UKRI TAS NODE IN FUNCTIONALITY

Annual Report **2022**

UKRI TAS NODE IN FUNCTIONALITY | **br**l Bristol Robotics Laboratory | University of BRISTOL | UKRI UK Research and Innovation

Contents

Executive summary

Over the last 12 months the UKRI Trustworthy Autonomous Systems (TAS) Node in Functionality has continued to push forward with our exploration of how creating autonomous systems with the ability to adapt, or evolve their functionality, changes how we specify, design, verify, validate, trust and regulate these systems.

We have been working closely with our project partners to understand the broader contexts under which autonomous systems need to operate and to develop frameworks for adaptive autonomous systems. Highlights include collaborating with Ocado Technology to develop trustworthy soft grippers which we are testing using their robot arms in the SoftTAS-Ocado research bay at the Bristol Robotics Laboratory (BRL). At BRL we have also been developing a swarm arena testbed in collaboration with Toshiba Bristol Research and Innovation Laboratory to test swarm technologies. In addition, we have been working in partnership with data scientists from LV=General Insurance to understand ethical considerations and regulations for machine learning algorithms in the real world.

We have also been working with other Nodes and the Hub as part of the wider TAS programme. This has included writing a joint paper with authors from all the other parts of the programme 'On specifying for trustworthiness' as the outcome of a workshop we ran at the first TAS All Hands meeting. We have been working with TAS Node in Resilience to use and develop modifications to their assurance of machine learning in autonomous systems (AMLAS) process to make it suitable for swarm systems, and with the

Governance and Regulation Node to respond to a call for evidence for government on the approach to regulating AI. In addition, we are collaborating on a TAS Hub Integrator project on 'Safety and desirability criteria for AI-controlled aerial drones on construction sites', with our project partner Foster + Partners.

This work has been supported by the development of strong internal communications, facilitated by series of regular meetings, seminars and workshops across all parts of the node, creating many levels of communication between Early Career Researchers, academics, PhD students, project partners and our external advisory board. Over the past 12 months these interactions have resulted in involvement in 7 conferences, 7 engagement activities with industry and the public, and 16 publications, with many more outputs in progress for the coming year.

Dr Shane Windsor
Functionality Node PI

1. Introduction to the UKRI TAS Node in Functionality

Objectives

In this research programme we are developing a Design-for-Trustworthiness framework for adaptive autonomous systems. This considers the technical aspects of autonomous system design and also the broader contexts under which they need to operate.

We are developing three different technologies, with very different methods of adaptation, and using these to focus the development of our methods for ensuring autonomous systems are safe, reliable, resilient, ethical and trustworthy.

The objectives of the TAS Functionality Node are to:

- Investigate how evolving functionality (adaptation) influences how autonomous systems need to be specified, designed, verified, validated, curated and regulated.

- Develop a 'Design-for-Trustworthiness' framework for evolving systems.

- Use these techniques to develop trustworthy autonomous technologies with evolving functionality.

- Create best-practice guidance for autonomous systems with evolving functionality.

Work Packages

The Node is structured around seven work packages (WPs), three focusing on developing technologies with different methods of adaptation (Swarm Robotics, Soft Robotics, and Uncrewed Air Vehicles), and four focusing on 'Design-for-Trustworthiness' considerations for evolving autonomous systems (Specification, Ethics, Regulation and Verification).
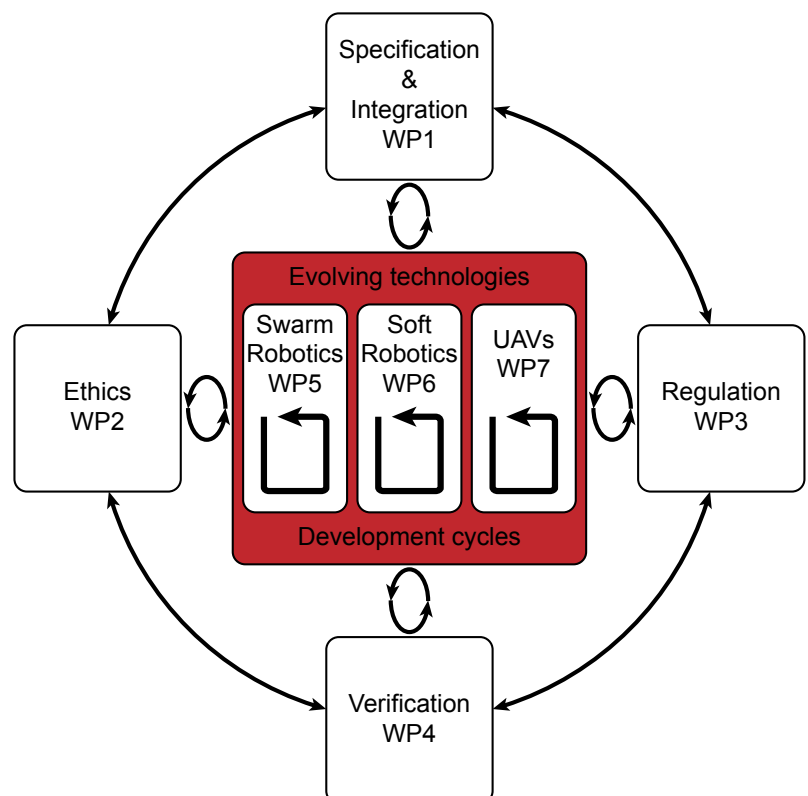
The Team

Academic Leads

Dr John Downer
Senior Lecturer
in Risk and
Resilience

Prof. Kerstin Eder
Professor of
Computer
Science

Dr Sabine Hauert
Associate
Professor in
Swarm Engineering

Prof. Jonathan Ives
Professor of
Empirical
Bioethics

Prof. Johnathan Rossiter
Professor
of Robotics

Dr Shane Winsor
Associate Professor
of Bio-Inspired
Aerodynamics

Researchers

Dr Dhaminda Abeywickrama
Research Fellow
in Specification of
Autonomous Systems

Dr Sergio Araujo-Estrada
Senior RA in
Unmanned
Air Vehicles

Dr Greg Chance
Research Fellow
in Verification of
Autonomous Systems

Anthony Le
RA in
Soft
Robotics

Dr Arianna Manzini
RA in Ethics
of Autonomous
Systems

Alix Partridge
RA in
Soft
Robotics

Helen Smith
RA in
Engineering
Ethics

Dr James Wilson
RA in
Swarm
Robotics
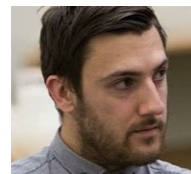
Dr Pete Winter
RA in Regulation
of Autonomous
Systems

PhD Students

Max Griffiths
PhD: Estimating
Trust in Automation
via Non-verbal
Behaviour

Suet Lee
PhD: Safety for
Robot Swarms

Matimba Swana
PhD: Investigating the ethical
and regulatory complexity of
in-human testing of robotic
nanoswarms

Project Manager

Katie Drury

Project partners and the TAS Node team at the Autumn 2022 Advisory Board meeting at Bristol Robotics Laboratory

Project Partners

Our project partners have supported our research programme since the kick-off in 2020. Collectively the partners form our **Strategic Advisory Committee**, where their role is to consider the Node's activities and provide a real-world/industry perspective on the research. They offer invaluable guidance and feedback based on their fields of expertise. Many of the partners also support our work by providing access to their facilities and equipment to support our experimental work and events. Other partners host researchers on industrial placements and many of them are directly involved in supervising our projects.

We are extremely grateful to be supported by the following companies and individuals:

Companies

- BT Applied Research
- Burges Salmon
- Dstl
- Foster + Partners
- LDRA Ltd
- LV= General Insurance
- Ocado Technology
- Olympus Surgical Technologies Europe
- Rovco Ltd
- Thales UK Ltd
- Toshiba Europe Ltd

Individual representatives

- Professor Simon Gregory (until 2022)
- Dr Martyn Thomas

Project Partner Highlights

OCADO TECHNOLOGY

The Functionality Node's SoftTAS group has been collaborating with Ocado Technology to develop a design framework for trustworthy soft grippers in the industrial grocery setting. Ocado Technology's robotic experts are part of the project's industrial advisory board offering top-level context and business applications in soft robotic grasping. Ocado Technology has provided two UR10 arms to evaluate the performance of trustworthy grippers developed according to the proposed design framework.

The SoftTAS group has visited Ocado's Erith fulfilment centre to see its technology systems in use from the storage and retrieval bots to human packing. This visit provided valuable context for the research to better address the grocery handling challenges. Discussions with senior management and engineers at Ocado Technology have provided an insight into the company's existing system architecture and how our research work could help drive efficiencies.

Back at the Bristol Robotics Laboratory (BRL), a SoftTAS-Ocado research bay was set up dedicated to the development of technologies which could benefit Ocado Technology in the future. This facilitates further collaboration and could result in many exciting research projects with real commercial impacts.

SoftTAS group visit to Ocado's Erith fulfilment centre

LV= General Insurance (LV= GI)

LV= GI have been working in partnership with researchers from the TAS Functionality Node, University of Bristol's Trustworthy Systems Lab (TSL) and Bio-Inspired Aerodynamics Engineering group to understand the commercial concerns of trustworthiness of AI and autonomous systems, as well as the ethical considerations of using these systems in the real world. Discussions have resulted in an understanding of the regulations that the insurance sector must follow, which includes the need for transparency of machine learning algorithms and a need to clearly demonstrate decisions that these systems make to regulators. LV= GI also discussed their plans for AI with evolving functionality, where risk models are updated on a regular basis as new information is fed into training pipeline.

David Hopkinson (Lead Data Scientist at LV) also presented a talk on 'Ethical AI in practice' at the University in May 2022 discussing governance and risk analysis of AI in the insurance sector.

Merve Alanyali, Head of Data Science Academic Partnerships and Research at LV= General Insurance commented:

"

Our relationship with the TAS Functionality Node is very valuable in expanding our knowledge and understanding of building trustworthy AI systems. Our knowledge exchange sessions have been both inspiring and insightful, and these conversations help us to be ahead of the approaches we need to ensure trust in applications of AI from a wide range of sectors.
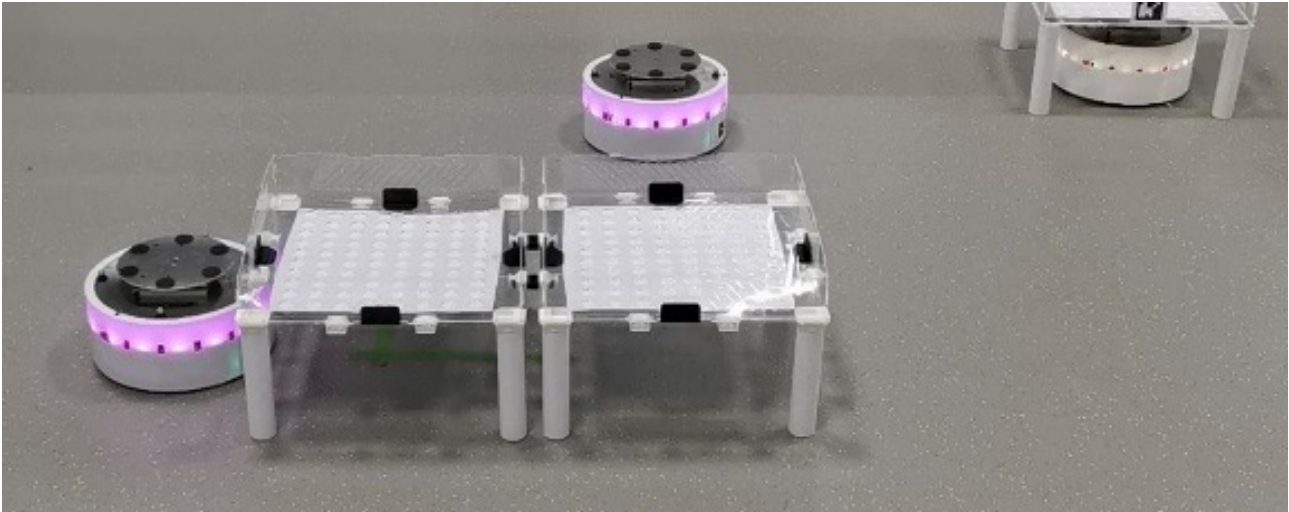
TOSHIBA BRIL

Toshiba Bristol Research and Innovation Laboratory (BRIL) has been working with the TAS Functionality Node Swarm Team to develop the DOTS arena testbed. This space allows the research team to execute hardware experiments, testing swarm algorithms and methodologies with real robots acting in a fully distributed manner. The facilities within the swarm area allow the research team to gain ground truth information from the agents and execute in depth monitoring and analysis of robot behaviour, giving insight to the trustworthiness of the systems that are being tested. The project is a sub-component of the wider Umbrella Project (funded by SGC/WECA and Toshiba), exploring the use of IIoT (including 5G) connected networks for intralogistics and smart city monitoring purposes. A digital twin of the testbed is integrated on the Umbrella Portal, allowing remote access to verify the behaviours in simulations followed by algorithm deployment on real robots.

Tim Farnham, Chief Research Fellow, Toshiba BRIL said:

"

The collaboration with the TAS Functionality Node Swarm Team has permitted the acceleration of swarm robotics research through creation of a proving ground for researchers to evaluate the performance and trustworthiness of swarm robotics in real-world use-cases. The facility has gained significant interest throughout the world and is being continuously extended and enhanced to support new use-cases and technologies that will be essential for successful commercial deployment of swarm systems. We believe that this partnership provides a unique opportunity and facility that bridges the gap between the academic swarm research and industrial deployment, and are actively encouraging other organisations to join us in the journey and learning experience.'

2. **Work** package updates

WP1: Design-for-Trustworthiness: Specification

https://tasfunctionality.bristol.ac.uk/specification/

Shane Windsor   **Kerstin Eder**   **Dhaminda Abeywickrama**
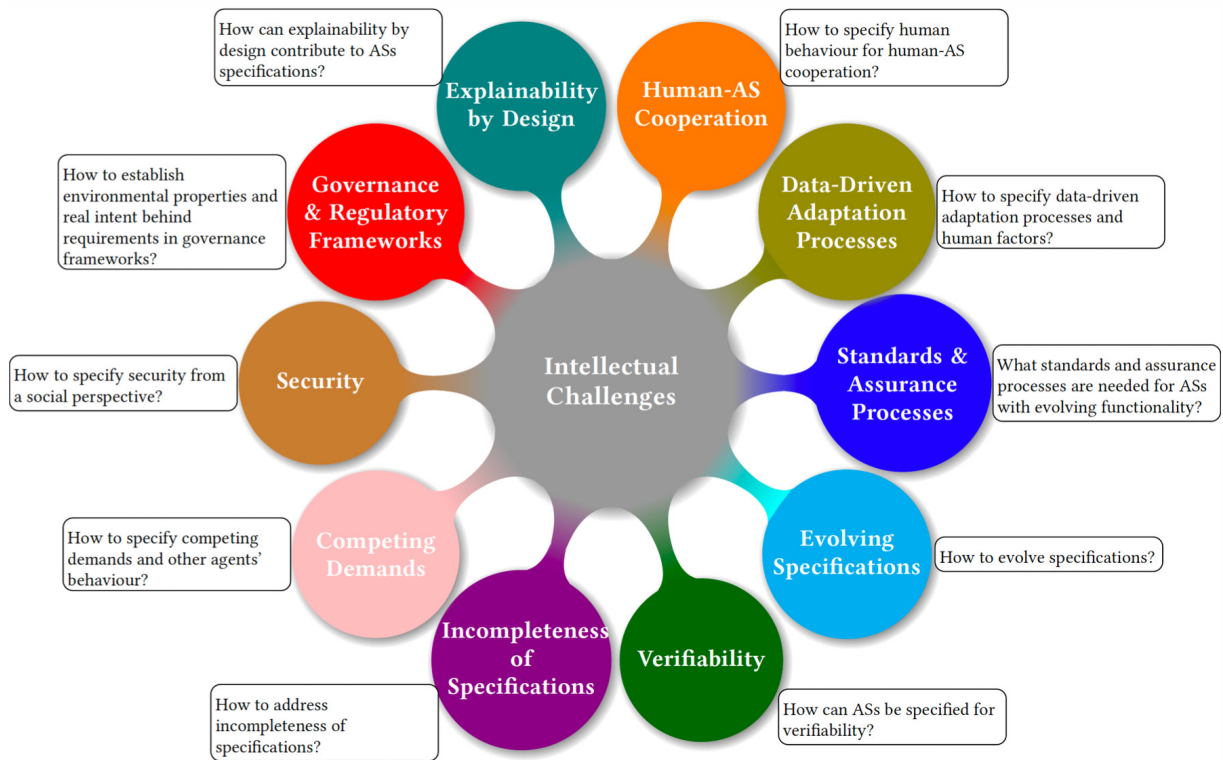

Objectives

- **Consider how we can specify and monitor systems with the ability to evolve their functionality**

- **Develop methods for specifying and monitoring technologies across Work Packages 5-7**

- **Explore the ethical, regulatory and verification implications of different specification and monitoring methods**

- **Promote non-functional requirements (e.g. trustworthiness) to first-class design objectives**

Highlights

- A Specification Challenges workshop was held with members of the TAS Hub network resulting in an academic paper 'On specifying for trustworthiness'

- The specification for trustworthiness for a soft robotic gripper was proposed that included functional and non-functional properties, based on a review of standard (with Ocado)

- A framework was developed for safety assurance for autonomous UAV flight control systems with evolving functionality based on assurance of machine learning in autonomous systems (AMLAS) process and existing safety-critical standards (with Visiting Prof. Alvin Wilby)

- A new framework for assurance of swarms including safety and non-functional considerations was proposed (with the TAS Node in Resilience)

How can explainability by design contribute to ASs specifications?

Explainability by Design

How to specify human behaviour for human-AS cooperation?

Human-AS Cooperation

How to establish environmental properties and real intent behind requirements in governance frameworks?

Governance & Regulatory Frameworks

Data-Driven Adaptation Processes

How to specify data-driven adaptation processes and human factors?

How to specify security from a social perspective?

Security

Intellectual Challenges

Standards & Assurance Processes

What standards and assurance processes are needed for ASs with evolving functionality?

How to specify competing demands and other agents' behaviour?

Competing Demands

Evolving Specifications

How to evolve specifications?

How to address incompleteness of specifications?

Incompleteness of Specifications

Verifiability

How can ASs be specified for verifiability?

Credit: iStock: sarawuth702

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What excites you the most and what is your biggest fear about living in a world of autonomous systems?

technological advancement
addressing inequality
healthcare potential
malevolent use
wide benefits to all
possible software errors
more free time
lack of empathy
liability
privacy
uncertainty
potencial
robot overlords
may be safer
helpful
enhancing humanity
problems of utopia
overpowering humans
lack of human control

Scoping Lit Review

Ethical Analysis

Design for Trustworthiness

Empirical Work with Developers

Empirical Work with Publics

WP2: Design-for-Trustworthiness: Ethics

https://tasfunctionality.bristol.ac.uk/ethics/

Jonathan Ives

Arianna Manzini

Helen Smith

Matimba Swana

Objectives

- **Determine ethical issues/concerns around trust and trustworthiness in autonomous systems with evolving functionality**

- **Identify possible solutions based on literature recommendations**

- **Conduct an empirical qualitative study to investigate how evolving functionality affects understandings of, and ethical concerns around, trust and trustworthiness in autonomous systems among developers, end users, and other stakeholders**

Highlights

- The main ethical concerns related to trust in autonomous systems with evolving functionality were identified in a scoping literature review

- An ethnographic study was conducted with TAS developers

- Qualitative interviews were held with stakeholders (developers, end users and project partners)

- The Ethics research team contributed to cross-project papers on ethical specification requirements, verification of trustworthiness and trust in swarms

- The team led on two public outreach events in the city of Bristol, as well as a BBC radio interview

WP3: Design-for-Trustworthiness: Regulation

https://tasfunctionality.bristol.ac.uk/regulation/

John Downer

Pete Winter

Helen Smith

Objectives

- **Understand the regulatory dimensions of autonomous systems with evolving functionality**

- **Examine how engineers go about developing autonomous systems in relation to existing or new regulation**
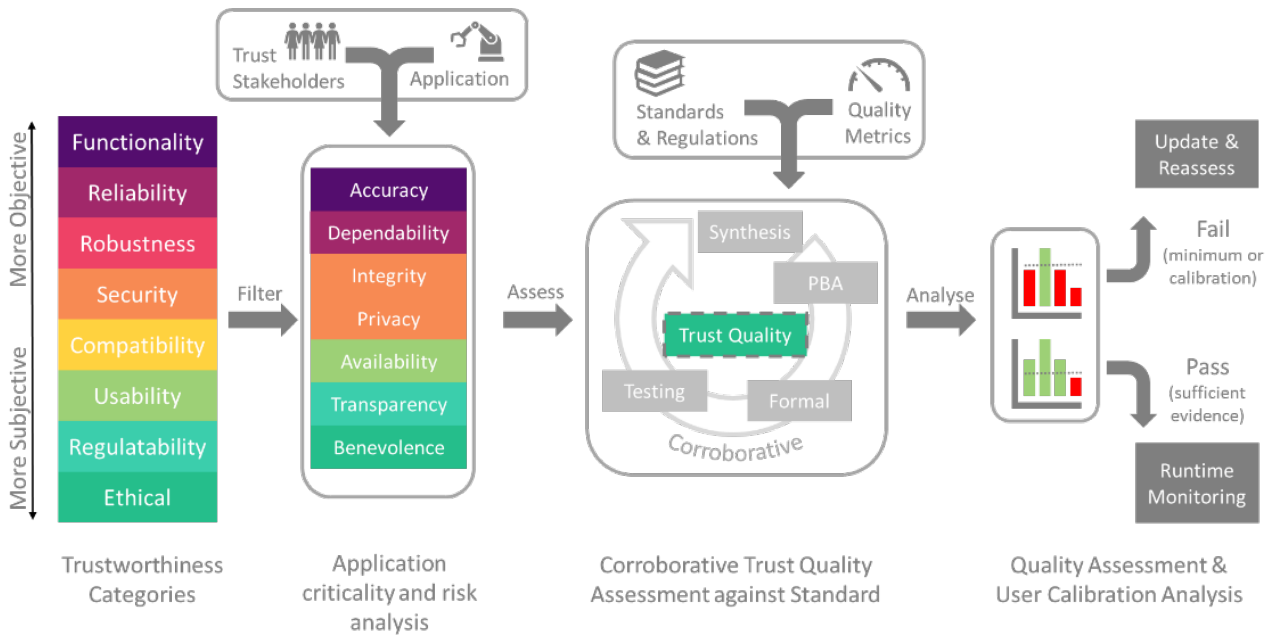
Highlights

- Seven Wicked(ish) problems of regulating autonomous systems were identified across eight key domains following interviews with project partners and a regulatory mapping exercise

- The role of vertical integration in the production of engineering knowledge was explored, focussed on UAVs

- The team responded to a call for evidence for government on the approach to regulating AI (with TAS Governance Node)

- Public engagement materials focussing on trust in robotics were developed and presented at public exhibitions in the city of Bristol

- The researchers contributed to papers on specifications, verification of trustworthiness and trust in swarms

The SUFFICIENT SAFETY problem

How SAFE is SAFE? Should SELF-DRIVING cars be REQUIRED to be...

a As safe as average human drivers

b Much safer than average human drivers

Photo credit: Gert Myers

Trust Stakeholders · **Application**

Standards & Regulations · **Quality Metrics**

More Objective
More Subjective

Trustworthiness Categories
Functionality
Reliability
Robustness
Security
Compatibility
Usability
Regulatability
Ethical

Filter →

Accuracy
Dependability
Integrity
Privacy
Availability
Transparency
Benevolence

Assess →

Synthesis
PBA
Trust Quality
Testing
Formal
Corroborative

Analyse →

Update & Reassess

Fail
(minimum or calibration)

Pass
(sufficient evidence)

Runtime Monitoring

Trustworthiness Categories

Application criticality and risk analysis

Corroborative Trust Quality Assessment against Standard

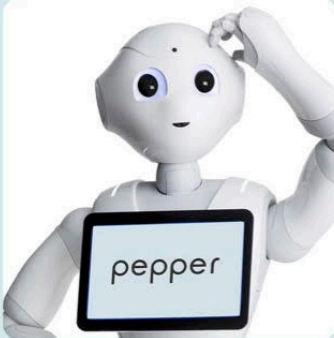Quality Assessment & User Calibration Analysis

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Friday 27th May 2022

Talk begins 8pm
zoom link available via Facebook or email

TEIGNMOUTH SCIENCE CAFÉ

Trust Me, I'm a Robot: Should we trust autonomous systems and can we use AI to test how safe they are? Dr Greg Chance

pepper

In this talk you will learn about cutting edge research at Bristol University into the verification of autonomous systems. Greg will discuss the recent tools and techniques developed at the Trustworthy Systems Lab that help to ensure automated systems, like self-driving cars, are well tested before they are released into public spaces, like our road networks. You will hear about the concept of trust for automated systems and how we can measure this objectively. There will also be a discussion on the consequences of when people fail to trust a system that is there to help them, or conversely, when they trust an AI system too much.

Greg Chance received the B.Sc. (Hons.) and Ph.D. degrees in physics from the University of Bath, in 2001 and 2005, respectively. He was previously at the Bristol Robotics Lab and is currently a Senior Research Associate with the Trustworthy Systems Laboratory, University of Bristol. His current research interests are simulation-based verification for autonomous systems and cybersecurity. He has ten years industrial experience researching for Oxford Instruments, and BAE Systems. Greg is a Chartered Engineer and a member of the Institute of Physics.

Twitter: @teignscicaf Facebook: Teignmouth Science Café
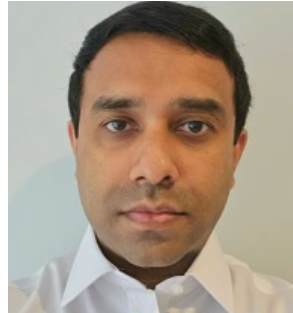
WP4: Design-for-Trustworthiness: Verification

https://tasfunctionality.bristol.ac.uk/verification/

Kerstin Eder **Greg Chance** **Dhaminda Abeywickrama**

Objectives

- **Specify requirements for trustworthy autonomous systems in a verifiable manner**

- **Investigate how evolving functionality can be verified and validated**

- **Identify design principles for verifiability**

Highlights

- Literature in trustworthiness of automation was reviewed and 'trust qualities' were analysed and prepared for publication

- Regular meetings were held with LV= General Insurance data scientists leading to better understanding of the commercial concerns of trustworthiness of AI and autonomous systems, as well as the ethical considerations of using these systems in the real world

- The team led a public outreach event on trustworthy automation

- The researchers contributed to papers on specifications, verification of trustworthiness and trust in swarms.

WP5: Adaptive technology: Swarm robotics

https://tasfunctionality.bristol.ac.uk/swarm/

Sabine Hauert

James Wilson

Matimba Swana

Suet Lee

Objectives

- **Research verifiable swarm behaviour design approaches**

- **Evaluate trustworthy swarms in a use case demonstrator**

- **Investigate implications of varying levels of functionality and robot number**

Highlights

- The swarm team have been developing an arena testbed for the DOTS swarm robots with Toshiba BRIL)

- They have determined how to issue swarm wide commands intuitively and explored how to automatically select metrics for fault detection

- Medical nano swarm stakeholder views have been collected via a PhD research project
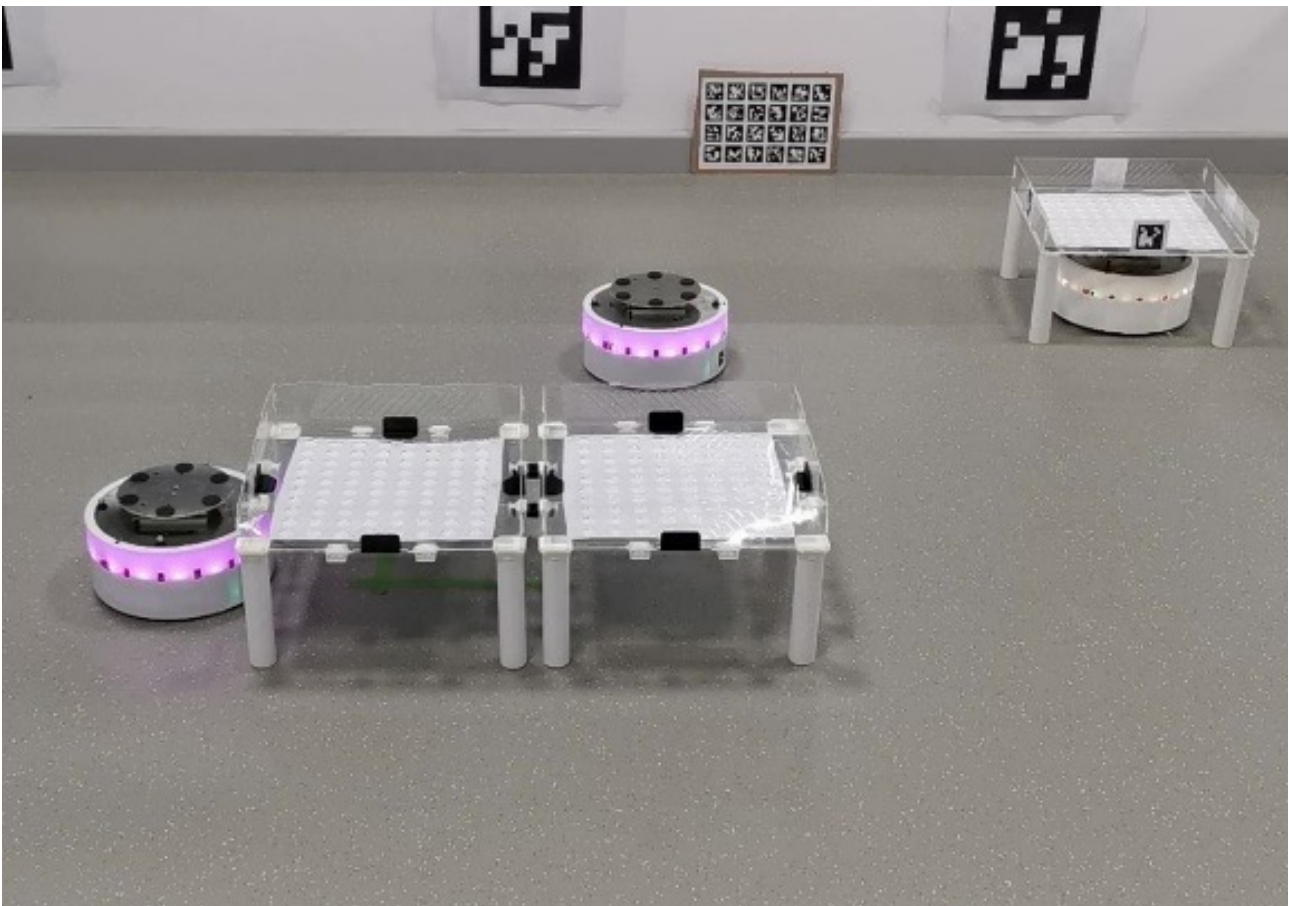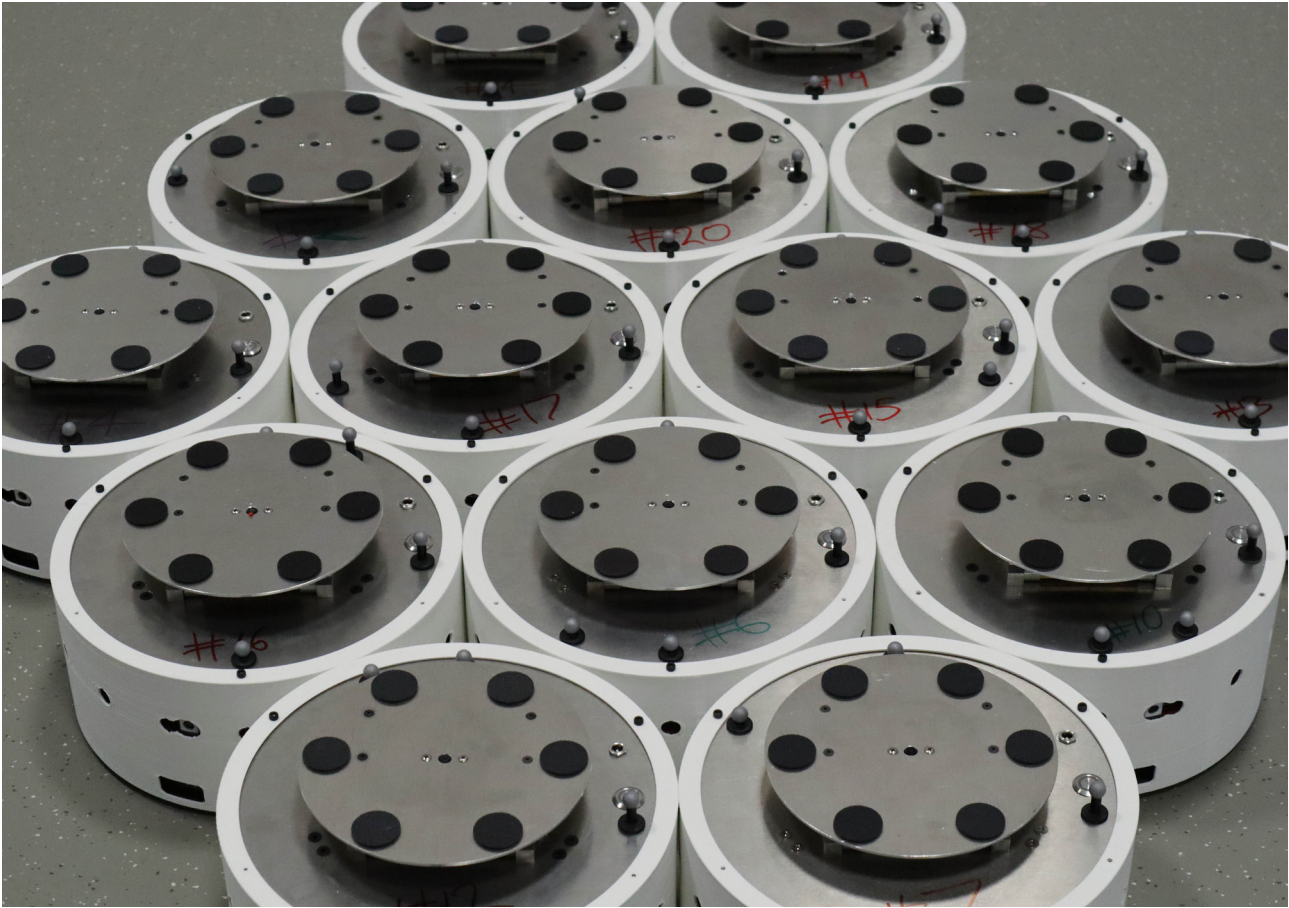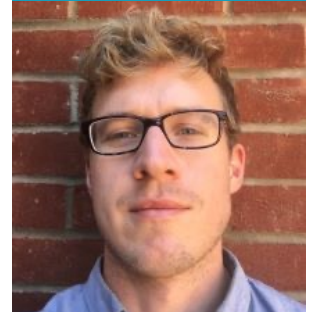
WP6: Adaptive technology: Soft robotics

https://tasfunctionality.bristol.ac.uk/soft-robotics/

Jonathan Rossiter   **Anthony Le**   **Alix Partridge**   **Max Griffiths**

Objectives

- **Develop a framework to describe trustworthiness in soft robotics systems considering the required fundamental measurements, variables and functions to produce a trustworthy calculus for soft robotics**

- **Present novel modular soft robotic applications and structures following the proposed design framework**

Highlights

- Collaboration with Ocado Technology has enabled a design framework for trustworthy soft grippers in the industrial grocery setting to be developed.

- A calculus is being developed to calculate the trustworthiness of soft robots is well underway

- Investigations of the predictability of simple soft elements (morphels) are underway

- A collaborative paper was written with the Ethics WP entitled 'ReRobot: Recycled Materials for Trustworthy Soft Robots'.

WP7: Adaptive technology: Uncrewed Air Vehicles

https://tasfunctionality.bristol.ac.uk/uav/

**Shane Windsor**   **Sergio Araujo-Estrada**

Objectives

- **Investigate strategies to produce trustworthy Uncrewed Aerial Vehicle (UAV) flight control systems with evolving functionality**

- **Explore approaches to integrate ethical and legal issues into the development phase**

- **Explore procedures to specify these systems to ensure they are trustworthy**

- **Explore strategies to verify their development and deployment**

Highlights

- Methods have been explored to improve robustness for reinforcement learning based flight control

- A specification and assurance case has been developed for a flight control system with machine learning (ML) components (with Visiting Professor Alvin Wilby)

- Hybrid controller with ML components monitored by conventional approaches

- Collaborating in a TAS Hub Integrator project on 'Safety and desirability criteria for AI-controlled aerial drones on construction sites', with project partner Foster + Partners
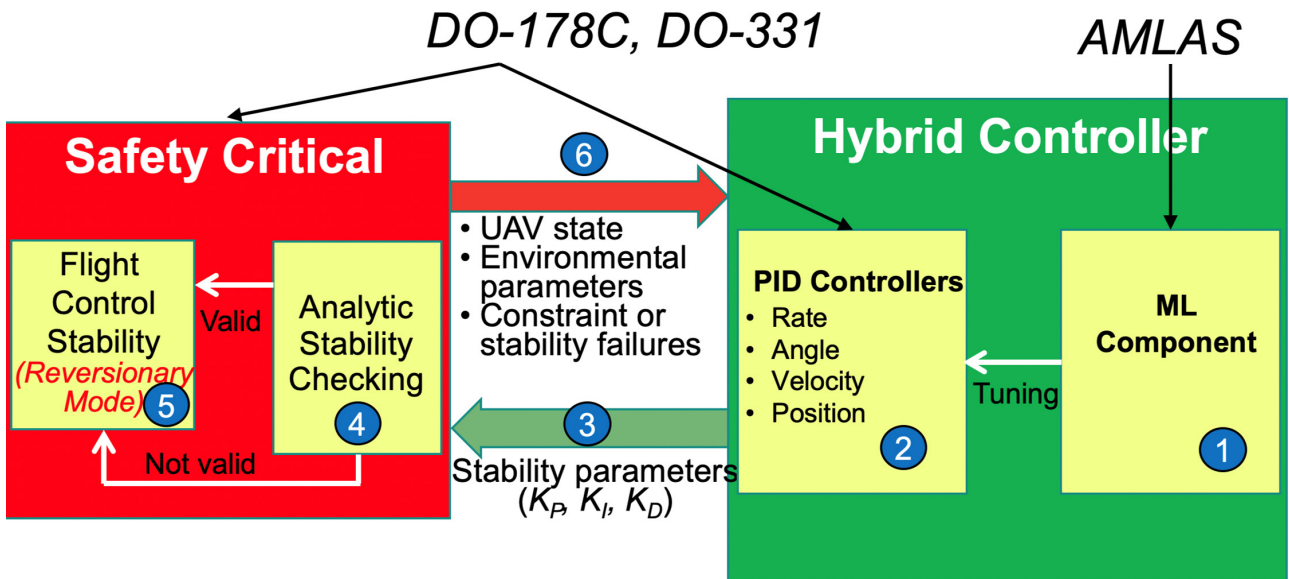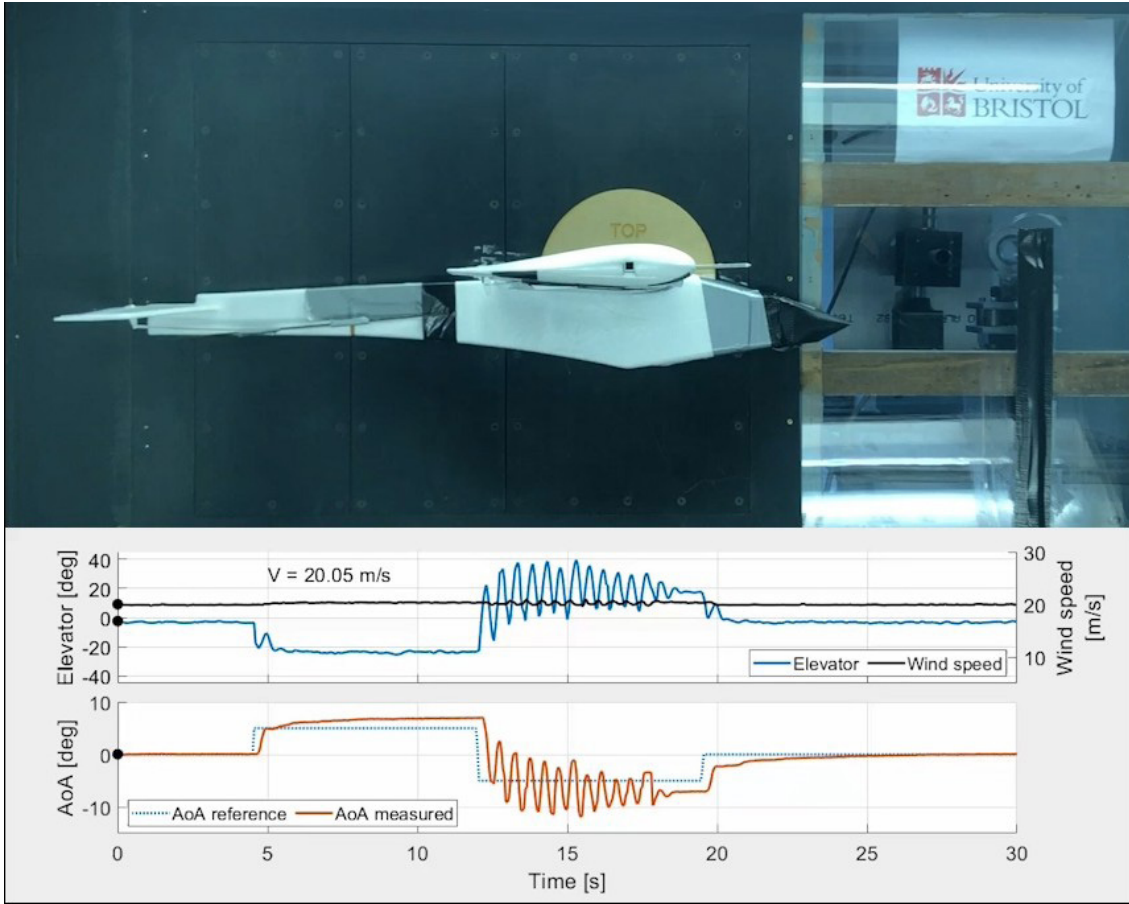
3. **Outreach** and activities

Regular activities in the Node

- **Weekly TAS Functionality Node seminars**
  involving all members where one of the team present an update on their research, give a primer on their discipline area, or provide an overview of the latest developments related to trustworthy autonomous systems. Seminars are recorded and accessible across the team.

- **Fortnightly researcher meetings**
  with the team coming together to discuss progress within the various work packages, share information, build interdisciplinary collaborations and provide general support to one another.

- **Monthly integration meetings**
  bringing together everyone to discuss opportunities for complementary research across the work packages and to discuss emerging results.

- **Monthly Leadership Team meetings**
  to monitor progress and to ensure integration of activities and research across the Node and wider TAS Hub. This includes reviewing staffing, budgets, and managing potential risks to the Node's success.

- **Seminar series**
  We convene a regular seminar series at the University focussed on Trustworthiness. Speakers include academic researchers from across the University of Bristol as well as invited external speakers, such as Node project partners or collaborators from the TAS Hub.

- **Meetings with individual project partners**
  held regularly between Node researchers and industry project partners to discuss technology development and related issues in relation to industry expertise and interests.

- **Strategic Advisory Committee meetings**
  held twice per year with representatives from each project partner, TAS Hub Node Liaison Officers and EPSRC to share Node research objectives and plans and to solicit strategic guidance, feedback and subject expertise.

- **External Advisory Board (EAB) meetings**
  An external board was established this year to complement the existing Strategic Advisory Committee. The EAB aims to gather independent feedback and advice about the Node's activities and forward plans to ensure the long-term objectives of the Node will be met. Representatives possess expertise in a wide range of robotics and autonomous systems applications and have experience leading large research programmes.

Activities within the Trustworthy Autonomous Systems (TAS) Hub

We have been actively promoting our research and working to build on collaborations with other members of the TAS Hub:

TAS All Hands Meeting and ECR Event (11-12 July 2022)

Research talks/posters:

- How should we regulate the first in-human nanoswarm cancer clinical trial? Matimba Swana

- Designing Interaction for Trustworthy Swarms, James Wilson

- Seven Wicked(ish) Problems of Regulating Autonomous Systems, Peter Winter

- Squishy, safe and ethical? An overview of ethical issues in soft robotics, Arianna Manzini

- Towards specifying for a trustworthy UAV flight control system with evolving functionality, Dhaminda Abeywickrama

- Standards and specification challenges for autonomous systems with evolving functionality – Experiences from two case studies, Dhaminda Abeywickrama

- ReRobot: Recycled Materials for Trustworthy Soft Robots, Alix Partridge.

Demos:

- Soft Trustworthy autonomous systems, Anthony Le.

Collaborative work across the TAS Hub

TAS Node in Resilience

- Our swarm and specification researchers have begun collaborating with the Assuring Autonomy Team at York University on the assurance of emergent behaviour for use in autonomous systems. Workshops will be held in Autumn 2022 and a joint paper is in development.

TAS Node in Governance and Regulation

- Researchers from our Regulations work package are currently working in collaboration with the UKRI Research Node on TAS Governance & Regulation (University of Edinburgh) and a group of multidisciplinary experts to explore how medical devices will be regulated across the UK in the future.

TAS Hub Integrator Project

- In Summer 2022 we were part of a successful bid for a project on *Safety and desirability criteria for AI-controlled aerial drones on construction sites,* a collaboration across the TAS Hub network between Southampton University, University of Bristol and external project partners, Fosters + Partners. The work will combine expertise from three disciplines, namely aeronautics, computer science, and sociology and will run over a ten-month period beginning in Autumn 2022.

TAS Hub Thought Pieces workshop

- Members of our academic leadership team participated in the TAS Hub's Thought Pieces workshop involving all TAS Nodes and industry partner Thales, aimed to generate white papers on the key challenges emerging in TAS research. The white paper focussing on 'Functionality' will be released in due course.

Engagement activities (academic)

IEEE 5th International Conference on Soft Robotics (RoboSoft)
(4-8 April 2022)
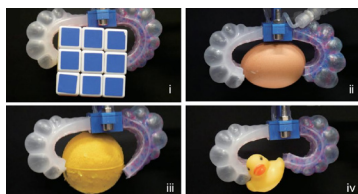
The soft robotics team presented ReRobot: Recycled Materials for Trustworthy Soft Robots. Read online at: https://doi.org/10.1109/RoboSoft54090.2022.9762170

IEEE International Conference on Robotics and Automation (ICRA 2022)
(23-27 May 2022)

James Wilson and Prof. Jonathan Rossiter represented the TAS Functionality Node at the in-person event which was attended by over 8000 researchers and industry representatives from across the globe.

SwarmHack
(13-15 June 2022)

Researchers from our swarm team participated in a three-day hackathon hosted by the Universities of York, Manchester and Sheffield. TAS Node Co-Investigator, Dr Sabine Hauert, was also a panelist during the event.

2022 International Conference on Unmanned Aircraft Systems
(21-24 June 2022)

Sergio Araujo-Estrada presented his research paper on Wind Tunnel Testing of an Avian-Inspired Morphing Wing with Distributed Pressure Sensing. Read online at: https://doi.org/10.1109/ICUAS54217.2022.9836045.

Perspectives in Hybrid Autonomous Systems Engineering (PHASE 2022) symposium
(28-30 June 2022)

Our lead academic, Prof. Shane Windsor, presented a talk on the Challenges and Opportunities Surrounding Adaptive Autonomous Systems. Node PhD student Matimba Swana participated in the poster session with her work on Robotic Nanoswarms. The event was hosted in the city of Bristol and included representatives from across the European academic and industry communities, as well as participants from UK and US government agencies.

European Association for the Study of Science and Technology (EASST) 2022
(6-9 July 2022)

Peter Winter gave a research talk on the Nine Wicked(ish) Problems of Regulating Autonomous Systems.

16th World Congress of Bioethics 2022
(20-22 July 2022)

Research papers were presented by the Node's ethics team, addressing aspects including AI in clinical decision-making, issues around the deployment of autonomous systems in healthcare and the related ethical considerations.

16th International Conference on the Simulation of Adaptive Behaviour (SAB 2022)
(20-23 September 2022)

Dr Sabine Hauert gave an invited talk on Swarms for People at this interdisciplinary conference held in Paris.

2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)
(23-27 October 2022)

TAS Node co-investigator, Dr Sabine Hauert, gave a keynote talk entitled Swarms for People at the Kyoto International Conference Center, Japan. The event, which was attended by over 3,800 on-site participants, focused on the overall theme of Embodied AI for a Symbiotic Society.

Engagement activities (industry)

Specification and Verification Challenges Workshops
(February 2022)

Our project partners participated in two workshops run by the Node in February which explored the verification and specification of trustworthy autonomous systems. Partners outlined their key challenges in these areas and the current approaches taken to address these. Discussions focussed on potential collaborative projects to better address some of the challenges raised. Following the workshops, three common lines of research were identified, and onward funding is now being sought to develop these further.

Verification Futures
(8 June 2022)

Greg Chance presented Agency-directed test generation of AV testing in simulation at the Verification Futures, a conference that addresses the challenges and opportunities in hardware and software verification with a technical audience from industry.

External engagement activities (public)

Soft Robotics Podcast
(18 February 2022)

Prof. Jonathan Rossiter was invited to take part in the Soft Robotics podcast series to discuss the state-of-the-art and future of flying micro robots and flapping wing robotics at the small scale. Listen on YouTube at: https://www.youtube.com/watch?v=PE4R30LzwXI

Teignmouth Science Café
(27 May 2022)

Greg Chance presented at this long-standing public forum that promotes public engagement with Science. His talk, which covered key aspects of trust and safety, was entitled 'Trust Me, I'm a Robot: Should we trust autonomous systems and can we use AI to test how safe they are?'

Bristol Data Science and AI Showcase
(7 June 2022)

Photo credit: Beeston Media

Our ethics researchers delivered an outreach activity focussing on the ethical and regulatory challenges of the deployment of autonomous systems. Their interactive exhibit was part of a large showcase organised by University of Bristol's Jean Golding Institute in the city of Bristol, at which the focus was on exploring the positive impacts of working together to do good with data. Node project partners were also in attendance and contributed to expert panel discussions on the future of data science and AI.
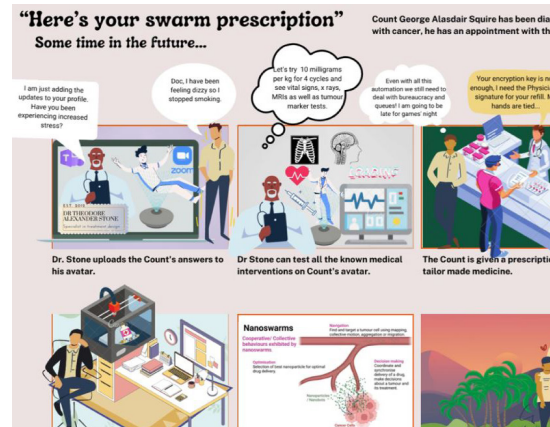
Reverse Think Tank
(13 July 2022)

This project aimed to engage the public in conversation around Responsible Innovation. TAS Node PhD student Matimba Swana created a five-minute video introducing the ethics and regulations of future nanoswarm technology for healthcare, to facilitate a 'reverse think tank' discussion with young people aged 15-18 years old

Living with AI Podcast
(10 August 2022)

A number of TAS Hub projects collaborated to create this public podcast episode, that considered whether we can trust machines to care for us. Dr Sabine Hauert discussed trustworthy light-based robotic devices for autonomous wound healing, alongside the other TAS Hub researchers.

FUTURES 2022: Schools Research Fair
(30 September 2022)
https://futuresnight.co.uk

Node researchers participated in a schools research fair at FUTURES 2022, an interactive festival of science in the UK South West region. The Node researchers focussed on trust and ethics questions in the context of autonomous systems and pupils from primary and secondary schools gave honest feedback on some of the key questions relating to autonomous technologies.

Future activities

As we enter the latter half of the TAS Functionality Node programme, we have planned several activities to communicate our findings as widely as possible, spanning academic, industry and public audiences. These include:

13th International Conference on Swarm Intelligence (ANTS 2022)

Paper accepted on Search Space Illumination of Robot Swarm Parameters for Trustworthiness (James Wilson)

16th International Symposium on Distributed Autonomous Robotic Systems (DARS 2022)

Paper accepted on Search Space Illumination of Robot Swarm Parameters for Trustworthy Interaction (James Wilson)

Global Forum in Bioethics in Research

Paper accepted on Robotic Nanoswarms (Matimba Swana)

4S/ESOCITE 2nd Joint Meeting 2022

Paper accepted on Governing AI Futures: The Wicked Dilemmas of Navigating Autonomous Systems (Pete Winter)

Logistics and Smart Infrastructure Workshop

The Node are preparing a workshop that will look at the emerging challenges for the implementation of autonomous technologies in logistics and smart infrastructure. The workshop will be supported by the TAS Hub and promoted widely to reach audiences from both within the Hub and further afield.

Somerscience festival (May 2023) South Somerset's first rural STEM festival. The swarm team are working on an exhibit focussing on Swarm Robotics.

Trust Me, I'm a Robot!

The TAS Functionality Node team have developed a suite of interactive activities aiming to increase public awareness of autonomous technologies and to discuss a range of questions the public might have in relation to trustworthiness of these, including *Would you trust a parcel-delivering drone? How do swarms of robots collaborate to complete a task? What scares you and excites you the most about living in a world of autonomous systems*? These activities will be used during 2023-24 at a range of public exhibits and showcases.

4. Publications

Abeywickrama, D. B., Bennaceur, A., Chance, G., Demiris, Y., Kordoni, A., Levine, M., Moffat, L., Moreau, L., Mousavi, M. R., Nuseibeh, B., Ramamoorthy, S., Ringert, J. O., Wilson, J., Windsor, S., & Eder, K. (2022). *On Specifying for Trustworthiness*. http://arxiv.org/abs/2206.11421

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Pulvirenti, E., Diteesawat, R. S., Hauser, H., & Rossiter, J. (2022). Towards a Soft Exosuit for Hypogravity Adaptation: Design and Control of Lightweight Bubble Artificial Muscles. *2022 IEEE 5th International Conference on Soft Robotics, RoboSoft 2022*, 651–656. https://doi.org/10.1109/RoboSoft54090.2022.9762121

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Find out more

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