

# Christopher Edwin Mower

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## Education

**University of Edinburgh, *PhD Informatics***Sep 2021, **Edinburgh, UK**

Thesis: An Optimization-based Formalism for Shared Autonomy in Dynamic Environments

Supervised by Professor Sethu Vijayakumar FRSE. Affiliated with the Edinburgh Centre for Robotics

**Imperial College London, *MSc Computing (Visual Information Processing)***Aug 2016, **London, UK**

Dissertation: Objective Assessment of Surgical Dexterity

Supervised by Dr Benny Lo.

**University of Manchester, *MSc Applied Mathematics with Numerical Analysis***Aug 2015, **Manchester, UK**

Dissertation: Shrinking For Restoring Definiteness

Supervised by Professor Nicholas J. Higham FRS, and Dr Craig Lucas (NAG).

**University of Sheffield, *BSc Mathematics***Aug 2012, **Sheffield, UK**

## Experience

**Huawei Noah's Ark Lab, *Senior Research Scientist***Aug 2024—, **London, UK**

- Work in the Reinforcement Learning team with Professor Haitham Bou-Ammar at the intersection of AI and robotics. Currently investigating applications of LLMs/VLMs in embodied AI, physical law discovery, and developing robotics software/hardware.
- Leading a sub-team (currently 5 people, consisting of research engineers and interns). Collaborating with other groups in Huawei (based in UK and China), universities (based in Germany and Switzerland), and companies (based in China).
- Co-leading collaboration with Prof Marco Hutter, ETH Zurich, Switzerland, on LLM/VLM applications in loco-manipulation.
- Co-leading collaboration with Prof Jan Peters, TU Darmstadt, Germany, using LLMs/VLMs to guide robots in fast, dynamic tasks.
- Organizing workshop with Prof Wolfram Burgard, TU Nuremberg.

**Huawei Noah's Ark Lab, *Research Scientist***Aug 2023—Aug 2024, **London, UK**

- Developed ROS-LLM, a novel framework that connects ROS and an AI agent for embodied AI.
- Provided consultancy to LEJU Robotics, Shenzhen, China, a Huawei customer, and developed a humanoid demo, delivered at HDC 2024 exhibition in Dongguan, China.
- Collaborating on projects with other groups internal to Huawei in China, Canada, and France.
- Also involved with grant applications, project proposal, recruitment, procurement, and supervision of interns.

**Balgrist University Hospital, *Visiting Scholar***Summer 2023, **Zürich, Switzerland**

- Worked in the Research in Orthopedic Computer Science group with Prof. Dr. Philipp Färnstahl.
- Coordination with clinicians and engineers for cadaver specimen trials.
- Developed approaches for dual-arm collaborative surgical robotics applied to endoscopic lumbar discectomy.

**KU Leuven, *Visiting Scholar***Spring 2023, **Leuven, Belgium**

- Worked in the Robot-Assisted Surgery group with Prof. Emmanuel Vander Poorten.
- Developed approaches for keyhole surgery, utilizing visual servoing, contact rich manipulation, and optimization-based control.

**King's College London, *Research Associate for Surgical Robot Control***May 2022—Aug 2023, **London, UK**

- Worked in the RViM Lab with Professor Christos Bergeles, and CAI4CAI group with Professor Tom Vercauteren.
- Robotic surgery, human-robot interaction, imitation learning, and shared autonomy.
- Developed and implemented OpTaS library; a task specification Python library for optimal control.
- Successful funding application (70,000 GBP) to support two visiting scholar positions.
- Collaborated on the European Union Horizon 2020 FAROS project.
- Visited KU Leuven, Belgium to integrate our HRI system into a novel dual arm setup for pedicle screw fixation.
- Supervised several masters projects and mentored PhD students. Additionally, King's Undergraduate Research Fellowship supervisor.
- Public engagement: demonstrated work at New Scientist Live, ExCeL London 2022 and Royal Society, London.
- Attended surgical summer school and other workshops/training sessions, and observed live surgery.

**University of Edinburgh, *Research Associate***Sep 2021—May 2022, **Edinburgh, UK**

- Worked in the SLMC Group with Professor Sethu Vijayakumar FRSE.
- Shared control for sequencing hybrid multi-contact, dual-arm interactions.
- Developed/implemented the ROS-PyBullet Interface; bridges ROS and PyBullet (a reliable contact simulator).
- Collaborated on the European Union Horizon 2020 project HARMONY and ORCA Hub.
- Contributed to the Smart Factory projects in collaboration with the Kawada Group, Japan.
- Affiliated with The Alan Turing Institute.
- Lab demonstrator: supervisor for the course System Design Project on HRI and UX. Marking assignments, group assessments, etc.

**Numerical Algorithms Group, *Numerical software developer intern***Jun 2014—Oct 2014, **Manchester, UK**

- Analyzed and implemented the routine **G02ANF** in FORTRAN that computes a correlation matrix, subject to preserving a leading principle submatrix by applying the smallest uniform perturbation of the remainder of the approximate input matrix.
- Authored documentation and example routines for **G02ANF**, and collaborated with NAG personnel on the development of several unit and functional tests.
- Routine included in the Mark 25 NAG C and FORTRAN Libraries, and NAG Toolbox for *MATLAB*. Acknowledged as a code contributor to the NAG Library—a commercial-grade library mainly used by major banks and insurance firms.

**University of Manchester, *Research intern***May 2014—Oct 2014, **Manchester, UK**

- Implemented a Python method that computes a unit triangular matrix with prescribed singular values, unit tests, and reviewed related code. Project supervised by Professor Nicholas J. Higham FRS.

## Scholarships, Awards, and Memberships

- Two awards for “Best Individual Contribution” and “Best Open-source Contribution” at Huawei yearly event (chosen from entire London Research Center).
- Star of London, Huawei (yearly internal Huawei award for excellence).
- **King’s Global Engagement Partnership Fund (GEPF) Award**, successfully applied and awarded funding (£70,000) to support a collaboration and visiting positions at KU Leuven, Belgium, and Balgrist University Hospital, Switzerland.
- **First prize for best poster** on *Non-prehensile Dual Arm Manipulation* at the 5th IEEE UK & Ireland RAS Conference 2022.
- **First prize** for “*Greatest Potential For Positive Impact*”, Robots for Resilient Infrastructure International Challenge, UK, 2017.
- **iCASE Studentship Award**, PhD funding, University of Edinburgh, The Costain Group, and UKRI-EPSRC, 2016.
- Member of the Institute of Electrical and Electronics Engineers (IEEE).
- **Industrial Bursary Award** (£3,000) University of Manchester, Numerical Algorithms Group (NAG), 2015.
- Travel grant (£200) from London Mathematical Society for *Prospects in Mathematics*, University of Oxford, 2014.

## Publications

### Journal:

- **C. E. Mower**, Y. Wan, H. Yu, A. Grosnit, J. Gonzalez-Billandon, M. Zimmer, J. Wang, X. Zhang, Y. Zhao, A. Zhai, P. Liu, D. Tateo, C. Cadena, M. Hutter, J. Peters, G. Tian, Y. Zhuang, K. Shao, X. Quan, J. Hao, J. Wang, H. Bou-Ammar, *ROS-LLM: A ROS framework for embodied AI*, [submitted to] **Nature MI**, 2025.
- A. Mutaz Zeidan, Z. Xu, **C. E. Mower**, H. Wu, Q. Walker, O. Ayoade, N. Cotic, J. Behar, S. Williams, A. Arujuna, Y. Noh, R. J. Housden, K. Rhode, *SeptalPro: A Clinician-Evaluated Force-Sensing Robotic Transseptal Puncture System for Cardiac Intervention*, [under review], **IEEE TBME**, 2025.
- H. Tian, M. Huber, **C. E. Mower**, Z. Han, C. Li, X. Duan, C. Bergeles, *Semi-Autonomous Laparoscopic Robot Docking with Learned Hand-Eye Information Fusion*, [under review] **IEEE TBME**, 2025.
- M. Huber, H. Tian, **C. E. Mower**, C. Budd, A. Davoodi, S. Vafadar, A. Harle, E. Vander Poorten, G. Morel, C. Bergeles, T. Vercauteren, *Hydra: Stereo Imaging Approach to Unified Vision-based Robot Calibration*, [under review] **Nature BME**, 2025.
- M. Huber, **C. E. Mower**, S. Ourselin, T. Vercauteren, C. Bergeles, *LBR-Stack: ROS 2 and Python Integration of KUKA FRI for Med and IIWA Robots*, **JOSS**, 2024.

### Conference:

- **C. E. Mower**, H. Bou-Ammar, *Al-Khwarizmi: Discovering Physical Laws with Foundation Models*, [under review], **ICML**, 2025.
- H. Tian, M. Huber, **C. E. Mower**, Z. Han, C. Li, X. Duan, C. Bergeles, *Excitation Trajectory Optimization for Dynamic Parameter Identification Using Virtual Constraints in Hands-on Robotic System*, **IEEE ICRA**, 2024.
- **C. E. Mower**, M. Huber, H. Tian, A. Davoodi, E. Vander Poorten, T. Vercauteren, C. Bergeles, *Vision and Contact based Optimal Control for Autonomous Trocar Docking*, **CRAS**, 2023.
- C. Budd, J. Qiu, O. J. Maccormac, M. Huber, **C. E. Mower**, M. Janatka, T. Trotouin, J. Shapey, M. Bergholt, T. Vercauteren, *Deep Reinforcement Learning Based System for Intraoperative Hyperspectral Video Autofocusing*, **MICCAI**, 2023.
- **C. E. Mower**, J. Moura, N. Zamani Behabadi, S. Vijayakumar, T. Vercauteren, C. Bergeles, *OpTaS: An Optimization-based Task Specification Library for Trajectory Optimization and Model Predictive Control*, **IEEE ICRA**, 2023.
- A. Mutaz Zeidan, Z. Xu, **C. E. Mower**, H. Wu, Q. Walker, O. Ayoade, N. Cotic, J. Behar, S. Williams, A. Arujuna, Y. Noh, R. J. Housden, K. Rhode, *Design and Development of a Novel Force-Sensing Robotic System for the Transseptal Puncture in Left Atrial Catheter Ablation*, **IEEE ICRA**, 2023.
- **C. E. Mower**, T. Stouraitis, J. Moura, C. Rauch, L. Yan, N. Zamani Behabadi, M. Gienger, T. Vercauteren, C. Bergeles, S. Vijayakumar, *ROS-PyBullet Interface: A Framework for Reliable Contact Simulation and Human-Robot Interaction*, **CoRL**, 2022 [Links: paper, video, code].
- **C. E. Mower**, J. Moura, T. Stouraitis, S. Vijayakumar, *Shared Autonomy for Enhancing Trajectory Optimization*, **IEEE ICRA SAPHRI Workshop**, 2022 [Links: paper, talk, poster, workshop].
- **C. E. Mower**, J. Moura, S. Vijayakumar, *Skill-based Shared Control*, **R:SS**, 2021 [Links: paper, video, talk, poster].
- **C. E. Mower**, J. Moura, A. Davies, S. Vijayakumar, *Modulating Human Input for Shared Autonomy in Dynamic Environments*, **IEEE RO-MAN**, 2019 [Links: paper, pdf].
- **C. E. Mower**, W. Merkt, S. Vijayakumar, *Comparing Alternate Modes of Teleoperation for Constrained Tasks*, **IEEE CASE**, 2019 [Links: paper, pdf, preprint, video].
- W. Merkt, Y. Yang, T. Stouraitis, **C. E. Mower**, M. Fallon, S. Vijayakumar, *Robust Shared Autonomy for Mobile Manipulation with Continuous Scene Monitoring*, **IEEE CASE**, 2017 [Links: paper, pdf, video, outreach demo, press (BBC), press (Made In Leeds TV)], **First prize for “Greatest potential for Positive Impact”**.

### Pre-print:

- **C. E. Mower**, H. Yu, J. Peters, J. Wang, H. Bou-Ammar, *Optimal Control Synthesis from Natural Language: Opportunities and Challenges*, 2024.

## Skills

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- **Programming:** Most fluent in Python, then C++, MATLAB, and FORTRAN. Some experience with Lisp, and Lua.
- **Hardware:** Experience developing/implementing demonstrations and experiments using the ANYmal/ALMA Quadruped, KUKA LBR Med Arm, KUKA LWR Arm, Leju Robotics Kuavo humanoid, Kawada Nextage humanoid, Clearpath Husky UGV, xArm robot, ViperX 300s arm, Universal Robot 5 (UR5) Arm, and Robotiq 3-finger adaptive gripper. Additionally, experience setting up and integrating several sub-systems: (i) human interfaces such as the Haption Virtuouse 6D and Touch X haptic devices, several joysticks, and 3DConnexion SpaceMouse, (ii) perception sensors such as the ASUS Xtion RGBD-camera, and Bumblebee2 FireWire stereo vision camera, and (iii) motion tracking systems such as Vicon.
- **Operating systems:** Most experienced using Ubuntu, Windows, and Mac OS.
- **Libraries, packages, and frameworks:** AprilTags, Black, CasADi, CVXOPT, Eigen, Geomagic Design X, Git, Gurobi, Ipopt, Knitro, LAPACK, LCM, Matplotlib, MoveIt, NAG Library, Numpy, Onshape, OSQP, Gym Library, OpenCV, Pandas, PyBullet, PyGame, PySINDy, PySR, PyTorch, ROS/ROS2, SNOPT, StableBaselines3, Scikit-learn, Scipy, vLLM, and CoppeliaSim (V-REP).
- **Financial management, and fund application:** able to handle financial resources, prioritize tasks effectively, and make informed decisions that align with organizational goals.
- **Document preparation and code editing:** Visual Studio Code, L<sup>A</sup>T<sub>E</sub>X, Emacs.
- **Soft skills:** mentoring, public speaking, self-motivated, and open to feedback and idea exchange.

## Open Source Projects

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Alongside research, I am an advocate for high quality open source projects.

- **OpTaS** (lead) [116 stars]: an optimization-based task specification library for trajectory optimization and model predictive control. *Presented at ICRA 2023.*
- **ROS-PyBullet Interface** (lead) [84 stars]: a framework for reliable contact simulation and HRI. *Presented at CoRL 2022.*
- **HEBO** (main contributor) [3.1k stars] Bayesian optimisation & Reinforcement Learning library developed by Huawei Noah's Ark Lab Resources.
- **LBR Stack** (co-lead) [173 stars]: ROS1/2 packages for the KUKA LBR (Med/IIWA). *Submitted to the Journal of Open Source Software.*
- **pyFRI** (lead) [25 stars]: This project provides Python bindings for the FRI Client SDK C++ for KUKA IIWA/Med LBR robot arms. *Submitted to the Journal of Open Source Software.*
- **ArUCo Markers** (lead) [20 stars]: A compact Python package for handling ArUCo markers.
- **Spatial CasADi** (lead) [12 stars]: Spatial transformation library for CasADi Python.
- **EXOTica** (main contributor) [155 stars]: an optimization toolset for prototyping/benchmarking motion planning and control.
- Contributor to popular projects: movement\_primitives, bullet3, kinpy, PythonRobotics, and urdf2casadi.

## Supervision and mentoring

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I have been involved with project proposal and supervision for several PhD, MSc, and BSc students. Additionally, I have contributed significantly as a mentor to a number of PhD students (e.g. weekly progress meetings, project collaboration).

### Supervision

- J. Qiu, PhD student, TU Darmstadt, intern at Huawei.
- M. Dierking, MSc student, TU Darmstadt, intern at Huawei.
- S. Das, MSc student, Imperial College London, intern at Huawei.
- Y. Wan, PhD student, University of Leeds, intern at Huawei.
- H. Yu, MSc student, UCL, intern at Huawei.
- C. Dave, BSc student, King's College London, King's Undergraduate Research Fellowship (KURF).
- A. Esfandiari, PhD student, King's College London, MSc thesis.
- S. Zhang, MSc student, King's College London, MSc thesis.
- R. Liu, MSc student, King's College London, MSc thesis.
- H. Wang, MSc student, King's College London, MSc thesis.

### Mentoring

- M. Huber, King's College London, PhD student.
- H. Tian, Beijing Institute of Technology, exchange PhD student at King's College London.
- A. Mutaz Zeidan, King's College London, PhD student.
- M. Aoyama, University of Edinburgh, PhD student.

## Responsibilities

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- Regularly review papers: RA-L, ICRA, IROS, CASE.
- Vice President for SIAM Student Chapter, University of Manchester, Sept 2014 — Sept 2015.
- Session chair, SIAM Student Chapter Conference, 2014, 2015.
- Program Representative for MSc Group, University of Manchester, Sept 2014 — Sept 2015.
- School of Mathematics Board Member, University of Manchester, Sept 2014 — Sept 2015.
- Team Captain for University of Sheffield Badminton Club, University of Sheffield, Sept 2010 — Sept 2012.

## Training

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- Surgical and Interventional Engineering Summer School 2022 at Guy's and St. Thomas' Hospital, King's College London.
- King's NeuroLab Teaching Sessions: Posterior lumbar spine approaches, June 2022.
- First aid at work, St. Johns Ambulance.
- National Pool Lifeguard Qualification, Royal Life Saving Society.

## References

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Available upon request.