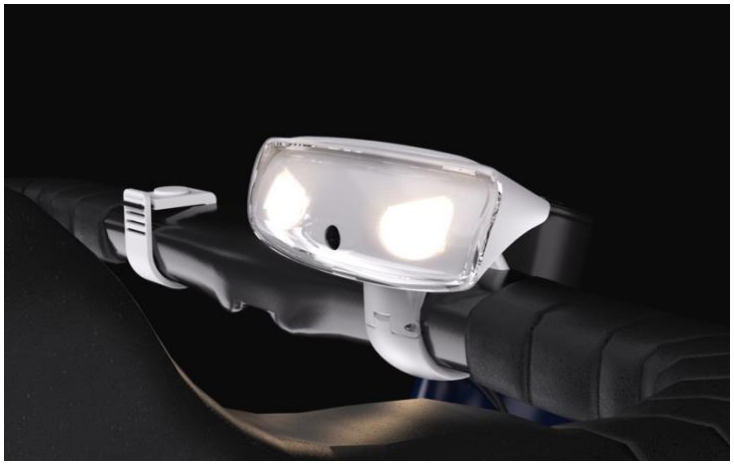
Implementation Pathway:
We have secured pilot funding with partners such as Government of Jersey to further develop our product and deliver cycle safety in road behavior change and infrastructure planning.

Issue

Road transport makes up a quarter of Europe's greenhouse emissions and continues to rise. Cycling is a low-carbon and cost-effective solution, yet according to Cycle UK, even with incentives such as cycle-to-work schemes, only around 4% of commuting trips are cycled in England. Better cycle infrastructure is key to cycling uptake, however progress is slow. Many dangerous junctions are overlooked as schemes are assessed on collision data updated bi-annually. There are currently no scalable ways to capture near miss data: this information is difficult for cyclists to report (easy to forget), hard for authorities to gather, and often tend to be subjective and unreliable (an "uncomfortable pass" is different person to person).

Concept

Our approach to improving cycling safety is with Pelation REBO, a near miss prevention bike light and dashcam. REBO helps existing cyclists actively prevent near misses on road journeys through behaviour change principles and makes it easier for cyclists to capture dangerous cycling incidents on the road. With a press of the handlebar bookmark button, REBO intelligently captures important details of an incident (front and rear footage, license plate numbers, time and location) before they're forgotten. These are automatically uploaded and analysed on the cloud, which not only increases the availability of incident data, but also generates more useful and higher quality early warning pre-collision evidence to enable authorities and stakeholders to act before, and not after collisions occur.



Front-mounted REBO device with accompanying handlebar button

Activity

The T-TRIG Grant was used to fund this project in three parts. 1) The research, development, and production of the physical prototype units including two different designs and numerous prototype iterations produced and tested in-house. 2) A two-month pilot in Oxford trialling six fully functioning prototype units with a cycle courier company to collect road incident data in a controlled environment. 3) A map visualisation and analysis of the incident data collected during the pilot to demonstrate this project's data use case.

Outcomes

Pelation was able to meet several of their milestones despite COVID-related disruptions during the project with the support of T-TRIG. There has been significant progress in the development of the REBO product, invaluable user feedback and interest throughout the length of the pilot, and a takeaway case study which demonstrates potential of their trial's incident data. Several stakeholders have shown interest in moving forward with different parts of the project, one of which includes a paid trial with the Government of Jersey starting in 2021.

Pelation
pelation.co.uk
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Marine Application of Carbon Capture Technology

PMW Technology Limited

Impact: *Advanced carbon capture could halve the cost of marine decarbonisation and give the UK a lead in its application.*

Implementation Pathway: *We will partner with major energy and shipping companies to pilot and then develop a demonstrator for shore and subsequently sea trials in 2023.*

Issue

Marine carbon emissions represent 2.5% of the global total (IMO) but conventional solutions are insufficient to achieve net zero emissions. Carbon capture has not been considered but may offer a lower cost transition for existing technology in advance of future developments.

Concept

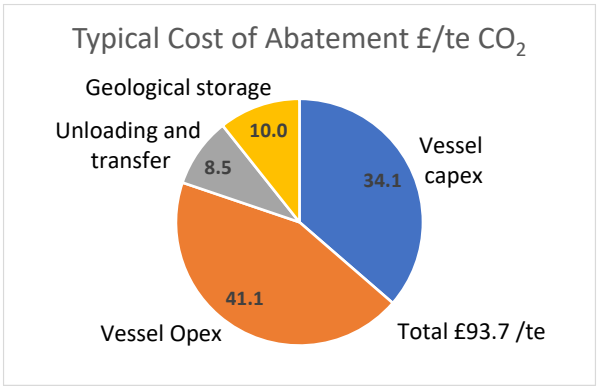
The options to deliver the commitment to achieve net zero carbon emissions from shipping by 2050 have been evaluated in studies for the DfT, calling for a transition to zero carbon fuels. The possibility of carbon capture was not assessed as conventional chemical technology would not be feasible on board ship. Recent developments in chemical-free carbon capture by PMW Technology use low temperatures to freeze the carbon dioxide out of engine exhaust gases, offering the possibility of a faster, cheaper route to marine decarbonisation.

Engine room of the SIEM Confucius – case study. https://www.corporate.man-es.com/

Activity

Working with naval architects Houlder Limited and the University of Chester, PMW Technology's T-TRIG project analysed the A3C low temperature carbon capture process applied to two modern ship designs. The case studies examined the feasibility, performance and cost of the process.

The delivery of liquid carbon dioxide from shipping to ports is an essential part of the concept and integration of port facilities with the proposed industrial carbon capture clusters was explored. Finally the costs of marine decarbonisation by carbon capture were evaluated on the same basis as prior DfT studies.



Outcomes

Process modelling by PMW Technology and the University of Chester proved the feasibility and assessed the energy consumption of the A3C process for decarbonizing shipping. Houlder Limited showed that for both case studies the equipment and carbon dioxide storage tanks could be located with small impacts on cargo carrying capacity while assuring ship stability. Working with Tees Valley Combined Authority, port unloading and transfer of liquid carbon dioxide to geological storage were found to support the development of the proposed UK carbon capture clusters, enhancing their utilization and further development. The total cost of marine carbon abatement by A3C carbon capture was shown to be a decisive 50% cheaper than zero carbon fuels on a comparable basis.

PMW Technology
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Shore Power for Shipping

Swanbarton Ltd & Marine South East

Impact:
Enable ship electrification at a lower cost and grid power, resulting in less CO2, NOx and particulate emissions.

Implementation Pathway:
We are doing an associated study into the deployment of flow battery power on ships. Following that, we aim to do a trial of the technology with a small ship or boat and an onshore charging system.

Issue

Electrification of shipping is desirable for emissions reduction, but solid batteries are expensive, their energy capacity is constrained, and their recharge within a short 'berth time' requires high power from the grid.

Concept

Flow batteries store energy in fluid electrolytes, which are pumped from tanks through the battery cell to react and discharge power. Flow battery duration is scalable: it can be increased through larger electrolyte tanks. Electrolyte fluids are less expensive per kWh than solid batteries. A flow battery ship can be replenished by pumping off the spent electrolyte and pumping on fresh electrolyte. The onshore recharging of spent electrolyte is then not limited to the ship's berth time, reducing the peak grid power required. The SPIDS (Shore Power Infrastructure for Decarbonisation of Shipping) project studied this system.

Activity

We have engaged with flow battery manufacturers, via the IFBF, to establish electrolyte energy densities.
We have run multiple discrete-event simulations (using SimPy) using 2018 ship data provided by Portsmouth International Port.
With Marine South East, we have studied the viability of the shore charging system and we have calculated the pumping rates required for electrolyte transfer.

Portsmouth International Port (© Copyright PIP)

Outcomes

Electrolyte energy densities vary considerably: 15Wh/L for old systems, 30Wh/L claimed for new vanadium electrolytes, 75Wh/L claimed for organic electrolytes promising and R&D projects aspire to ~240Wh/L using novel chemistries such as lithium-flow, zinc-air and graphite-sulphur. Initial calculations suggest that flow battery propulsion (75Wh/L) is viable for short-range ships (100-200 nautical miles). This is the scope of a separate study, working with a naval architect.
The SPIDS simulation showed that the flow battery system studied required only 10-20% of the grid power that would be required for solid ship battery charging, which is highly beneficial. As an illustration, the shore charging system for cross channel ferries visiting Portsmouth would require 4 large onshore electrolyte holding tanks, each at 15m high & 17m diameter.
The ship/shore electrolyte transfer is viable with off-the-shelf pumps and pipes. The pumping uses approximately 1% of the energy stored in the transferred electrolyte.
The SPIDS project offers a novel approach to the full electrification of short distance shipping. Our ambition is to deploy a trial system to encourage the shipping industry to consider alternatives to fossil fuels.

Swanbarton Ltd
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Advanced Eco-driving Strategies through Novel Longitudinal Control of Vehicles

Impact: *The system is easily implemented by fleet operators and could provide 5-10% reduction in fuel use and carbon emissions.*

Implementation Pathway: *We have partnered with fleet operators to further develop and test the prototype system.*

University of Cambridge

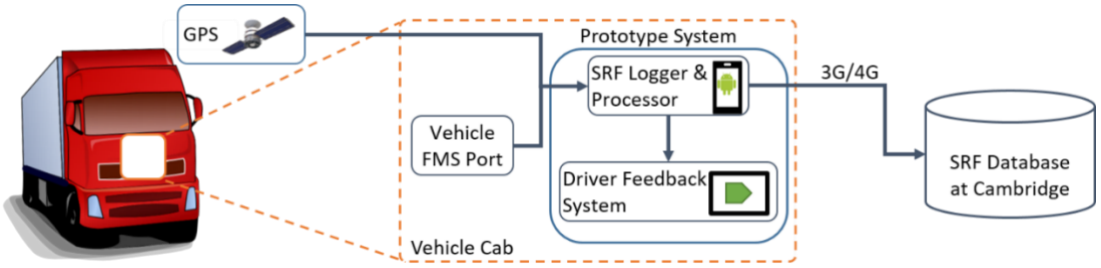
Issue

The Department for Transport has set a voluntary target for fleet operators to reduce their carbon emissions by 15% by 2025. Fleet operators need to identify quick measures to reduce their fuel consumption to meet this target.

Two strategies for minimising fuel consumption are event coasting and adaptive speed limiting. Even the best lorry drivers significantly underestimate their potential to coast while approaching a roundabout or exiting motorways. In addition, most people drive faster than the average traffic flow speed (often less than the posted speed limit). These driving behaviours cause higher fuel consumption and higher carbon emissions. They also cause harsher braking, which generates fine particle emissions that pose significant health risk to humans, especially to the vulnerable groups such as senior citizen and children in the vicinity.

Concept

The project aimed to design, develop and test a novel in-cab system to reduce fuel consumption of lorries through improved longitudinal control. The in-cab system, consisting of a display, speaker, and microcontroller, instructs the driver to follow advanced eco-driving strategies, including optimised coasting and adaptive speed limiting, to minimise fuel use.



Schematic diagram of the prototype system

Activity

The initial in-cab prototype system was completed in February 2020. However, due to the Covid-19 pandemic, it was not possible to complete the remaining systems, and install and test them during real operations. As an alternative that could be completed and distributed, a prototype Android app for smart coasting was developed. The system can be easily shared with operators and drivers to install and use regardless of the conditions and regulations surrounding Covid-19.

Outcomes

A coasting application was developed during this project, enabling fleet operators to analyse coasting opportunities without relying on intensive in-field training, and trial and error to identify the optimial coasting point. In addition, a prototype Android app for smart coasting was developed, which can be installed and operated by lorry drivers.

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Real-time eco-driving

University College London

Impact: *Real-time eco-driving will provide significant fuel savings that can be achieved using exisiting technologies.*

Implementation Pathway: *We will implement the proposed eco-driving strategy in the UCL driving simulator and assess its viability as a guidance system for drivers.*

Issue

The transport sector contributed 33% of all carbon dioxide emissions in the UK, according to a 2018 report from the Department for Business, Energy and Industrial Strategy. Emissions can be reduced if drivers were guided to a more environmental driving style referred to as eco-driving.

Concept

In order to get the most benefits from eco-driving, it should not only consider vehicle characteristics, but take account of it's surroundings, to suggest a speed which is both safe and acceptable to the driver. These requirements are often conflicting, so to find a suitable trade-off, the eco-driving strategy is formulated as an optimisation problem. This balances the minimising energy consumption given a vehicle's characteristics, whilst making sure that the result is not significantly different from conventional driving.

However, the resulting optimisation takes a significant amount of time to deliver a recommended speed. This means that the eco-driving strategy cannot be updated often enough to take into account changes in the surroundings. This in turn prevents a vehicle from following a speed that ensures safety and gives the largest reduction in energy usage.

Research at UCL has suggested that with few simplifications and comparing against similar situations observed in the past, it is possible to reduce the time of computation using machine learning approaches.

Image from Fleet News article on "Eco driving courses".

Activity

At UCL we used a T-TRIG grant to apply machine learning to the original eco-driving problem. We assessed the effectiveness of the strategy in microscopic traffic simulation on an urban scenario in the UK.

This allowed us to determine possible energy savings in autonomous vehicles which always followed the recommendations, and in a driving simulator where real life drivers were provided live recommendations on a screen.

Outcomes

An effective eco-driving strategy was developed which can provide speed recommendations in 0.002s. Analysis of this in a simulated environment demonstrated considerable energy savings, with 15% energy savings in high-density traffic and 9% in low-density traffic. Additionally, no severe impact on travel time or energy usage of other road users was observed. Savings of this magnitude can be achieved if used in autonomous vehicles to select the driving speed.

In order to assess the viability of the strategy as a driver guidance system, a simulator study will be performed to assess the users' acceptance and optimize the way that eco-driving information can be conveyed. Using the T-TRIG grant we developed software for UCL's driving simulator that creates a graphical environment which represents a real-word road layout and can generate simulations without requiring any additional programming. This gives users an easy and quick way to develop test cases that can be readily used for experiments.

UCL
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Open Call

Development of a thermal management system for e-bike battery charge/discharge optimisation

Alp Technologies LTD

Impact: *The use of temperature sensors in Alp's AI system will reduce BRIC operation and maintenance costs by 40%.*

Implementation Pathway: *We estimate a 12-18 month program to develop an AI predictive maintenance solution and commercialise the product through partner e-bike suppliers, components manufacturers and e-bike retail shops.*

Issue

In the UK, only 6% of cyclists currently own an e-bike, with 14% of cyclists intending to buy one in the next 12 months and 45% of current cyclists saying they would be interested in test-riding an e-bike (Mintel, 2019). These figures are expected to grow even more in relation to Covid-19 pandemic. For many people, an e-bike is an attractive alternative for avoiding public transports, traffic jams, parking problems and costs.

The major challenge facing us is how to boost the use of e-bikes, with the high cost of e-bikes being a major deterrent.

Concept

Alp Technologies has developed a low-cost and long-lasting IoT battery pack called BRIC that can use new or recycled li-ion battery cells for micro mobility solution. Its design allows easy monitoring, maintenance and replacement of each cell.

Activity

Within this T-TRIG project Alp Technologies proposed to develop a novel thermal management system by monitoring temperature at the cell level in its battery bike system (BRIC) in order to prolong overall battery pack life and maximize individual cell utilization before disposal.

Outcomes

This project has enabled Alp Technologies to carry out the necessary design developments and lab experiments to validate the positive impacts of adding individual temperature sensors to its battery pack system. Utilizing the temperature sensors data with our in-house AI have shown great potentials to enhance performance, safety and reduce operation and maintenance costs. In total, the combination of this innovation with our existing battery system made of used cells has the potential to reduce existing energy storage cost by up to 80%.

An additional and unexpected impact emerged from this project where this system is found to be highly suitable for applications where high performance and accuracy are needed for batteries in electric vehicles, aeronautics (e.g. planes and drones) and space vehicles.

Alp Technologies LTD
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Vehicle Tests of Turbo Range Extender (TREx)

Impact:
The TREx will eliminate range concerns of EVs while reducing emissions and fuel consumption.

Implementation Pathway:
We will partner with Jaguar Land Rover and Geely to commercialise the brand new range extenders in 2024.

Birmingham High Performance Turbomachinery Ltd

Issue

One of the main barriers when people consider buying an electric vehicle (EV) is the range. Current EVs have an average range of 181 miles on a full charge, and the range is influenced by temperature, battery life, and driving conditions. The proposed micro gas turbine range extender can extend the range to 900 miles with a full tank, with refueling takes a few minutes. The technology can give a competitive edge to the British automotive industry, impacting a European light vehicle market estimated at half a trillion Euros.

Concept

Current pure EVs have 181 miles travel range and eight hour battery charging time on average. One of the solutions to the problem is to use a range-extender on-board to produce electricity when needed. Current range extenders are mostly based on motorcycle piston engines. Their HC and CO emissions are higher that of the mechanical cars (FEMA News 25/10/2019). We propose a microgas turbine range extender (TREx). The TREx has the intrinsic property of low emissions and expected to cut CO2 emissions by 60% and NOx by 85% from the level of IC engines due to its continuous and lean combustion against discontinuous combustion of IC engines. It gives a competitive edge to the British automotive industry and impacting a European light vehicle market estimated to be worth half a trillion Euros.

This project is proposed to couple the engine with an alternator and test its electric charging ability. The milestones of the project include coupling the gas turbine with the alternator and achieve high standard alignment of the two shafts to suit high speed working conditions, and fully test the electric charging ability of the TREx. The success in reaching these milestones will eliminate technical barriers for the TREx to be used in EVs.

Activity

At Birmingham High Performance Turbomachinery, we used the T-TRIG grant to fund the introduction of air bearings, development of a high speed anternator, and investigation of charging feasibility of a radically-configured low emission and high efficiency microgas turbine engine for range extended vehicles. This is a key step towards the application of the turbo range extender to EV powertrains and providing an environmentally sustainable option for automotive industry.

Artist's impression of the TREx system.

Outcomes

The project results in a new and fire tested microgas turbine and the TREx, ready for commercialization along these two lines. A number of key stakeholders have shown strong interest, including Jaguar Land Rover and Geely Cars.

With further funding, the UK can become a leader in a new generation of range extended EVs featuring extremely low emissions and high fuel economy. This will help the UK to travel as petrol and diesel cars leave the market in 2030, and as the UK strives for net zero by 2050.

BHPTurbo
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CAV automated verification & validation

Impact:
Our software tool will reduce the amount of testing and increase the robustness of CAV systems.

Implementation Pathway:
Next stage is to start a pilot with a CAV developer company. This will allow us to refine our methods using their own CAV software and system, taking into account their specific issues.

CavPoint

Issue

The most significant challenge for the mass deployment of CAVs (Connected Automated Vehicles) is to assure that they behave properly under “all” possible conditions.

They must operate within a wide range of driving scenarios and when you consider all of the combinations of variations that could arise in these scenarios, this leads to an astronomical number of scenarios to test for - in practice these are impossible to carry out. The goal of testing, verification and validation is to identify which of these scenario variations have issues, and then to resolve them. Finding these is akin to finding a needle in a haystack.

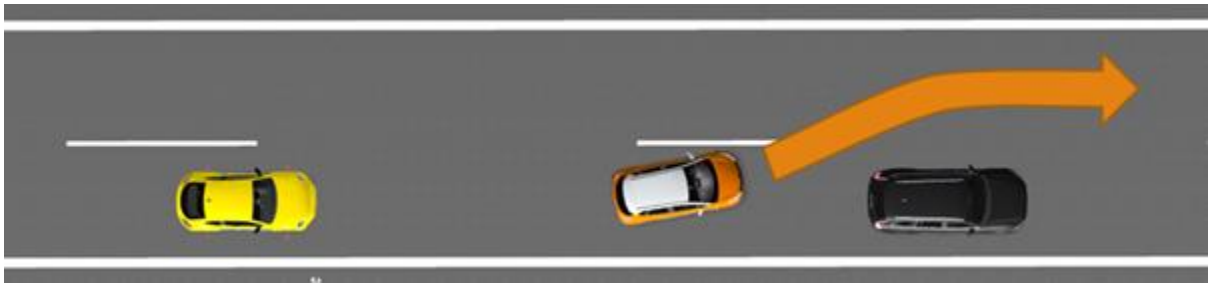
Concept

We are using innovative techniques to reduce the number of tests to be performed, and for these to be targeted at the critical scenarios. This enables faults to be found more quickly, so engineers can concentrate on resolving issues instead of searching for them.

We carry out an active search for these issues using a combination of optimisation techniques and key performance indicators. Once we have found the issues, we combine the similar ones into a smaller number of clusters so that it is easier for the development engineer to understand the problem and correct issues.

Activity

We have used a realistic and reasonably complex automated driving scenario, an ACC (Adaptive Cruise Control) system responding to a cut out driving manoeuvre, as a case study to develop our algorithms. After identifying the key variations to this scenario and the key performance indicators to measure this scenario, we investigated a range of machine learning algorithms to carry out the active search and to cluster the results.



Example of driving scenario, taken from CarMaker simulation software.

Outcomes

We have shown promising results in finding issues in our device-under-test. After only 20 iterations of an example optimisation algorithm, we have increased the proportion of issues found by 100x.

After finding these issues, we have clustered them together into common-cause groups, reducing the number of items reported to the development engineer by 50x so that it is easier for them to understand and therefore to resolve.

CavPoint
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Low cost drone detection machine learning for autonomous threat library updates

Houndstooth Wireless Limited

Impact:
This innovation will reduce the burden and cost associated with recurring drone threat library updates

Implementation Pathway:
We will develop the techniques learned in this project to higher Technology Readiness Levels (TRLs) to be installed in operational systems by 2021.

Issue

Misuse of consumer drones poses an increasing threat most recently seen in aviation and prisons, but also across other critical infrastructure and public spaces. Current drone detection systems hold a library of known threats which were previously fingerprinted. The task of keeping a threat library up to date with new drone models is time consuming and costly, as is the deployment of updated libraries to detection networks.

Concept

This project aimed to solve this challenge using Machine Learning techniques. The focus of innovation is the use of Machine Learning (ML) algorithms for the automation of drone detection library updates. While the use of ML for radio signal detection and classification is not new, the implementation of ML within the distributed hardware nodes of a low cost drone detection system is novel.

Activity

Initially the project developed and tested ML techniques for drone detection and classification. It then migrated the ML model onto drone detection hardware. State-of-the-art methods were then used to assess the level of confidence in predictions made by ML models. The project also proposed a concept archictecture to allow an entire system to function without requiring manual library updates.

Photo of drone taken by Houndstooth Wireless Ltd

Outcomes

Overall, the project proved that the concept is viable. A proof of concept system architecture was generated to allow the idea to be tested. The investigation into confidence scores, used to identify if an unseen threat was present, took significant effort. Results proved the idea is sound, and in specific applications identification of unseen threats is possible. However, additional work is needed in order to obtain consistently useful confidence scores and raise the technology readiness level (TRL). This is expected through further projects, and the concept is expected to be deployed into operational systems during 2021. This will offer a world-class, cost effective and practical drone detection solution for the challenge outlined.

Houndstooth Wireless
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Application of Hyperloop Technology to Existing Rail Systems

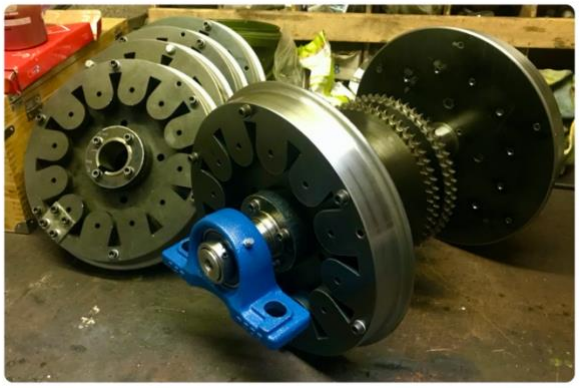
Impact: *The Traction Hub delivers safe braking, reducing the impact of an unpredicatable climate on an operator's service.*

Implementation Pathway: *Assemble a consortium of key industry stakeholders and the industry regulator to progress technology readiness levels, establish the economic benefits and regulate for the GB mainline*

Lenz Ltd.

Issue

During autumn and winter seasons, railway stakeholders face the challenge of operating services under low adhesion conditions, resulting in reduced grip that creates dangerous braking scenarios. To mitigate this, reduced speed limits are imposed on 10% of services, costing operators a combined £345m in annual throughput revenue and fines distributed through track access charges of £300m due to poor service reliability.



Structural compnents of dyamometer

Concept

To combat low adhesion, Lenz proposes the Traction Hub, a retrofitted, sustainable solution that applies the principles of electromagnetism to increase the frictional coefficient from 0.015 to at least 0.25 and achieve greater traction.

Mitigating slip has the added benefits of allowing vehicles to traverse greater inclines - currently limited to 3 percent above horizontal - and improve performance during acceleration and braking, while requireing no new infrastructure. Our product will save operators losing £24,600 per vehicle annually by tackling problems such as "leaves on the line" at the source.

Activity

Lenz is an Edinburgh based startup with a founding team that originally built Hyperloop prototypes during their time leading the University of Edinburgh's Hyperloop Team. The blue-sky concept of Hyperloop alerted us to how far behind current technology stands, and the T-TRIG grant allowed the team to pioneer the use of magnetic-friction wheels to solve reliability and safety issues on today's railways.

The fund enabled the simulation, procurement and testing of a one-fifth scale prototype locomotive rig. Wheelsets of multiple embodiments of the patented design were tested under conditions that simulate low adhesion on rails.

Outcomes

We were able to verify the proof of concept and develop a laboratory testing case that mimics the true environment on the GB Mainline, thus establishing effectiveness at TRL4 with a demonstratable device for attracting investment.

The next steps are to target rolling stock companies, manufacturers and operators of passenger and freight services to implement this solution on a test vehicle before pursuing pilots. We are appealing to stakeholders, leaders and experts in the rail industry to get in touch to explore the offering, and support implementing the product within their sector and further afield.

"predictable braking control and better acceleration performance - no matter the weather"

Lenz Ltd.
www.lenzlabs.com
contact@lenzlabs.com

“CAVTAG”

R4DAR Technologies

Impact: *CAVTAG will provide the all-weather comprehension of the world around us enabling people or systems to make the decision.*

Implementation Pathway: *We are on course to trial our innovation at the end of 2021 as part of a UKRI “Future of Flight” project. Further funding with DfT and Highways England support is key to trialing as part of the SMLL and on the UK road network.*

Issue

Safety remains the primary concern with regards to the adoption of autonomous mobility systems whether it be delivery drones or driverless cars. Although much confidence has been placed in using machine learning and AI to overcome hardware limitations, significant concerns remain about the reliability of these systems to operate in all circumstances. New sensor technologies will be essential to ensure high fidelity and integrity data is available to enable people or systems to make the right decision.

Concept

Advanced Driver Assistance Systems (ADAS) on autonomous vehicles require all-weather, self-sufficient, and resilient systems that can reliably understand the world around them. Camera and Lidar technologies rely on scene interpretation based on previous training data and are unreliable at detecting and identifying hazards at >100m particularly in adverse weather conditions. GPS positioning is not always accurate or available and ‘blackspots’ in communications networks will always exist.

R4DARs innovation provides the resilient all-weather capability to locate and unambiguously identify what something is, where it is and the what’s its status without any reliance on GPS or communications networks. “No signal, no problem.”

Highways England are currently deploying radar onto the UK SMART motorway network. Fitting the R4DAR innovation to Highways England vehicles, contractor’s recovery trucks, and even traffic officers would increase their visibility to radar, greatly improving the ability to safely monitor the location of vehicles and vulnerable road users (VRUs).

Activity

R4DAR Technologies used the T-TRIG grant to fund the proof of concept investigation and development of a low-cost, light weight identification beacon capable of being read by an automotive grade radar. This work has been key to providing the technical foundations for the innovation while providing credibility when forging strong industry relationships as we look to trial and demonstrate this technology as part of the Smart Mobility Living lab (SMLL).

Example R4DAR beacon use cases

Outcomes

R4DAR have successfully proven in simulation that it is possible to encode extra information onto a reflected radar signal and then decode that information within an automotive grade radar. We were not able to manufacture the proof of concept beacon hardware within the timescale of the T-TRIG grant but we are on schedule to trial and demonstrate our innovation in 2021 as part of a UKRI “Future of Flight” grant. R4DAR in partnership with the Satellite Applications Catapult, Oxfordshire County Council and three other influential SME’s will trial a system solution based around R4DARs beacon technology. The system will provide drones with a localised navigation and surveillance capability essential for safe operation in high risk very low-level flight (VLLF) environments.

R4DAR Technologies
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Developing a Low Cost, Reliable, and Anonymised Automated Traffic Counting System

Impact:
LiDAR will reduce the processing time and latency to communicate with autonomous vehicles.

Implementation Pathway:
We have adapted our algorithms to the rail sector and have taken part in the Transport for Wales Lab (TfWL) Accelerator Programme, where we were "highly commended".

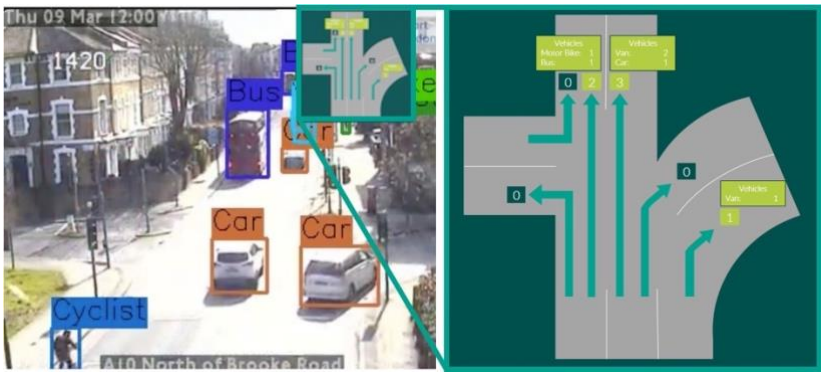
Route Konnect

Issue

Existing technology to detect vehicles is almost half a century old. Electromagnetic inductive-loops embedded within the road are only able to detect metallic vehicles, are prone to failure, and are almost impossible to access and maintain due to road accessibility issues – a study in New York found that of their 15,000 existing sensors, 25% were not operating at any given time. Cities face four layers of challenges affected by the traffic on our roads. These are ; 1) developing infrastructure for the future of mobility, 2) reducing emergency response times in a safe and intelligent manner, 3) reducing air quality issues, and 4) reliably detecting vehicles in real-time to achieve all of the above.

Concept

Tackling these four layers with a holistic approach becomes lucrative in future proofing the UK's transport needs. Their concept achieves this by developing units that utilise proven LiDAR (similar to radar, but uses lasers over radio to observe echoes) and camera technology and techniques used on autonomous vehicles, but in a novel approach by combining these two together to place it on existing infrastructure. Taking this 'sensor fusion' approach allows for a more robust solution.



Snapshot of turning count detection by vehicle classification using TfL London Traffic Cameras

Activity

Route Konnect made use of the T-TRIG grant to further develop the algorithms for a combined LiDAR and camera solution. By doing this, detecting parameters such as vehicle type and vehicle speeds benefited from the fusion of the two technologies together for increased accuracy.

Outcomes

Route Konnect tested the algorithms within simulation, creating benchmark data that was then verified by real-world test data from TfL traffic cameras. The results of the showed 97% accuracy for vehicle category detection, with speed detection within 5 mph of actual vehicle speed. The LiDAR algorithms for the same dataset produced a vehicle category detection accuracy of 90% with speed detection within 1.4mph of actual vehicle speed. Combining the best of these two results in added accuracy.

As a result of these solutions, the algorithms are being used across a number of use cases with existing CCTV infrastructure to anonymously detect vehicle and pedestrian flow. Route Konnect is also taking this technology further through Innovate UK collaborations with city councils in the pipeline.

Route Konnect
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TRS-RAP

The Floow Limited

Impact:
Road assessment program predictivity enhancements. Enabling informed change.

Implementation Pathway:
Adding value into existing Road Assessment Programs. Further work is needed in scientific study whilst recommending enhanced data usage in RAP in the short term.

Issue

Telematics Road Safety Road Assessment Program (TRS-RAP) is a T-TRIG funded project that investigates the potential of reusing mass user behaviour data to enhance understanding of locational risk. Exisiting RAP approaches statistically estimate risk levels on the road network using observed features about locations. This annotation approach although helpful considers infrstructure primarially and not the localised statistical behaviour of drivers. The hypothesis explored in this study is that the addition of new factors taken from localised anonymous behavioural data will help enhance localised risk predictivity.

Concept

TRS-RAP explores the potential to add new factors and predictive power using large scale anonymous telematics behavioural data to better understand risk by location. This creates aggregate behavioural features to test added value in a testbed region (West Midlands).

Activity

A testbed investigation evaluate telematics behavioural data with input from stakeholders. This creates an evidence base in a large scale west midland testbed to understand behaviour around incidents. This will be used to evaluate the predictive potential from localised behavioural mapping for powering enhancments to future road assessment programs.

The project was delivered with partners in the DfT, Road Safety Foundation, TfWM, The West Midlands Road Safety Partnership and iRAP.

Outcomes

A large test region has been evaluated determining behavioural risk factors and alignment to accident outcomes. This has been evaluated against existing RAP assessments with new methodologies to incorporate high fidelity behavioural data into existing models. Factors have been examined for correlations to incidents and prior assessments. Recommendations are provided to RAP programs regarding behavioural data quality.

The Floow Limited
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Age-Friendly and Accessible

Revolutionising Personalised Accessible Travel

Impact:
CityMaaS platform will alleviate travel anxiety, reduce wasted time and allow independent living.

Implementation Pathway:
We have partnered with ValpiBus in Portugal for initial roll-out and are in discussions with coffee shop chains and property aggregation services.

CityMaaS

Issue

Travel is one of the most important parts of daily life, but also one of the most challenging, especially for people with limited mobility. Accessible travel can be inefficient and in some cases non-existent, which leads to higher unemployment and social isolation. In order to address this problem with a scalable digital solution, we must ensure digital engagement is possible and maximised for people with impairments.

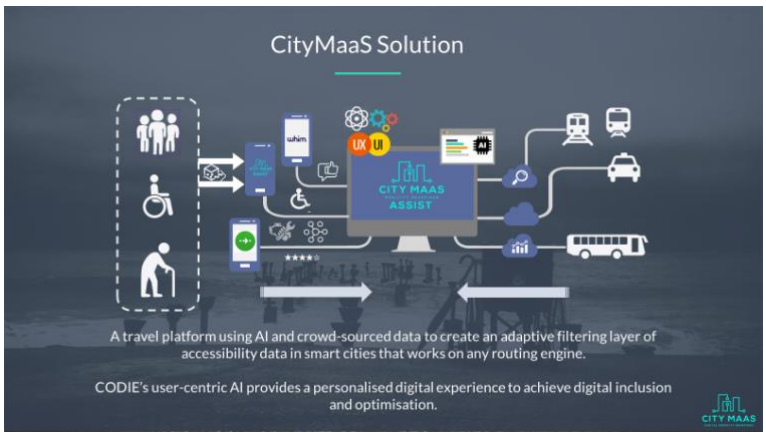
Concept

CityMaaS's platform uses AI to optimise and personalise the travel experience, enabling the community to help themselves and reward each other. It also has CODIE, an embedded technology where a localised machine learning engine continuously analyses and learns the individual's interactions in order to dynamically change the user interface elements, adapting to the user's needs.

Activity

CityMaaS has developed algorithms to predict accessibility levels and to enhance journey experience based off of individual requirements. These underlying technologies for the CityMaaS platform, allow users to search for localised, real-time information and plan personalised journeys.

CODIE's algorithms have been trained and deployed to predict user intention and adjust the user interface and user experience of an app, ensuring the widest possible audience and more succesful interactions for businesses.



CityMaaS Ecosystem overview

Outcomes

CityMaaS has demonstrated that accessibility can be predicted with a high degree of accuracy and has proven that CODIE is able to predict human intent and adapt user interface and experience elements.

The project has allowed CityMaaS to sign letters of intent with investors and our first commercial partner. CityMaaS Assist is live and CODIE is being deployed within a live app in Q3 2020. We have created proprietary algorithms and intellectual property and have expanded the core tech team and depth of knowledge. This has enabled us to focus on commercialization, revenue generation and international expansion over the next 12 months. With additional funding of £650,000, CityMaaS is well placed to ensure the UK remains globally respected for its inclusivity and diversity.

CityMaaS
CityMaaS.io
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Creating a tailored transport service for older adults in towns and small cities

Impact:
Tandem will enable an affordable, reliable transport option for older adults in towns and small cities.

Implementation Pathway:
Tandem is in discussions with local authorities to pilot shared transport services that complement (or even substitute) traditional bus routes that are increasingly not economically viable.

Tandem

Issue

Many older adults find it difficult to travel, and this lack of mobility is linked to poor wellbeing. These travel issues are exacerbated in towns and small cities, where traditional public transport systems are increasingly not working for their residents (lower patronage has resulted in service cutbacks which reinforces further drop in patronage) and where populations of older adults tend to be higher compared to larger cities.

Tandem workshop participants in Northamptonshire

Concept

Tandem partners with local transport providers to transform taxis into shared 'micro-buses'. By using technology to match passengers going the same way at the same time, Tandem enables passengers to access the service of a taxi for the price of a bus, providing an affordable, reliable and safe transportation option. In piloting our initial service, although we have experienced significant demand (more than 6000+ passenger journeys in less than one operational year) we have recognised specific barriers faced by older adults in accessing and adopting this service.

Activity

We used the T-TRIG grant to work towards three objectives: a) research through a mix of co-creation workshops and online surveys in partnership with Social Research Associates and the Universities of Aberdeen and Glasgow b) development of a prototype incorporating insights from the research and c) formation of partnerships with potential local authorities who might be interested in partially funding our service to increase the range of transport options available to their constituents, including older adults.

Outcomes

Tandem has been pleased with the outcomes achieved from this T-TRIG grant: a) we were able to conduct research with more than 100 older adults, and plan to help our academic partners from Aberdeen and Glasgow formally publish their work in academic journals in 2021, b) we have developed a prototype that will now be a strong foundation for a more sophisticated user-facing app being developed and c) we are in conversations with multiple local authorities around piloting a live service in 2021 for routes that would also help serve older adult audiences.

Tandem
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Event-based transport

Esoterix Systems Ltd

Impact: *Improve access to affordable, accessible transport for older people by making intelligent use of all available supply.*

Implementation Pathway: *Esoterix is seeking partners who want to support community-led approaches to local transport problems. We are engaging with local authorities who submitted applications to the DfT Rural Mobility Fund.*

Issue

An older or disabled person's ability to go shopping, attend events or visit their GP is often down to the availability of affordable and accessible transport. But, despite being a deciding factor, transport is usually an afterthought and almost always arranged separately to the purpose for the travel. This may mean that some journeys may not happen, as it becomes too difficult (or expensive) to arrange.

Concept

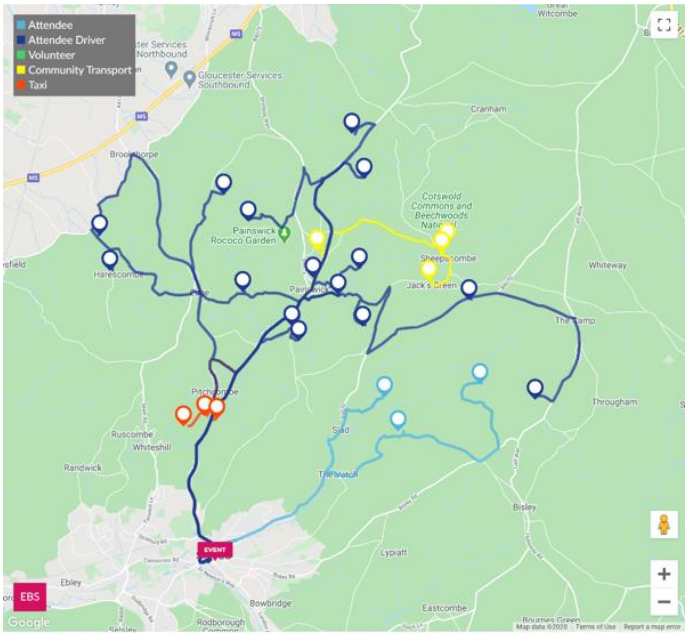
A more proactive approach is to use the aggregating function of the event itself to assist the organisation of affordable transport to it. For example, those registering to attend a social event or a health clinic would be offered transport at the time of booking the event. The event booking site would then automatically organise the transport to be delivered from suppliers registered with it, typically minimising the overall cost by using shared transport (e.g. community transport or shared taxis) and highly affordable transport (e.g. volunteers and liftshares from other attendees) where possible.

Such suppliers often have different constraints – community transport may be area restricted whilst liftshares don't want to deviate too much from their direct route. This project prototyped software which planned optimal routes whilst accommodating these varying supplier constraints.

Activity

The protype software – codenamed the Esoterix Brokerage System (EBS) – was developed and then tested on randomly generated demand for events held in different geographies, including rural, peri-urban and urban. The events themselves were based on realistic real-world scenarios defined by experts from partner organisations, the Centre for Transport and Society at the University of the West of England and ITP World.

The scenario pictured on the left is for an event where 25 people wanted transport. In this case a high proportion of trips could be provided by other attendees (blue), the rest being served by a community transport minibus (yellow) and a shared taxi (orange).



EBS output for an event in Painswick, Gloucestershire

Outcomes

The project proved EBS did create cost-effective transport plans in multiple scenarios and geographies using suppliers with varying constraints and cost models. For example, it prioritised the selection of volunteer drivers over taxis, but also preferred a full shared taxi to largely empty community transport vehicle. The results also demonstrated the impact an event-with-transport booking platform could have if it nudged driving attendees to offer lift-shares.

Esoterix Systems
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Smart Crossings for blind and partially sighted people

Impact:
The Smart Crossing will enable visually impaired people to use Zebra Crossings with confidence.

Implementation Pathway:
We will partner with a local highway authority to trial a system on highway, with a view to achieving DfT authorisation for wider use across the UK.

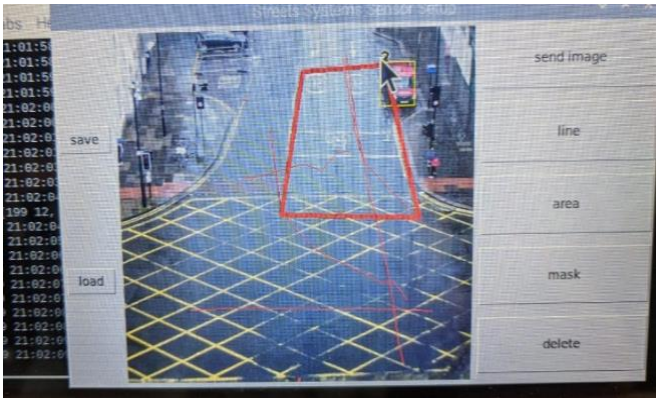
Streets Systems

Issue

Blind and partially sighted people vocally express safety concerns in regard to uncontrolled and zebra crossings over segregated cycle tracks. Conflict between the two groups creates an unnecessary tension when attempts to increase safety of one group is perceived as creating additional risks for the other.

Concept

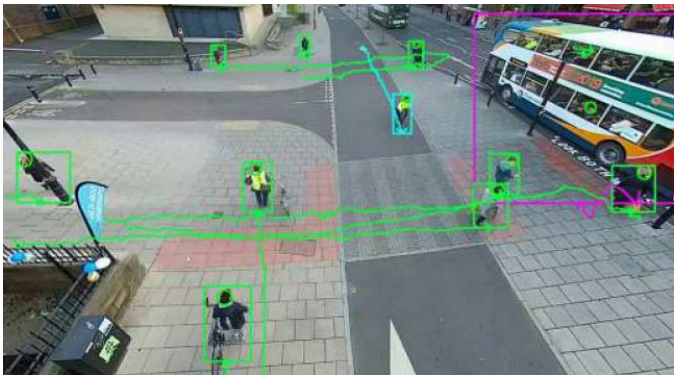
Proposed technological solution to the described problem is based on computer vision and radar technology working in tandem and providing users with information when the monitored cycle track is clear to cross. The solution is a micro-computer that constantly monitors the environment and when requested adds confidence before a person decides to enter the crossing.



Screenshots from the software, demonstrating highlighted items of nterest identified at crossings.

Activity

We discussed the concept with a user group that provided valuable feedback and input. We captured their experiences and expectations and included them in our design that was implemented in the solution. We tested multiple hardware options, integrating off-the-shelf components, with in-house manufactured enclosures with micro-computers running bespoke software. Performance tests led us to our final solution that is efficient and affordable, while assuring users safety and ease of configuration.



Outcomes

We have developed a software-hardware combination in a form-factor suitable for installation on a Belisha Beacon. The device is capable of detecting cyclists and signalling when the way is clear upon receiving a request from a pedestrian demand unit.

The project produced a battery powered unit that can be easily deployed and tested in various locations. A self-contained device with its core functionality and all configuration done using a graphical application displayed on a included touchscreen is ideal for the developed solution. We hit our milestones in terms of software & hardware development, user engagement and attracting interest from stakeholders by submitting a bid to TfGM's requirement for a solution to crossing cycleways in Manchester.

Streets Systems
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Understanding user requirements of an inclusive transport information device

Impact:
Elderly and impaired travellers will be better equipped to use public transport around the UK.

Implementation Pathway:
The next stage is to conduct a pilot trial with the device.

Zipabout Limited

Issue

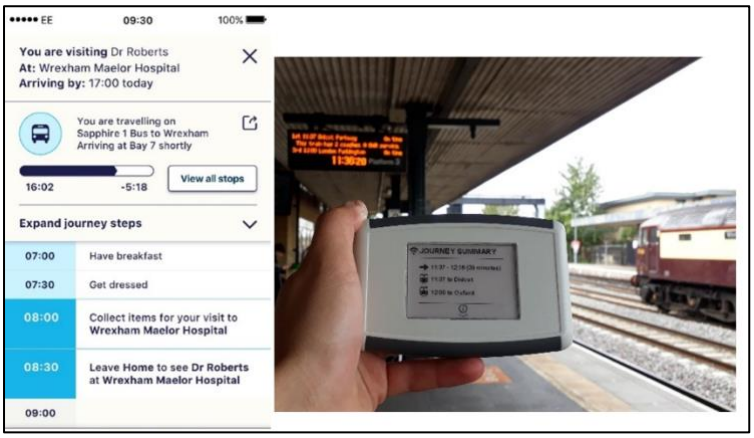
Travel around the UK can be difficult, especially for those who are somehow physically or cognitively impaired. There is a lack of clear and understandable information supplied when planning a journey and during a journey, to ensure that people feel well-informed and supported throughout. Many elderly and disabled people tend to abstain as a result leading to a lower quality of life.

Concept

This project built on previous work by Zipabout Limited to examine the specifications for a handheld device to provide travel information, including real-time tracking and updates about delays, alternative journey provision, crowding data and station facilities.

Activity

A thorough literature review was conducted to examine the needs of the elderly and impaired when travelling. An online survey was conducted to examine needs of general users of transport and those either aged >65 or who had some form of disability (*n* = 26). A focus group was then conducted (*n* = 3) with people who match these criteria, to explore advantages, disadvantages and requirements for travel. Professionals in the industry (*n* = 2) were also interviewed to provide an operational perspective.



The Journey Assistant Developed as part of the RSSB project

Outcomes

Older or impaired participants found travelling more difficult and anxiety-provoking than their counterparts. Crowding is important to this group, particularly on buses, and they tended to use apps and website less frequently for journey information. Bus demand is not being met leading to a lack of trust in bus reliability, a lack of comfort when overcrowded, or anxiety when digital information was unavailable, particularly in unknown locations. Train travel was acceptable when it proceeded as planned but issues such as delays, cancellations or seat-booking issues, leading to damaged luggage, long waits and physical trauma, could cause journeys to become ‘a nightmare’.

After testing with industry professionals, there was a consensus that information needs to be clearly presented, particularly for crowding and that current provision is not satisfactory. These issues could all be alleviated through a variety of measures; clearer journey information, real-time bus tracking and crowding data to prevent missed journeys and provide more comfortable options; alternative station facilities available before and during the journey, and crowding data would negate most of the issues encountered.

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Potholes and Resilient Infrastructure

Real-Time Resilience Modelling

City Science

Impact: *City Science have developed a robust process to deliver near-instantaeous modelling of resilience impacts on transport.*

Implementation Pathway: *The system has been made available in the Cadence 'What-If' modelling suite and demonstrated on large scale UK road networks. We will work with users and partners to model flood risk using the tool and identify future enhancements using additional resilience data.*

Issue

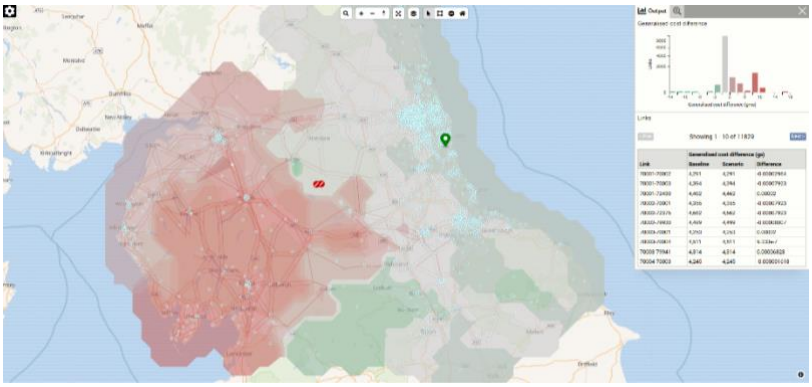
In the 2019-20 winter the UK experienced severe winter flooding including recording the wettest February since 1766. Storm Dennis alone caused the highest number or flood warnings on record, heavily impacting travel on the UK's roads. Ensuring that networks are resilient is of key concern to transport planners and network managers. However, existing tools do not enable quick, efficient evaluations of resilience impacts limiting the use of models in strategic or operational planning.

Concept

Our project set out to address this, focusing on new ways to structure transport modelling algorithms to run efficiently and effectively to provide resilience insights in real-time. In addition, we reviewed resilience datasets which were then combined with a enhanced simulation code to deliver fast and robust impact analysis for localised flooding events. This was implemented in a web-based application - Cadence.

Activity

The project focused on three main areas of work: 1) research into strategies to radically speed up resilience modelling in strategic and real-time environments; 2) research into resilience datasets and methods to link these to existing strategic modelling assets; and 3) development of a system to demonstrate the benefits of the approach.



Impact Analysis Example for Hypothetical Flooding Event

Outcomes

The project has delivered a tool that enables users to quickly simulate the impact of flooding on major transport networks. The system scales to some of the UK's largest road models, delivering results to a web application in a fraction of the time of alternatives. This provides immediate insights for transport planners and network managers alike.

The project has also provided initial research into automated network development and network pruning techniques to enable much faster runs within operational environments. The project has identified critical complexities in developing real-time 'computationally rational' systems which still need to be overcome, but created capabilities and code that we expect to have significant long-term efficiency benefits on wider transport modelling.

Both elements of the project are being taken forward. The resilience simulation will form part of the Cadence 'What-If' suite of tools. Additional resilience datasources have been identified which will enhance this toolset in the future. The fundamental research is proposed to be progressed through Innovate UK funding with the computer science department of a leading UK university.

City Science
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Mind-My-Bumpy-Ride

Liverpool John Moores University

Impact: *Timely pothole maintenance; Low-cost detection; making roads safer; and improving journey experience.*

Implementation Pathway: *We will partner with local authorities, cycling commissioners and charities to realise the potential of the technology and promote the use of the app and algorithm.*

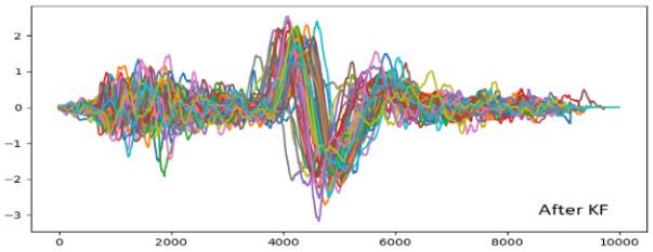
Issue

Potholes are “the number one enemy for road users” Secretary-of-State-for-Transport (2019). They put significant strains on local councils, with one complaint per 46 seconds (FSB, 2019), compensation quadrupled and the number of potholes increased by 50% (HighwaysEngland, 2019). Only 30% of the public are satisfied with the situation (Parliament, 2019). To be informed of potholes not spotted by inspection, councils encourage public reporting, generally via websites/apps. However, these reports are generally based on qualitative judgements, lacking the exact locations/impact (Parliament, 2019). Potholes are a threat to cyclists, who can suffer serious injury.

Concept

Mind-My-Bumpy-Ride proposes a novel and cost effective way to identify, in real-time, potholes that can affect cyclists on local/unclassified roads. The app uses mobile phone sensors to record motions, and use artificial intelligence techniques to learn and recognise a particular behaviour. Combining this behaviour recognition with the location recorded by the phone’ GPS, the relative size and location of a pothole can be estimated. The estimation can be verified by cross-checking with records from other users travelling on the same road and using the same app.

The bike with phone and air quality sensors



An example of the sensor data

Activity

A mobile application and a machine learning algorithm have been developed for the purpose of collecting sensor data. By conducting a number of experiments of different types of riding behaviour, we have collected the sensor data for recognising the pattern when encountering a pothole. The key technology is a new algorithm utilising machine learning to study the pattern of riding around a pothole.

Outcomes

The data including accelerometer, gyroscope and GPS have been collected by the app as a prototype. The machine learning model for pattern recognition delivers some good initial results by considering one dimension in gyropscope.

The project has hit several key milestones in the plan and shown the potential of improving riding experience and the infrastructure. However, the technology is still at proof-of-concept stage. With further work, the algorithm can be improved and more factors can be taken into account in a wider programme.

Liverpool John Moores University
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Shape-Pot

University of Liverpool

Impact: *Shape-Pot will change the way UK roads are monitored and maintained, enabling predictive maintenance.*

Implementation Pathway: *We will partner with Robotiz3d and several Councils to further develop the technology, aiming to make it available by 2022.*

Issue

Condition of UK roads is deteriorating, with cracks and potholes appearing more frequently. Over the last decade, 17.9 million potholes have been filled, at a cost exceeding £1bn. Ageing of roads, increasing number of users, and enhanced vulnerability under extreme climate scenarios are causing an increase in pothole occurrence, creating a pressing need for effective solutions to this problem. A new way for monitoring road condition and enable data-driven management would be a game changer in this scenario.

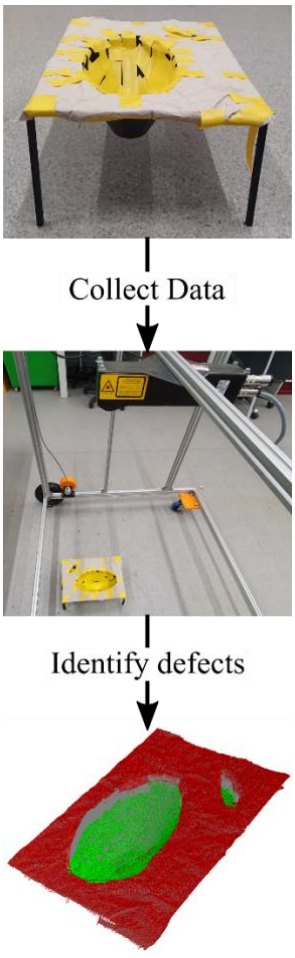
Concept

The current practice is based on time-consuming, labour intensive, and hence costly, monitoring and remediation processes and is in part due to outdated repair methods; moreover, the poor on-site quality testing means that future repair of the same site is often required.

We envisage autonomous platforms traveling on the UK roads in the future to collect high-quality data about the condition of the road surface and flagging defects such as cracks and potholes. Such data will then be fed to AI-driven road maintenance systems capable of optimally planning interventions, thus improving the overall safety and health of the UK road network. In the future, such vehicles may also be equipped with devices to repair the identified defect with minimal human intervention, therefore increasing efficiency and quality of repairs.

Activity

The @LERT lab led by Dr Paoletti at the University of Liverpool have used T-TRIG funding to develop the first-of-its-kind device for accurate and autonomous characterisation of road defects. By using technologies originally designed for metrology and manufacturing, the team has shown that the geometry and appearance of road surface and road defects can be characterised with a level of accuracy that is beyond what is achieved today.



Example of detection of 3D-printed pothole in a lab setting.

Outcomes

The research team has had good success in building the physical prototype and the associated software, with lab tests demonstrating that cracks and potholes can be reliably identified. The integrated sensors and data analysis algorithms are capable of accurately reconstructing the geometry of the identified defects. Moreover, a tool to generate synthetic data representing road defects in the same format used by commercial sensors has been developed. Unfortunately, the Covid-19 pandemic has forced the team to postpone field testing

The Shape-Pot project was extremely useful for engaging with key stakeholders (road owners, road maintenance crews, contractors, manufacturers etc), who showed great interest in the project. The University of Liverpool team, and the partner spin-off Robotiz3d, are looking for further funding and partners to develop the technology towards commercialization.

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