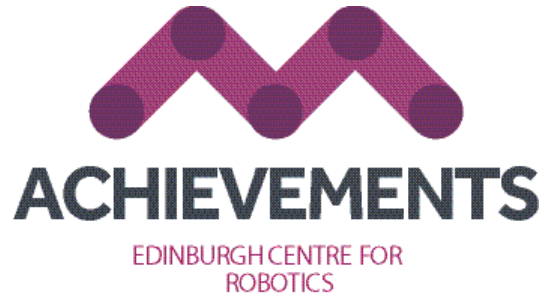


**EPSRC Centre for Doctoral Training in
Robotics and Autonomous Systems
Newsletter**

Winter 2020



Logo by Borja Marin, 2018 cohort, and winner of our Winter Logo Design Competition.



Promotions



We would like to congratulate the following staff on their recent promotions:

Dr Ramamoorthy, an academic at the University of Edinburgh has been promoted to Professor and has been awarded the position of Personal Chair of Robot Learning and Autonomy within the School of Informatics at the University of Edinburgh.

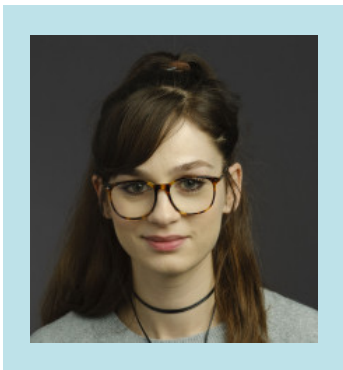
Dr Michael Mistry, a Director of the Centre who is an academic at the University of Edinburgh, has been promoted to Professor.

Dr Timothy Hospedales, an academic at the University of Edinburgh, has been promoted to Professor.

Dr Katya Komendantskaya, an academic at Heriot-Watt University has been promoted to Professor.

Dr Sen Wang, Dr Suphi Erden and Dr Xianwen Kong, academics at the Heriot-Watt University have been promoted to Associate Professors.

Summer School win for CDT student Robin Trute



Robin Trute, PhD student in the 2019 cohort, participated in the Connected Everything Summer School focused on digital manufacturing. Connected Everything is supported by an EPSRC funded NetworkPlus grant co-hosted by the Smart Products Beacon at the University of Nottingham.

The event considered the use of collaborative robots (COBOTs) in a COVID-19 world, focussing on applications in food production, healthcare and help around the home.

Students were put into teams and Robin's team came up with the winning design which was a pneumatic robot that uses pressurized air and soft tissue to protect against bruising of patients when lifting them up. You can see some clips from the summer school including Robin presenting at 7:27 [here](#).

Dr Morteza Amjadi Delivers Talk at Wearable Technologies Webinar

On 28th July, Dr Morteza Amjadi delivered an invited talk at Wearable Technologies Webinar organised by Colloquia in Intelligent Sensing, Measurement and Actuators together with the Institute of Electrical and Electronics Engineers. He presented his group's research activities on the design of soft and wearable sensors based on functional nanocomposite materials for biomedical and soft robotic applications. Dr Amjadi also shared his insights into the future of wearable sensing technologies.

At this event, the world-renowned pioneer in wearable medical devices, Professor John A. Rogers from Northwestern University, USA also presented his research on the development of flexible bioelectronic devices.



Emanuele De Pellegrin Presents Paper at ICAPS 2020

2020 cohort student Emanuele De Pellegrin presented a paper on his masters project at ICAPS 2020 titled PDSim: Planning Domain Simulation with the Unity Game Engine.

Emanuele presented both the paper and the project during the KEPS (Knowledge Engineering for Planning and Scheduling) workshop.

This is the abstract:

PDSim is an extension for the Unity game engine that adds support for simulating a classical plan through the visualisation of 3D animations of user-defined models and objects. With PDSim it is possible to define models for PDDL types and animations for actions and predicates in a 3D environment. This paper will present the main features of the PDSim system as well as its long-term goals.



ICAPS is one of the main conferences for automated planning and the KEPS workshop is the only one responsible for knowledge engineering for AI planning and scheduling.

A video of the presentation can be seen [here](#).

Papers accepted at IROS 2020 Conference

Six papers from the Statistical Learning and Motor Control Group at the University of Edinburgh involving ECR students and staff were accepted at the International Conference on Intelligent Robotics and Systems IROS 2020 conference, which was held in Las Vegas from October 25th - 29th.

Henrique Ferrolho, Wolfgang Xavier Merkt, Vladimir Ivan, Wouter Wolfslag and Sethu Vijayakumar, **Optimizing Dynamic Trajectories for Robustness to Disturbances using Polytopic Projections**, Proc. IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS 2020), Las Vegas, USA (2020). [\[pdf\]](#) [\[video\]](#) [\[digest\]](#)



This paper presents a novel formulation to optimize dynamic trajectories robust to disturbance forces and uncertain payloads. We exploit the structure induced by the kinematics of the robot to formulate a non-trivial nonlinear programming problem that would otherwise be intractable.

Theodoros Stouraitis, Lei Yan, Joao Moura, Michael Gienger and Sethu Vijayakumar, **Multi-mode Trajectory Optimization for Impact-aware Manipulation**, Proc. IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS 2020), Las Vegas, USA (2020). [\[pdf\]](#) [\[video\]](#) [\[digest\]](#)

This paper proposes an impact-aware multi-mode trajectory optimization (TO) method that comprises both hybrid dynamics and hybrid control in a coherent fashion, while impacts are considered through an explicit contact force transmission model. This enables robot manipulators to halt objects with large momentum, e.g. mass of 20kg travelling at speed of 0.88 m/s.

Songyan Xin and Sethu Vijayakumar, **Online Dynamic Motion Planning and Control for Wheeled Biped Robots**, Proc. IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS 2020), Las Vegas, USA (2020). [\[pdf\]](#) [\[video\]](#) [\[digest\]](#)

Wheeled-legged robots combine the efficiency of wheeled robots when driving on suitably flat surfaces and versatility of legged robots when stepping over or around obstacles. This paper introduces a planning and control framework to realise dynamic locomotion for wheeled biped robots. We propose the Cart-Linear Inverted Pendulum Model (Cart-LIPM) as a template model for the rolling motion and the under-actuated LIPM for contact changes while walking. Combining the two, online dynamic hybrid locomotion has been demonstrated on wheeled biped robots.

Jiayi Wang, Iordanis Chatzinikolaïdis, Carlos Mastalli, Wouter Wolfslag, Guiyang Xin, Steve Tonneau and Sethu Vijayakumar, **Automatic Gait Pattern Selection for Legged Robots**, Proc. IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS 2020), Las Vegas, USA (2020). [\[pdf\]](#) [\[video\]](#) [\[digest\]](#)

This paper presents a framework that automates gait pattern selection for legged robots, without requiring heuristics or human intuition. More specifically, the framework employs Mixed-integer Nonlinear Programming (MINLP) and a neural network model to create a mapping from task and environment specifications to optimal gait pattern selection. We have tested with a 2D half-cheetah model and the 3D quadruped robot ANYmal. Additionally, we discover qualitative similarities between state-space trajectories for a given gait pattern, which allows us to design initial guess to warm-start trajectory optimisation techniques and achieve online computation rates.

Traiko Dinev, Songyang Xin, Wolfgang Merkt, Vladimir Ivan and Sethu Vijayakumar, **Modeling and Control of a Hybrid Wheeled Jumping Robot**, Proc. IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS 2020), Las Vegas, USA (2020). [\[pdf\]](#) [\[video\]](#) [\[digest\]](#)

This paper proposes a receding-horizon approach for the control of a jumping two-wheel robot in simulation. This is done using a proposed template model for its dynamics.

Wouter Wolfslag, Christopher McGreavy, Guiyang Xin, Carlo Tiseo, Sethu Vijayakumar and Zhibin Li, **Optimisation of Body-ground Contact for Augmenting Whole-Body Loco-manipulation of Quadruped Robots**, Proc. IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS 2020), Las Vegas, USA (2020). [\[pdf\]](#) [\[video\]](#) [\[digest\]](#)

In this paper we enhance the robustness and manipulation capabilities of quadruped robots by equipping them with prongs: small legs rigidly attached to the body. We analyze the effect of the prongs on robustness, and demonstrate pushing obstacles and picking up a box with the legs of the robot.

Dr Suphi Erden presents at BioRob2020

Dr Mustafa Suphi Erden, an Associate Professor and supervisor at Heriot-Watt University presented a conference paper alongside William McColl, Djouzar Abassebay and Shaun Haldane at the IEEE International Conference on Biomedical Robotics and Biomechatronics 2020.



BioRob2020 was due to take place in New York City but was held virtually this year from November 29-December 1, 2020.

In this paper, a prototype exoskeleton is proposed to perform active finger movements to mimic a therapist for assessment of hand spasticity. Current methods for assessing spasticity are based on the subjective appreciation of physiotherapists as there is no quantifiably standardized method of evaluation and no rigorous method to record data for monitoring. For the purpose of imitating the therapist's movements and recording data pertaining to spasticity, servos are used to manipulate each joint in an index finger in a programmable and controlled way. Film type force sensors are used at fingertip to judge the maximum opening and closing capability of the patient's hand in relation to the force which would be felt by a therapist due to the patient's resistance to passive movement. Using potentiometers and positional data from the servo motors the trajectory of the finger joints is recorded in parallel to the fingertip force applied during the movement. The exoskeleton is a three degrees of freedom system which can move the index finger through an entire range of motion. The physical prototype and the software control module have been tested to validate the functionality of the mechanical structure, measuring, and recording capabilities. A GUI software tool is designed to be user friendly for the medical therapists and to produce a report document in a style familiar to them. Positive feedback was obtained from medical therapists about this initial prototype.

The eighth IEEE International Conference on Biomedical Robotics and Biomechatronics – BioRob2020 – is a joint effort of the two IEEE Societies of Robotics and Automation – RAS – and Engineering in Medicine and Biology – EMBS. BioRob covers both theoretical and experimental challenges posed by the application of robotics and mechatronics in medicine and biology. The primary focus of Biorobotics is to analyze biological systems from a "biomechatronic" point of view, trying to understand the scientific and engineering principles underlying their extraordinary performance. This profound understanding of how biological systems work, behave, and interact can be used for two main objectives: to guide the design and fabrication of novel, high performance bio-inspired machines and systems for many different applications; and to develop novel nano-, micro-, and macro- devices that can act upon, substitute parts of, and assist human beings in prevention, diagnosis, surgery, prosthetics, rehabilitation, and personal assistance.

More info:
[BioRob2020](#)

Report on our Annual Conference, October 6th 2020

Our annual conference took place online this year, and we found it to be just as engaging and diverse as ever. We were joined on Zoom by four keynote speakers, and about 100 students, staff and industry representatives.

We kicked off with keynote speaker Professor Metin Sitti from the Max Planck institute who did a talk on soft-bodied small scale robotics that featured memorable robots modelled on baby jellyfish.

Rich Walker from Shadow Robots gave an informative talk that discussed the evolution of his robotic hand company, and gave students lots of practical advice for their own business ventures.

Prof Sara Bernardini showed us some of the projects underway at Royal Holloway, focusing on Robotics in Extreme Environments. We saw robotics that perform maintenance on wind turbines, drones that can travel down boreholes and self-building platforms.



Our final Keynote speaker was Prof Maja Mataric from The University of Southern California who gave a very interesting talk titled Socially Assistive Robotics Right Now, which discussed the need for personalised embodied systems for in-home support of health, wellness, education and training.

As we were unable to have our usual post-conference dinner together, we had a virtual robot-themed cocktail/mocktail making party and contest. Cocktails created during the event included "We Love Python," "Reinforcement Blending," and "Dear Supervisor, the hydraulic oil has a strange colour". The winner was "An Robot Air Leth-Mhisg" which translates to "The Tipsy Robot" and was created by student Helmi Fraser.

Students had created padlets to showcase their research activities online and sessions were included in the programme to allow the delegates to view these and to interact with the students either via a Zoom call or by leaving comments and questions for students on their individual Padlets.

Our industry representatives judged the student padlets and awarded the prize for best padlet to Nathan Western from the 2018 cohort.

Our keynote speakers kindly reviewed the case studies submitted by our students for inclusion in our Annual Review, and awarded the prize for best case study to Emily Rolley-Parnell, a student in the 2019 cohort. Both students received gift vouchers to the value of £200.

While we would have preferred to hold the event in person, we feel this year's conference was another success thanks to the hard work and creativity of the staff and students at the Edinburgh Centre for Robotics.

Professors Helen Hastie and Yvan Petillot appointed to lead the National Robotarium



Professor Helen Hastie and Professor Yvan Petillot have been appointed as joint academic leads of the National Robotarium.

The National Robotarium, a partnership between Heriot-Watt University and the University of Edinburgh, is a world-leading centre for Robotics and Artificial Intelligence based at Heriot-Watt's Edinburgh campus. Taking a responsible and collaborative approach, its pioneering research develops new prototypes, supports early stage product development, and drives forward productivity. Key areas of research applications include power systems, manufacturing, healthcare, human-robot interaction, assisted living and hazardous environments.

Speaking on her vision for the National Robotarium, Professor Hastie said: "The National Robotarium will forge a centre of excellence for fundamental research, as well as its translation into the marketplace, leveraging the world-leading talent of the staff at the Edinburgh Centre of Robotics and the students at the Centre for Doctoral Training in Robotics and Autonomous Systems.

"There are a whole range of sectors, from healthcare to agriculture, where autonomous systems could provide valuable assistance and the research and industry-related activities of the National Robotarium will enable this."

Commenting on why the National Robotarium will accelerate the commercial development of autonomous systems, Professor Petillot explained: "Working at the interface between academia and industry, the National Robotarium will translate world-class research into new products and markets for the benefit of the UK.

"It will become a major innovation hub, working across multiple sectors and offering our staff and students the opportunity to co-create new products and businesses to support the net-zero and circular economy of the future."

Professor David Lane, the inaugural academic director, will continue his association with the National Robotarium through an ongoing position on its Scientific Advisory Board.

The National Robotarium building will open on Heriot-Watt's Edinburgh campus in 2022.

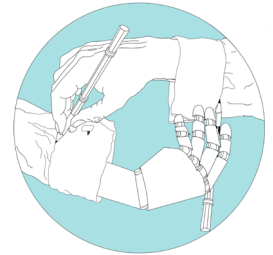
Source: <https://www.hw.ac.uk/news/articles/2020/national-robotarium-leaders.htm>

ECR Staff to lead Research Nodes as part of the UKRI Trustworthy Autonomous Systems Programme

The UK Research and Innovation (UKRI) has launched six new research projects or, “nodes” aimed at tackling challenges in the development of autonomous systems. These are part of the Trustworthy Autonomous Systems (TAS) programme which will undertake fundamental, creative and multidisciplinary research in various areas key to ensure autonomous systems can be built in a way society can trust and use.

The Edinburgh Centre for Robotics has been awarded funding for two nodes:

Professor Subramanian Ramamoorthy at the School of Informatics, University of Edinburgh will be leading the UKRI Research Node on Trustworthy Autonomous Systems (TAS) Governance & Regulation.



This research node aims to develop a novel framework for the certification, assurance and legality of TAS. This requires consideration of a range of issues from safety certification of autonomous robots to incorporating values such as fairness, accountability and responsibility in AI-driven diagnostic decisions.

The project will establish a new software engineering framework to support TAS governance, and trial them with external stakeholders in the domains of mobile autonomous systems, AI-driven diagnostics and social care. Newly developed computational tools for regulators and developers will complement the new methods of governance. In particular, this will include a deeper understanding, from multiple disciplinary perspectives, of how and why autonomous systems fail. The team also aim to improve understanding of the iterative nature of design processes associated with such technologies, and recommend ways to better govern such processes.

The Node will take a deeply inter-disciplinary approach to its work, bringing together researchers with backgrounds in Computer Science and AI, Law, AI ethics, Social Studies of Information Technology and Design Ethnography. The diverse team offers a uniquely holistic perspective that combines technical, social science and humanities research to guarantee that autonomous systems can be trusted and integrated into society with confidence.

Professor Helen Hastie from the School of Mathematical and Computer Sciences at Heriot-Watt University is leading the UKRI Trustworthy Autonomous Systems Node in Trust.

This project will explore solutions to manage trust in autonomous systems, covering scenarios that require interaction with humans. Examples include self-driving cars, autonomous wheelchairs or ‘cobots’ in the workforce. The group's work will help design the autonomous systems of the future, ensuring they are widely used and accepted in a variety of industry-relevant applications.



Professor Hastie explains: “The challenge of managing trust between the human and the system is particularly difficult because there can be a lack of mutual understanding of the task and the environment. The new consortium will perform foundational research on how humans, robots and autonomous systems can work together by building a shared reality through human-robot interaction.

“By adopting a multidisciplinary approach, grounded in psychology and cognitive science, systems will learn situations where trust is typically lost unnecessarily, adapting this prediction for specific people and contexts. We will explore how to best establish, maintain and repair trust by incorporating the subjective view of humans towards autonomous systems, with the goal being to increase adoption and maximise their positive societal and economic benefits.

“Trust will be managed through transparent interaction, increasing the confidence of those using autonomous systems, allowing them to be adopted in scenarios never before thought possible. This might include jobs that currently endanger humans, such as pandemic-related tasks or those in hazardous environments.”

Sources:

<https://www.ukri.org/news/new-trustworthy-autonomous-systems-projects-launched/>

<https://www.ed.ac.uk/informatics/news-events/stories/2020/3-2-million-project-governance-regulation-machines>

<https://www.hw.ac.uk/news/articles/2020/national-robotarium-unveils-3m-research.htm>

Congratulations to Dr Boris Mocialov



Congratulations to Dr Boris Mocialov who passed his viva on October 23rd 2020.

His thesis is entitled "Data Mining and Modelling for Sign Language"

Abstract:

Sign languages have received significantly less attention than spoken languages in the research areas of corpus analysis, machine translation, recognition, synthesis and social signal processing, amongst others. This is mainly due to signers being in a clear minority and there being a strong prior belief that sign languages are simply arbitrary gestures. To date, this manifests in the insufficiency of sign language resources available for computational modelling and analysis, with no agreed standards and relatively stagnated advancements compared to spoken language interaction research. Fortunately, the machine learning community has

developed methods, such as transfer learning, for dealing with sparse resources, while data mining techniques, such as clustering can provide insights into the data. The work described here utilises such transfer learning techniques to apply neural language model to signed utterances and to compare sign language phonemes, which allows for clustering of similar signs, leading to automated annotation of sign language resources. This thesis promotes the idea that sign language research in computing should rely less on hand-annotated data thus opening up the prospect of using readily available online data (e.g. signed song videos) through the computational modelling and automated annotation techniques presented in this thesis.

Boris' examiners were:

External - Prof. Alessandro Vinciarelli from the University of Glasgow

Internal - Dr Theo Lim from Heriot-Watt University

He will continue his research specifically on sign languages in South-Asian countries by joining the Department of Statistics and Applied Probability at the National University of Singapore.

Congratulations to Dr Jan Stankiewicz

Congratulations to Jan Stankiewicz who passed his viva on 06/11/2020.

His thesis (entitled "Using a quadcopter to model the visual navigation behaviours of flying insects") involved the development of a new flying biorobot which was used to evaluate biological hypothesis relating to the navigation strategies used by bees and wasps. He quantified the accuracy of path integration models in natural environments and introduced CWSSIM as a biologically relevant method for appearance-based navigation with insect-eye views of the world.

Jan's examiners were:

External - Professor Andy Philpides from the University of Sussex

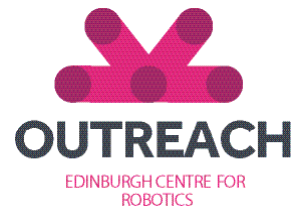
Internal - Dr. Chris Xiaoxuan Lu from the University of Edinburgh.

In December Jan will begin a 6-month contract as a research assistant for Barbara Webb at the University of Edinburgh.



Verena Rieser Presents on Chatbots

Professor Verena Rieser has been involved in a number of outreach activities including:



Speaking at the Royal Society of Edinburgh (RSE) Curious online event. The talk was titled "Designing a Feminist Alexa – An Exercise in Empathic Design and looked at the potential societal impact of anthropomorphising of chatbots and Personal Intelligence Assistants."

She was involved in an RSE online discussion as part of "RSE Investigates...AI" called How machines learn to talk. Challenges and opportunities of machine learning for Conversational AI.

In October she was interviewed by MIT Technology Review in an article called "How to make a chatbot that isn't racist or sexist" which can be found [here](#).

And in November she was interviewed by Venture Beat on metrics in conversational AI for an article called "Pandorabots' Bot Battle highlights lack of industrywide metrics for open domain AI." The article can be read [here](#).

Cocktail Hour

Finally we are pleased to reveal the winning recipe from our Cocktail/Mocktail making competition that was held during our virtual conference in October.

An Robot Air Leth-Mhisg (The Tipsy Robot) by Helmi Fraser



Ingredients

2 shots blended whisky or a single malt with a smooth and sweet profile i.e Highland Park, Auchentoshan, Arran.
1/2 shot of an Islay whisky (something peaty, anyway)
1 shot squeezed lemon juice
a few drops of squeezed orange juice
1 shot of honey-ginger syrup
ice
lemon peel
orange peel

Method

1. In a shaker put the blended whisky, lemon juice, orange juice, honey-ginger syrup and ice
2. Shake vigorously
3. strain over ice in a glass of your choice
4. Pour the peat whisky slowly over the back of a teaspoon
5. Garnish with lemon and orange peel

[View the recipe with additional animations here!](#)

Correction: In the Summer 2020 Newsletter article headed "Dr Verena Rieser features in NLP podcast", NLP stands for Natural Language Processing lab not Neuro-linguistic Programming.

[Newsletters](#) are available on our [website](#) and posted on twitter @EdinRobotics. In addition to this newsletter, information about our most recent achievements and activities can also be found in the [news](#) section on our website. Our annual reports are also available for review and download [here](#).

The centre is very active on social media and we would encourage you to follow us on Twitter @EdinRobotics to keep up-to-date with our activities.

<https://www.edinburgh-robotics.org/>



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