Engagement and Impact 2018

Queensland University of Technology

QUT09 (ST) - Impact

Overview

Title

(Title of the impact study)

Aircraft Flight Assist System for the ROAMES network infrastructure management system

Unit of Assessment

09 - Engineering

Additional FoR codes

(Identify up to two additional two-digit FoRs that relate to the overall content of the impact study.)

Socio-Economic Objective (SEO) Codes

(Choose from the list of two-digit SEO codes that are relevant to the impact study.)

85 - Energy
96 - Environment

Australian and New Zealand Standard Industrial Classification (ANZSIC) Codes

(Choose from the list of two-digit ANZSIC codes that are relevant to the impact study.)

26 - Electricity Supply

Keywords

(List up to 10 keywords related to the impact described in Part A.)

Infrastructure Inspection

Energy Infrastructure

Digital Asset Management

Airborne Surveillance

Airborne Remote Sensing

Autonomous Systems

Sensitivities

Commercially sensitive

No

Culturally sensitive

No

Sensitivities description

(Please describe any sensitivities in relation to the impact study that need to be considered, including any particular instructions for ARC staff or assessors, or for the impact study to be made publicly available after EI 2018.)

Aboriginal and Torres Strait Islander research flag

(Is this impact study associated with Aboriginal and Torres Strait Islander content?
NOTE - institutions may identify impact studies where the impact, associated research and/or approach to impact relates to Aboriginal and Torres Strait Islander peoples, nations, communities, language, place, culture and knowledges and/or is undertaken with Aboriginal and Torres Strait Islander peoples, nations, and/or communities.)

No

Science and Research Priorities

(Does this impact study fall within one or more of the Science and Research Priorities?)

Yes

Science and Research Priority	Practical Research Challenge
Environmental change	Resilient urban, rural and regional infrastructure.

Impact

Summary of the impact

(Briefly describe the specific impact in simple, clear English. This will enable the general community to understand the impact of the research.)

The Flight Assist System (FAS) research was a critical enabler for the development of the Remote Observation Automated Modelling Economic Simulation (ROAMES) network infrastructure management system. ROAMES was able to substantially reduce the maintenance costs (by $40M/year) of Queensland's Ergon Energy's powerline network by creating an accurate virtual model of this network and nearby vegetation which was only possible due to data collection empowered by the FAS technology. Further ROAMES led to more effective asset management processes, inspired new energy infrastructure natural disaster response strategies, and facilitated new large-data processing and visualisation capabilities that have significantly changed network infrastructure management.

Beneficiaries

(List up to 10 beneficiaries related to the impact study)

Ergon Energy - Queensland - electricity transmission system operator

Energex- Queensland- electricity transmission system operator

SP Energy Networks -UK- electricity transmission system operator

National Grid - UK- electricity transmission system operator

Elia- Belgium- electricity transmission system operator

Countries in which the impact occurred

(Search the list of countries and add as many as relate to the location of the impact)

Australia
England
Scotland
Wales
Belgium
Northern Ireland

Details of the impact

(Provide a narrative that clearly outlines the research impact. The narrative should explain the relationship between the associated research and the impact. It should also identify the contribution the research has made beyond academia, including:

- who or what has benefitted from the results of the research (this should identify relevant research end-users, or beneficiaries from industry, the community, government, wider public etc.)
- the nature or type of impact and how the research made a social, economic, cultural, and/or environmental impact
- the extent of the impact (with specific references to appropriate evidence, such as cost-benefit-analysis, quantity of those affected, reported benefits etc.)
- the dates and time period in which the impact occurred.

NOTE - the narrative must describe only impact that has occurred within the reference period, and must not make aspirational claims.)

THE PROBLEM: The costs of managing a large powerline network are significant, for example, consider inspection of Ergon Energy's network with over 150,000 km of powerlines, 1 million power poles, 100 million trees and including 600 towns and cities. Since some of the worst bushfires in Australia's history have been started by powerlines, routine inspection of vegetation encroachment on powerlines is vital.
Traditionally, powerline inspection was performed by a ground crew which was found to be inefficient and unreliable. The alternative of using aircraft required flying for long periods of time at low altitude above powerlines which was deemed unsafe and tedious for pilots.

THE SOLUTION: QUT in collaboration with the Cooperative Research Centre (CRC) for Spatial Information and Ergon Energy conducted research into how to achieve precision aircraft flight above powerlines for inspection in a reliable, efficient, and safe way. This led in 2011 to a prototype Flight Assist System (FAS) technology that could efficiently inspect the whole of Ergon Energy's state-wide powerline network. The resulting flight planning, in-flight quality assurance and flight control technology, plans and then assists low altitude flight above powerline infrastructure to capture high-quality sensor data. The FAS technology is able to automatically execute aircraft heading changes to follow pre-calculated optimised flight plans and thereby reduce pilot workload, enhance pilot safety, and enable rapid data capture. The research has enabled a solution to a large-scale problem which was seemingly physically impossible and cost prohibitive and has changed the way large-scale aerial inspection is conducted [1].

During the period 2012-16, the system became fully operational and the technology's impact became realised as the subsequent development and data integration into the ROAMES system allowed infrastructure managers to investigate and monitor the condition and performance of their network rapidly, in high fidelity, and conceive new operational procedures and paradigms [1].

The impact of this work has been highly significant, deriving sustainable and ongoing commercial benefits, providing reliable, single pass capture of hundreds of thousands of kilometres of network and thousands of low altitude flight hours without incident.

TYPE OF IMPACT: Research has made impacts of the following types: Economic, Societal and Environmental.

ECONOMIC IMPACT: The research's primary impact is through significant economic benefits to ongoing management of large powerline infrastructure networks through quicker, safer and more reliable inspection, with flow-on cost savings to energy consumers. In 2013, the Ergon CEO announced the system was saving them an estimated $14M per annum [3] and Ergon exercised an Australian and global license on the flight automation technology. In 2014, the ROAMES system was purchased by the Dutch multinational Fugro for an undisclosed price, which was speculated to exceed $20M [2, 3]. In 2015, ROAMES inspected 200,000km as operations expanded beyond Ergon's network, and Fugro-ROAMES began offering services in the USA and Europe [4]. In 2016, the Energex company contracted Fugro-ROAMES services in support of their 3.2 million customers [5]. By March 2016 Fugro-ROAMES had grown to 70 employees in Australia and announced their plan to recruit 40 more employees by mid-2016 [1]. In 2016, the savings to Ergon Energy were being publicly estimated to exceed $40M per annum [9].

SOCIETAL IMPACT: The overall safety and risk to society have been improved. The research has enabled precise centimetre-level accurate modelling of powerlines and their surrounds which has contributed to improved public safety, reduced bushfire risk and better natural disaster response through providing more accurate and timely information about the state of the powerline network [9].
As an example, following February 2015's Category 5 cyclone Marcia in which 350 homes were destroyed in Queensland, Fugro-ROAMES enabled rapid prioritisation of recovery activities and Ergon Energy restored power to more than 51,000 customers (80% of those impacted) within a record 10 days, while saving more than $10M [6].

ENVIRONMENTAL IMPACT: The use of a few aircraft instead of numerous ground vehicles has a positive impact on the environment and promotes sustainable and effective management of tree species near man-made infrastructure [3]. The risk of bushfires caused by encroaching vegetation on powerlines has been reduced and contributes to enabling positive environmental impact, through rapid data acquisition enabling accurate modelling of infrastructure and surrounds.

EXTERNAL RECOGNITION OF IMPACT: The research has contributed to Ergon Energy receiving the 2015 International Edison Award for Innovation [7] and the Queensland Spatial Excellence Awards [8].

EVIDENCE OF IMPACT

[1] Krishan Sharma, “Roames is game to boost STEM interest”, The Australian newspaper, 8 March 2016

[2] 2014 Fugro Annual report

[3] BRIDGET CARTER, “Ergon's tree-watch system Roames could reap $40m in sale”, The Australian. September 17, 2013

[4] 2015 Fugro Annual report

[5] 2016 Fugro Annual report

[6] Fugro press release, FUGRO SUPPORTS ERGON ENERGY’S RESPONSE TO CYCLONE WITH ROAMES TECHNOLOGY, 18 Mar 2015

[7] Fugro press release, FUGRO’S ROAMES SERVICE WINS PRESTIGIOUS INDUSTRY HONOUR, 10 Jun 2015

[8] 2015 Ergon Annual report

[9] Byron Connolly, “Fugro Roames recruits drones to help scan power lines”, CIO Australia from IDG

Associated research

(Briefly describe the research that led to the impact presented for the UoA. The research must meet the definition of research in Section 1.9 of the EI 2018 Submission Guidelines. The description should include details of:
- what was researched
- when the research occurred
- who conducted the research and what is the association with the institution)

In 2009, QUT’s research, in collaboration with the CRC for Spatial Information & Ergon Energy, began with experimental data collection and a survey of pilots. This identified that aerial survey pilots found it challenging to fly over infrastructure for long periods of time, flying unsatisfactory paths resulting in poor data. These shortcomings motivated research into aircraft automation for infrastructure inspection to answer:
1: How to plan the inspection sequence for a large powerline network?
2: How to safely & reliably automate precision aircraft inspection flight above powerlines?
Inspired by the resilience of missile guidance architectures and biologically-inspired metaheuristics for complex optimization problems, a novel multi-layered automation architecture approach was investigated (2009-10). New automation techniques were investigated to achieve the 3 functions of i) state-wide inspection flight planning, ii) precision aircraft control & iii) infrastructure sensing. Importantly, the created technology was amenable for use in civilian airspace by non-experts through integration with existing commercial aircraft technology. Validation of the created approach was undertaken through flight tests over powerline infrastructure utilising a flight test aircraft (2010) before a concept demonstrator was created (2011-12) and the technology was licenced to ROAMES. During 2011-14, further control & planning technology was invented & patented for further capability.

FoR of associated research

(Up to three two-digit FoRs that best describe the associated research)

09 - Engineering

References (up to 10 references, 350 characters per reference)

(This section should include a list of up to 10 of the most relevant research outputs associated with the impact)

[1] Bruggemann Troy, Ford Jason J and Walker Rodney (2010) Control of Aircraft for Inspection of Linear Infrastructure. IEEE Transactions on Control System Technology, 19(6), p.1397-1409. DOI:10.1109/TCST.2010.2093937

[2] Bruggemann Troy & Ford Jason J (2011) Compensation of Unmodeled Aircraft Dynamics in Airborne Inspection of Linear Infrastructure Assets. In I. Mareels (Eds). Proceedings of the 1st Australian Control Conference 2011. Paper presented at 1st Australian Control Conference (AUCC), Melbourne, Australia (pp.148-154). Australia, Engineers Australia.

[3] Bruggemann Troy and Ford Jason J (2011) Guidance of Aircraft in Periodic Inspection Tasks. In I. Mareels (Eds). Proceedings of the 1st Australian Control Conference 2011. Paper presented at 1st Australian Control Conference (AUCC), Melbourne, Australia (pp.445-451). Australia, Engineers Australia.

[4] Li Zhengrong, Bruggemann Troy, Ford Jason, Mejias Luis and Lui Yuee (2012) Toward automated power line corridor monitoring using advanced aircraft control and multisource feature fusion. Journal of Field Robotics, 29(1), p.4-24. DOI:10.1002/rob.20424

[5] Bruggemann Troy and Ford Jason J (2013) Automated Aerial Inspection Guidance with Improved Turn Planning. In V. Sreeram (Eds) Proceedings of the 3rd Australian Control Conference 2013. Paper presented at 3rd Australian Control Conference (AUCC), Perth, Australia (pp.282-288). Australia, Engineers Australia. DOI:10.1109/AUCC.2013.6697286

[6] Techakesari O, Bruggemann T & Ford J (2013) Control of infrastructure inspection aircraft vertical dynamics in the presence of thermal disturbances. In V. Sreeram (Eds) Proceedings of the 3rd Australian Control Conference 2013 (AUCC), Perth, Australia (pp.34-40). Australia, Engineers Australia. DOI:10.1109/AUCC.2013.6697244

[7] Mejias, Luis, Lai, John, & Bruggemann, Troy (2015) Sensors for missions. In Valavanis, Kimon P. & Vachtsevanos, George J. (Eds.) Handbook of Unmanned Aerial Vehicles (pp.385-399)Dordrecht, Netherlands, Springer. DOI:10.1007/978-90-481-9707-1_6

[8] Patent WO2015081383A1, Bruggemann and Ford, METHOD AND APPARATUS FOR DEVELOPING A FLIGHT PATH, 2015
CA2969552A1 (Canada), EP3077881A1 (Europe), US20160299506 (US), 2014360672 (Australia)

Additional impact indicator information

Additional impact indicator information

(Provide information about any indicators not captured above that are relevant to the impact study, for example return on investment, jobs created, improvements in quality of life years (QALYs). Additional indicators should be quantitative in nature and include:
- name of indicator (100 characters)
- data for indicator (200 characters)
- brief description of indicator and how it is calculated (300 characters).)