Curriculum Vitae - Michael Burke

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Personal Statement

I have recently been appointed a Lecturer in Robot Learning and Control at Monash University, Australia. Prior to this, I was a Research Associate working on robot learning at the University of Edinburgh, from 2018-2020. Before this, I led the Mobile Intelligent Autonomous Systems group at the Council for Scientific and Industrial Research (CSIR), South Africa, where I was responsible for a team of 20 staff and students working in computer vision, machine learning and field robotics and had worked since 2009. I completed a PhD in statistical signal processing at the University of Cambridge while on a leave of absence from the CSIR between 2012 and 2016, where I developed sequential Monte Carlo tracking models for human pose estimation, and investigated pantomimic gesture recognition for human-robot interaction.

My research interests are in the development of probabilistic machine learning and computer vision tools for robotics applications. Specifically I am interested in bridging robot perception and control, by making use of probabilistic programming and leveraging advances in representation learning.

I have a broad background in robotics, data science and computer vision research and development in support of industry and government, and am equally comfortable in the many roles I am regularly called upon to fill: programmer, mathematician, engineer, manager, academic and teacher.

Education

- **University of Cambridge** — Cambridge, United Kingdom
  PhD Engineering — *2012 - 2016*
  - Thesis: Fast upper-body pose tracking for human-robot interaction
  - Supervisor: Dr Joan Lasenby
- **University of Stellenbosch** — Stellenbosch, South Africa
  MScEng. Electronic Engineering (Distinction) — *2009 - 2011*
  - Thesis: Visual servo control of a human-following robot
  - Supervisor: Dr Willie Brink
- **University of Pretoria** — Pretoria, South Africa
  BEng. Electronic Engineering (Distinction) — *2005 - 2008*
  - Undergraduate thesis: Design and construction of a fully autonomous robo-soccer robot

Academic Work Experience

- **Electrical and Computer Systems Engineering** — Monash University
  Lecturer — *Dec. 2020 -*
  - Investigating the intersection between novel sensing, machine learning and control, with applications in health and industry.
  - Teaching for the newly established undergraduate degree in Robotics and Mechatronics engineering.

- **Institute for Perception, Action and Behaviour** University of Edinburgh
  Research Associate *Oct. 2018 - Nov. 2020*
  - Developing novel robot learning from demonstration and perception algorithms for manipulation tasks and surgical robotics.
  - Managing installation and configuration of a new surgical robotics laboratory.
  - Research activities in explainable machine learning for robotics as part of the ORCA HUB, a £36 Million pound programme addressing the offshore energy industries vision of a fully autonomous energy field.
  - Student supervision and course material design.

- **Computer Science and Applied Mathematics** University of Witwatersrand
  Visiting lecturer *Aug. 2017 - Aug. 2020*

- **Mobile Intelligent Autonomous Systems** Council for Scientific and Industrial Research
  Acting Emerging Research Area Leader *Jan. 2018 - Sept. 2018*
  - Leading a team of 20 staff and students working in computer vision, machine learning and field robotics.
  - Setting and directing research agenda to ensure long term group sustainability.
  - Responsible for annual operating budget (parliamentary grant funding) of $> £1$ million.
  - Financial planning, human resource management and overseeing R&D outputs.
  - Proposing and securing contract research and development projects to support group activities.

- **Mobile Intelligent Autonomous Systems** Council for Scientific and Industrial Research
  Senior Researcher *July. 2015 - 2017*
  - Developing a probabilistic image interest and saliency prediction tool using semi-supervised machine learning and explainable AI.
  - Investigating autonomous 3D mapping systems for drone-based coastal infrastructure monitoring.
  - Mobile robot planning and exploration on manifolds in 3D space.
  - Contract R&D for agricultural and mining applications of computer vision and field robotics.

- **Mobile Intelligent Autonomous Systems** Council for Scientific and Industrial Research
  Researcher *Jan. 2009 - Apr. 2012*
  - Developed numerous data fusion applications in vision and laser-based navigation, planning and control.
  - Investigated adaptive control of tracked vehicles in highly variable terrain using proprioceptive terrain slip estimation.

Grants and Contract Funding

Royal Academy of Engineering Fellowship (£500 000 - declined for Monash lectureship) 2020
Nesta AI for Good: AI powered prosthetics (£15 000) 2020
Mining Precinct: Underground localisation and mapping (£10 000) 2018
Omnia Fertilizer: Predictive modelling for agriculture (£25 000) 2017
CSIR Young Researchers Establishment Fund: Image interest prediction (£38 000) 2016
Greta Burkill Travel Fund (£350) 2014
Rex Moir Conference Fund (£650) 2014
Bruckmann Travel Fund (£700) 2013
Rex Moir Conference Fund (£650) 2013
CSIR Cambridge Trusts Scholarship (£60 000) 2012

Awards and Achievements

Best Paper Runner-up: Conference on Robot Learning 2019 2019
Best Paper Award: Articulated Motion and Deformable Objects 2014 2014
CSIR Recognition Reward: Emerging Researcher 2013
CSIR Recognition Reward: Outstanding Contribution by a Team 2011
Best Paper Runner up: Robmech 2011 2011
CSIR Recognition Reward: Runner-up, Outstanding Contribution by an Individual 2010

Student Supervision and Teaching

I am passionate about teaching and student supervision. Although I have spent much of my career in industrial research, I have retained strong connections with universities.

- Presented numerous training workshops on probabilistic machine learning and computer vision for field robotics, including regular lectures at CSIR machine learning reading groups.
- Supervised over 20 interns and vacation work students from a broad range of backgrounds in the UK and in South Africa, a number of whom took part in a CSIR Data Science for Impact and Decision Enablement training programme.
- Practical coursework design for Decision Making for Robotics (postgraduate research course) at the University of Edinburgh.
- Co-supervised Masters (7) and PhD (1) students:
  - Mkhuseli Nxgande, **PhD, 2020** - Style transfer for bias remediation in driver drowsiness detection systems, University of Kwazulu-Natal
  - Sijie L, **MSc, 2020**, Object classification using proprioceptive force and proximity information for upper limb prostheses, University of Edinburgh
  - Windy Mokuwe, **MSc, 2020** - Probabilistic generation of convolutional neural network saliency maps, University of Pretoria
  - Ditebogo Masha, **MPhil, 2020** - Proprioceptive terrain analysis for a mobile robot, University of Johannesburg
  - Mounika Gurram, **MSc, 2019** - Surgical skill assessment from video, University of Edinburgh
  - Qihao Shan, **MSc, 2019** - Behaviour cloning from non-expert demonstrations of surgical tasks, University of Edinburgh
  - Katie Lu, **MSc, 2019** - Active viewpoint selection and motion planning for 3D reconstruction, University of Edinburgh
  - Artũras Straižys, **MSc, 2019** - Precision cutting of soft deformable materials, University of Edinburgh
- Co-supervising Masters (1) and PhD (2):
  - Zimkhitha Sijovu, **MSc** - Probabilistic graphical models for robot manipulator and camera calibration, Stellenbosch University
  - Miguel Jaques, **PhD** - Unsupervised learning with known physics priors, University of Edinburgh
  - Artũras Straižys, **PhD** - Precision cutting of soft deformable materials, University of Edinburgh

External Examining

- External course evaluation and moderation for the University of Pretoria and the University of Johannesburg (4th year and postgraduate engineering modules).
- External examiner for 2 Bachelors theses, over 15 Masters students and 2 PhD students at a range of institutions, including the University of Witwatersrand, University of Kwazulu-Natal, Stellenbosch University, the University of Johannesburg and the University of Angers in France.

Academic leadership

Reviewing and Editorial responsibilities

- Associate editor for IEEE Robotics and Automation Letters, (2020 - present)
- Reviewer for numerous conferences, journals and funding agencies, including:
  - IEEE International Conference on Robotics and Automation (2014 - 2020),
  - IEEE/RSJ International Conference on Intelligent Robotics and Systems (2014 - 2020),
  - Neural Information Processing Systems (2020),
  - International Conference on Learning Representations (2019, 2020),
  - Conference on Robot Learning (2019, 2020),
  - Proceedings of the National Academy of Sciences (2017, 2018),
  - Signal Processing Letters (2017, 2018, 2019, 2020),
  - Symposium on Robot and Human Interactive Communication (2016 - 2018),
  - International Federation of Automatic Control (2014, 2019),
  - National Research Foundation in South Africa (2016 - 2020),
  - Czech Science Foundation (2020).

Committees

- Programme chair for:
  - PRASA-RobMech 2016,
  - Women in Science Without Borders 2018,
  - 2019 Workshop on Robust Artificial Intelligence for Neurorobotics.
- Founder of the IEEE South Africa Control Systems and Robotics and Automation Joint Section Chapter (Treasurer 2010, Co-Chair 2011).
- Session chair at the
  - IFAC world congress,
  - International Conference of Robotics and Automation,
  - IEEE AFRICON.
- CSIR research ethics committee (responsible for reviewing internal unit ethics applications)
- CSIR research grant review committee (responsible for reviewing internal grant proposals)
- CSIR technology demonstrator review committee (responsible for reviewing internal technology demonstrator submissions)

Seminars and Invited Talks

- On the unreasonable effectiveness of proprioceptive sensing - 1st Scottish Online Seminar on Robots in Healthcare (2020)
- Learning with inductive biases seminar at Monash University (2019)
- Presentation and panel discussion at ACM Multimedia 2017, Mountain View, CA, USA (2017)
- Talk at Centre for High Performance Computing National Conference, South Africa (2017)
- Seminar at National Research Foundation Centre of Excellence for Mathematics and Statistical Sciences at University of Witwatersrand, South Africa (2017)
- Talk at British Machine Vision Association Student Symposium (2013)

Outreach and Engagement

- Regularly present robot demonstrations to junior, high school and university students in addition to high profile visitors and government representatives, including:
  - Minister for the Department of International Relations and Cooperation (South Africa),
  - Minister of Science and Technology (South Africa),
  - Executives from large multinational companies including Volkswagen, Anglo-American and Exxaro,
  - Members of the World Economic Forum,
  - The National Museum of Scotland.
- Provided numerous interviews for print media, online outlets and television.
- Presented seminars at science competitions for 3 South African high schools.
- Taken part in numerous initiatives targeting gender and racial transformation, including job shadowing and developmental science weeks.
- Committed to improving diversity in computer science and engineering (>45% students supervised are female, (> 70% BAME).

Research Management

- Led unit and group level strategy, setting the road-map for future research objectives and initiatives in robotics and data science,
- Helped draft numerous end-year and quarterly reports and plan group strategy with executive management.
- Representative in bilateral talks on ICT between South Africa and the Republic of Korea.
- Successfully motivated for group funding to be increased by R4 Million (£200 000) after funding cuts prior to my return to the CSIR in 2015.
- Regularly presented to industry partners to secure contract R&D funding.
- Responsible for shortlisting, interviewing and hiring a senior research scientist, a staff scientist, lab technician, 4 Masters students and numerous interns.

- Managed large robotics laboratories (Vicon-motion capture systems, GPU-rigs and servers, Cameras, LiDAR and multiple robots, including Adept Mobile Robot Pioneers, an Adept Mobile Robot Seekur platform, an iRobot packbot 510, Barret WAM, PR2, Baxter, UR10s, Franka Emika Panda, Wonnik and Shadow hands).
- Led the installation and configuration of surgical robotics lab at University of Edinburgh, including 2 Universal Robots manipulators, a Franka Emika Panda robot, ultrasound units, RGB-Depth, Force Torque and GelSight sensing.

Selected Publications

Please see Google Scholar for a full list, and for links to electronic versions of papers.

Journal Articles

Daniel Angelov, Yordan Hristov, Michael Burke, and Subramanian Ramamoorthy. Composing diverse policies for temporally extended tasks. *Robotics and Automation Letters (RA-L)*, 2020.

Martin Asenov, Michael Burke, Daniel Angelov, Todor Davchev, Kartic Subr, and Subramanian Ramamoorthy. Vid2param: Online system identification from video for robotics applications. *Robotics and Automation Letters (RA-L)*, 2020.

Mkhuseli Ngxande, Jules-Raymond Tapamo, and Michael Burke. Bias remediation in driver drowsiness detection systems using generative adversarial networks. *IEEE Access*, 2020.

Patrick Kanda, Michael Burke, and Rangan Gupta. Time-varying causality between equity and currency returns in the united kingdom: Evidence from over two centuries of data. *Physica A: Statistical Mechanics and its Applications*, 506:1060–1080, 2018.

Michael Burke and Joan Lasenby. Estimating missing marker positions using low dimensional Kalman smoothing. *Journal of Biomechanics*, 49(9):1854–1858, 2016.

Michael Burke and Joan Lasenby. Pantomimic gestures for human–robot interaction. *IEEE Transactions on Robotics*, 31(5):1225–1237, 2015.

Conference Proceedings

Artūras Straižys, Michael Burke, and Subramanian Ramamoorthy. Surfing on an uncertain edge: Precision cutting of soft tissue using torque-based medium classification. In *International Conference on Robotics and Automation (ICRA)*, 2020.

Miguel Jaques, Michael Burke, and Timothy Hospedales. Physics-as-inverse-graphics: Unsupervised physical parameter estimation from video. In *International Conference on Learning Representations (ICLR 2020)*, 2020.

Mamuku Mokuwe, Michael Burke, and Anna Sergeevna Bosman. Black-box saliency map generation using bayesian optimisation. In *International Joint Conference on Neural Networks, IJCNN 2020*.

Michael Burke, Yordan Hristov, and Subramanian Ramamoorthy. Hybrid system identification using switching density networks. In *Conference on Robot Learning (CoRL)*, 2019a.

Michael Burke, Svetlin Penkov, and Subramanian Ramamoorthy. From explanation to synthesis: Compositional program induction for learning from demonstration. In *Robotics: Science and Systems*, 2019b.

Yordan Hristov, Daniel Angelov, Michael Burke, Alex Lascarides, and Subramanian Ramamoorthy. Disentangled relational representations for explaining and learning from demonstration. In *Conference on Robot Learning (CoRL)*, 2019. (**Best paper runner-up**).

Michael Burke. A generative Bézier curve model for surf-zone tracking in coastal image sequences. In *IEEE Africon 2017, Cape Town, 18-20 September 2017*, 2017.

Michael Burke and Joan Lasenby. Fast upper body joint tracking using kinect pose priors. In *International Conference on Articulated Motion and Deformable Objects*, pages 94–105. Springer, Cham, 2014. (**Best paper)**.

Michael Burke and Joan Lasenby. Multilinear function factorisation for time series feature extraction. In *2013 18th International Conference on Digital Signal Processing (DSP)*, pages 1–8. IEEE, 2013.

Michael Burke. Path-following control of a velocity constrained tracked vehicle incorporating adaptive slip estimation. In *2012 IEEE International Conference on Robotics and Automation*, pages 97–102. IEEE, 2012.

Michael Burke and Willie Brink. Gain-scheduling control of a monocular vision-based human-following robot. In *18th World Congress of the International Federation of Automatic Control*, 2011.

Theses and Editorial Works

Michael G Burke, Regina R Maphanga, Gerhardus J Jansen van Rensburg, Alfred EJ Bogaers, and Sonali Das. *Women in Science Without Borders 2018, Resilience in Diversity: School of Tourism and Hospitality, University of Johannesburg, South Africa, 21-23 March 2018: Proceedings*. University of Johannesburg, School of Tourism and Hospitality, 2018.

Michael Burke and Deon Sabatta. *2016 Pattern Recognition Association of South Africa and Robotics and Mechatronics International Conference (PRASA-RobMech)*, volume 5. 2016.

Michael Glen Burke. *Fast upper body pose estimation for human-robot interaction*. PhD thesis, University of Cambridge, 2015.

Michael Glen Burke. *Visual servo control for a human-following robot*. Master's thesis, University of Stellenbosch, 2011.

Working Papers

Miguel Jaques, Michael Burke, and Timothy Hospedales. NewtonianVAE: Proportional control and goal identification from pixels via physical latent spaces. *arXiv preprint arXiv:2006.01959*, 2020.

Michael Burke, Katie Lu, Angelov Daniel, Artūras Straižys, Craig Innes, Kartic Subr, and Subramanian Ramamoorthy. Learning robotic ultrasound scanning using probabilistic temporal ranking. *arXiv preprint arXiv:2002.01240*, 2020a.

Michael Burke, Kartic Subr, and Subramanian Ramamoorthy. Action sequencing using visual permutations. *arXiv preprint arXiv:2008.01156*, 2020b.

Todor Davchev, Kevin Sebastian Luck, Michael Burke, Franziska Meier, Stefan Schaal, and Subramanian Ramamoorthy. Residual learning from demonstration. *arXiv preprint arXiv:2008.07682*, 2020.

Todor Davchev, Michael Burke, and Subramanian Ramamoorthy. Learning modular representations for long-term multi-agent motion predictions. *arXiv preprint arXiv:1911.13044*, 2019.