Christopher Edwin Mower

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Education

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

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	**London, UK**
MSc Computing (Visual Information Processing)	*August 2016*

Dissertation: Objective Assessment of Surgical Dexterity
Supervised by Dr Benny Lo.

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

Dissertation: Shrinking For Restoring Definiteness
Supervised by Professor Nicholas J. Higham FRS, and Dr Craig Lucas (NAG).

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

Experience

King's College London	**London, UK**
Research Associate	*May 2022 —*

- Work in the RViM Lab with Christos Bergeles, and CAI4CAI group with Tom Vercauteren.
- Robotic surgery, human-robot interaction, imitation learning, and shared autonomy.
- Collaborating on the European Union Horizon 2020 project FAROS.

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

- Worked in the SLMC Group with Sethu Vijayakumar.
- Shared control for sequencing hybrid multi-contact, dual-arm interactions.
- Developed and implemented ROS-PyBullet interface, see Projects section below.
- 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.

University of Edinburgh	**Edinburgh, UK**
Lab demonstrator	*January 2019 — June 2020*

- Supervisory role for the course System Design Project on HRI and UX. Marking assignments, group assessments, etc.

The Numerical Algorithms Group (NAG)	**Manchester, UK**
Numerical software developer intern	*June 2014 — October 2014*

- 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.

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

- Implemented a method in Python that computes a unit triangular matrix with prescribed singular values, unit/functional tests, and reviewed related code developed by PhD students at University of Manchester. Used Git/Github for source control.
- Project supervised by Professor Nicholas J. Higham FRS.

Scholarships and Awards

- **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**, University of Edinburgh, The Costain Group, and UKRI-EPSRC, 2016.
- **Industrial Bursary Award**, University of Manchester, Numerical Algorithms Group (NAG), 2015.
- Travel grant from London Mathematical Society for *Prospects in Mathematics*, University of Oxford, 2014.

Publications

Christopher E. Mower, João Moura, Theodoros Stouraitis, Sethu Vijayakumar, "*Shared Autonomy for Enhancing Trajectory Optimization*", Proc. of the IEEE ICRA Workshop on Shared Autonomy in Physical Human-Robot Interaction: Adaptability and Trust, 2022. [Links: paper, talk, poster, workshop]

Christopher E. Mower, João Moura, Sethu Vijayakumar, "*Skill-based Shared Control*", Robotics: Science and Systems (R:SS), 2021. [Links: paper, video, presentation, poster]

Christopher E. Mower, João Moura, Sethu Vijayakumar, "*Modulating Human Input for Shared Autonomy in Dynamic Environments*", IEEE RO-MAN, 2019. [Links: paper, pdf]

Christopher E. Mower, Wolfgang Merkt, Sethu Vijayakumar, "*Comparing Alternate Modes of Teleoperation for Constrained Tasks*", IEEE CASE, 2019. [Links: paper, pdf, preprint, video]

Wolfgang Merkt, Yiming Yang, Theodoros Stouraitis, **Christopher E. Mower**, Maurice Fallon, Sethu 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*", see below**]

Skills

o **Programming**: Most fluent in Python, then C++, MATLAB, and FORTRAN. Some experience with Lisp, and Lua.
o **Hardware**: Experience developing/implementing demonstrations and experiments using the KUKA LWR Arm, Kawada Nextage humanoid, Clearpath Husky UGV, Universal Robot 5 (UR5) Arm, and Robotiq 3-finger adaptive gripper. Additionally, experience setting up and integrating several sub-systems: human interfaces (i.e. joystick, space mouse), sensors (i.e. ASUS Xtion RGBD-camera, and Bumblebee2 FireWire stereo vision camera), and motion tracking (i.e. Vicon).
o **Operating systems**: Most experienced using Ubuntu and Mac OS. Some experience using Windows.
o **Libraries, packages, and frameworks**: CasADi, Eigen, Git, Gurobi, Ipopt, Knitro, LAPACK, LCM, Matplotlib, NAG Library, Numpy, Gym Library, OpenCV, Pandas, PyBullet, PyGame, PyTorch, ROS/ROS2, SNOPT, Scikit-learn, Scipy, and CoppeliaSim (V-REP).
o **Document preparation and code editing**: LaTeX, Emacs, and Vim. Some experience using Visual Studio Code.
o **Time management**: Org-mode (for Emacs).
o **Soft skills**: mentoring, public speaking, self-motivated, and open to feedback and idea exchange.

Responsibilities

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

Projects

o **ROS-PyBullet Interface** (*currently private, release planned in next several months*): a framework that provides an interface between the Robot Operating System (ROS) with a reliable impact/contact simulator Pybullet. The package can be easily used alongside physical systems, and is intended to enable easy development/prototyping of control and machine learning algorithms in contact-rich scenarios.
  - Written in Python within a ROS package.
  - I am the lead developer alongside other core contributors from the SLMC Group, University of Edinburgh. In addition, I regularly submit pull-requests and review others code.
o **EXOTica**: an extensible tool-set for inverse kinematics, trajectory optimization, and optimal control with a design advocating modularity, extensibility, and integration with ROS.
  - Written in C++ with bindings for Python.
  - Summary of my contributions: several task maps (maps joint states to some task space), modifications/additions/bug-fixes to EXOTica core functionality, and Python bindings; a facility that allows a user to interactively tune a cost function; unit/functional tests for each contribution; code reviews on others pull-requests.
  - Source control for EXOTica is done using Git/Github and leverages continuous integration.

Additional

o Professional qualifications: First aid at work (St. Johns Ambulance, UK), National Pool Lifeguard Qualification (Royal Life Saving Society, UK).
o Personal interests: Badminton (competed at county and university level, coaching experience), Guitar.

References

Available upon request.