

# Graeme Best

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## EDUCATION

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**Doctor of Philosophy, The University of Sydney**, Sydney, Australia (Aug. 2014-Mar. 2018)

Australian Centre for Field Robotics

(Defence expected to be in May 2018.)

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**Bachelor of Engineering (Honours), Monash University**, Melbourne, Australia (2009-2014)

Electrical and Computer Systems Engineering

First Class Honours

GPA 4.00/4.00

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**Bachelor of Science, Monash University**, Melbourne, Australia (2009-2014)

Computer Science (Double Major) | Mathematics (Minor)

GPA 3.88/4.00

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International Exchange, **Technical University of Denmark**, Copenhagen, Denmark (2012)

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International Exchange, **Monash University**, Kuala Lumpur, Malaysia (2010)

## RESEARCH INTERESTS

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- Robotics
- Algorithms
- Planning
- Active perception
- Multi-robot systems
- Field robotics
- Decentralised algorithms
- Probabilistic methods

## RESEARCH EXPERIENCE

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Postdoctoral Scholar at **Oregon State University**, Corvallis, USA (Mar. 2018-2021)

*Robotic Decision Making Laboratory*

Supervisor: Prof. Geoff Hollinger

Project: *"Information-Aware Decision Making in Teams of Autonomous Vehicles and Humans"*

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PhD Scholar at **The University of Sydney**, Sydney, Australia (2014-2018)

*Australian Centre for Field Robotics*

Supervisors: A/Prof. Robert Fitch and Prof. Stefan Williams

Thesis: *"Planning Algorithms for Multi-Robot Active Perception"*

A fundamental task of robotic systems is to use on-board sensors and perception algorithms to understand high-level semantic properties of an environment. The performance of perception algorithms can be greatly improved by planning the motion of the robots to obtain high-value observations.

I am developing planning algorithms for these tasks with an emphasis on long planning horizons, decentralised coordination, limited communication, and general classes of perception models. I have proposed algorithms motivated by several key ideas: Monte Carlo tree search, self-organising maps, branch and bound, optimal stopping, sweep-planes, set cover, variational methods, and Bayesian inference.

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Honours Scholar at **CSIRO Computational Informatics**, Brisbane, Australia (2013)

*Autonomous Systems Laboratory*

Developed a real-time signal processing and machine learning algorithm for a six-legged robot [15].

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Vacation Scholar at **Defence Science and Technology Organisation**, Sydney, Australia (2013/14)

*Littoral Unmanned Systems Group*

Developed planning algorithms for marine robotics operations in defence applications [13]. Included several sea-trials.

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Vacation Scholar at **CSIRO ICT Centre**, Brisbane, Australia (2012/13)

*Autonomous Systems Laboratory*

Developed a teleoperation system with Android user interface and TurtleBot mobile robot [14].

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## TEACHING EXPERIENCE

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Teaching Associate at **The University of Sydney**, Sydney, Australia (2015-2017)

*Information Technologies, and Aeronautical, Mechanical and Mechatronics Engineering*

Engineering Computing (MATLAB) (×5)

Data Structures (Java) (×2)

Mechatronics 1 (C)

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Teaching Associate at **Monash University**, Melbourne, Australia (2013-2014)

*Electrical and Computer Systems Engineering*

Computer Systems (FPGA microprocessors) (×2)

Engineering Design (robotics)

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High-School Tutor at **The University of Melbourne**, Melbourne, Australia (2010-2011)

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Mathematics Tutor at **'A' 4 Maths Learning Centre**, Melbourne, Australia (2009-2013)

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## PUBLICATIONS

### Journal articles

- [1] **G. Best**, S. Huang, and R. Fitch. *Decentralised mission monitoring with spatiotemporal optimal stopping*. [Under review] IEEE Robotics and Automation Letters (RA-L), 2018.
- [2] V. Kuo, **G. Best**, and R. Fitch. *Zero mutual interference communication for multi-robot systems*. [In progress] IEEE Transactions on Automation Science and Engineering (TASE), 2018.
- [3] **G. Best**, O. M. Cliff, T. Patten, R. R. Mettu, and R. Fitch. *Dec-MCTS: Decentralized planning for multi-robot active perception*. [To appear] International Journal of Robotics Research (IJRR), 2018.
- [4] **G. Best**, J. Faigl, and R. Fitch. *Online planning for multi-robot active perception with self-organising maps*. Autonomous Robots (AURO), 2018.
- [5] **G. Best**, W. Martens, and R. Fitch. *Path planning with spatiotemporal optimal stopping for stochastic mission monitoring*. IEEE Transactions on Robotics (T-RO), 33(3), 2017.

### Peer-reviewed conference articles

- [6] **G. Best**, M. Forrai, R. Mettu, and R. Fitch. *Planning-aware communication for decentralised multi-robot coordination*. IEEE Int. Conf. on Robotics and Automation (ICRA), 2018.
- [7] **G. Best**, O. M. Cliff, T. Patten, R. R. Mettu, and R. Fitch. *Decentralised Monte Carlo tree search for active perception*. Int. Workshop on the Algorithmic Foundations of Robotics (WAFR), 2016.
- [8] **G. Best** and R. Fitch. *Budgeted maximum set cover with path constraints for informative path planning*. Australasian Conference on Robotics and Automation (ACRA), 2016. **Best student paper**
- [9] **G. Best**, J. Faigl, and R. Fitch. *Multi-robot path planning for budgeted active perception with self-organising maps*. IEEE Int. Conf. on Intelligent Robots and Systems (IROS), 2016. **RoboCup Best Paper finalist**
- [10] J. Faigl, R. Pěnička, and **G. Best**. *Self-organising map-based solution for the orienteering problem with neighborhoods*. IEEE Int. Conf. on Systems, Man, and Cybernetics (SMC), 2016.
- [11] **G. Best** and R. Fitch. *Bayesian intention inference for trajectory prediction with an unknown goal destination*. IEEE Int. Conf. on Intelligent Robots and Systems (IROS), 2015.
- [12] **G. Best**, W. Martens, and R. Fitch. *A spatiotemporal optimal stopping problem for mission monitoring with stationary viewpoint*. Robotics: Science and Systems (RSS), 2015.
- [13] **G. Best** and S. Anstee. *Motion planning for autonomous underwater vehicle supervision*. Australasian Conference

on Robotics and Automation (ACRA), 2014.

- [14] **G. Best** and P. Moghadam. *An evaluation of multi-modal user interface elements for tablet-based robot teleoperation*. Australasian Conference on Robotics and Automation (ACRA), 2014.
- [15] **G. Best**, P. Moghadam, N. Kottege, and L. Kleeman. *Terrain classification using a hexapod robot*. Australasian Conference on Robotics and Automation (ACRA), 2013.

### **Workshop articles and posters**

- [16] M. Forrai, **G. Best**, and R. Fitch. *Communication planning for decentralised multi-robot coordination*. Int. Sym. on Multi-Robot and Multi-Agent Systems (MRS), 2017.
- [17] M. Forrai, **G. Best**, and R. Fitch. *Communication planning for decentralised coordination with limited resources*. Robotics: Science and Systems (RSS) Workshop on Robot Communication in the Wild: Meeting the Challenges of Real-World Systems, 2017.

### **Theses**

- [18] **G. Best**. *Planning algorithms for multi-robot active perception*. [Near submission] Ph.D. thesis, Australian Centre for Field Robotics, The University of Sydney, Sydney, Australia, 2018.
- [19] (Co-supervised) M. Forrai. *Communication planning for decentralised multi-robot coordination*. B.E. Honours thesis, School of Aerospace, Mechanical and Mechatronic Engineering, The University of Sydney, Sydney, Australia, 2017.
- [20] **G. Best**. *Terrain classification using a hexapod robot*. B.E. final year project report, Department of Electrical and Computer Systems Engineering, Monash University, Melbourne, Australia, 2013.

## **PRESENTATIONS AND CONFERENCES**

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### **Invited talks**

- Multi-robot Systems Lab, Stanford University, Palo Alto, USA, Dec 2017
- Robotic Decision-Making Lab, Oregon State University, Corvallis, USA, Dec 2017
- Field Robotics Centre, Carnegie Mellon University, Pittsburgh, USA, Nov 2017
- ACT lab, University of Southern California, Los Angeles, USA, Dec 2016
- AMPR group, University of New Mexico, Albuquerque, USA, Dec 2016

### **Conference presentations**

- Int. Sym. on Multi-Robot and Multi-Agent Systems (MRS), USC, USA, Dec 2017 (Poster)
- Workshop on Robot Communication in the Wild, MIT, USA, July 2017 (Poster)
- The Algorithmic Foundations of Robotics (WAFR), San Francisco, USA, Dec 2016 ([https://youtu.be/A\\_ErOT2bR-I](https://youtu.be/A_ErOT2bR-I))
- Australasian Conference on Robotics and Automation (ACRA), UQ, Brisbane, Dec 2016
- IEEE Int. Conf. Intelligent Robots and Systems (IROS), Daejeon, South Korea, Oct 2016
- IEEE Int. Conf. Intelligent Robots and Systems (IROS), Hamburg, Germany, Sept 2015
- Robotics: Science and Systems (RSS), Rome, Italy, July 2015
- Australasian Conference on Robotics and Automation (ACRA), UOM, Melbourne, Dec 2014
- Australasian Conference on Robotics and Automation (ACRA), UNSW, Sydney, Dec 2013
- CSIRO ‘Big Day In’, Macquarie University, Sydney, Australia, Feb 2013

### **Other conference attendance**

- Australasian Conference on Robotics and Automation (ACRA), UTS, Sydney, Dec 2017
- Robotics: Science and Systems (RSS), MIT, USA, July 2017
- IEEE Multi-Robot Systems Summer School, National Uni. Singapore, Singapore, June 2016
- Australasian Conference on Robotics and Automation (ACRA), ANU, Canberra, Dec 2015
- NICTA Machine Learning Summer School, Sydney, Australia, Feb 2015
- IEEE Agricultural Robotics Summer School, Sydney, Australia, Feb 2015
- QUT Robotics and Autonomous Systems Winter School, QUT, Brisbane, Australia, July 2014
- DSTO Summer Vacation Scholars’ Presentation Day, Sydney, Australia, Feb 2014

## **RESEARCH SERVICE**

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- Workshop organiser: “Informative Path Planning and Adaptive Sampling”, ICRA 2018
- Coordinator for *Collaborative Decision-Making Reading Group* with ~20 members from USyd, UTS and DSTO, 2017
- Contributor for grant: “System-Level Active Perception”, 2017-2018
- Co-supervisor for Michael Forrai’s Honours thesis, 2016-2017
- Contributor for grant: ARC Discovery Project “Active Segmentation for Cooperative Mobile Robots in Outdoor

- Environments", 2014-2017
- Co-chair for Integrated Planning and Control session at IEEE IROS 2015, Hamburg
  - Volunteer at IEEE Agricultural Robotics Summer School, 2015, Sydney
  - Reviewer for:
    - Autonomous Robots
    - IEEE Robotics and Automation Letters
    - IEEE Transactions on Cybernetics
    - Journal of Systems Architecture
    - IEEE/RSJ Int. Conf. on Intelligent Robots and Systems (IROS) 2018
    - IEEE Int. Conf. on Robotics and Automation (ICRA) 2018
    - Int. Sym. on Multi-Robot and Multi-Agent Systems (MRS) 2017
    - IEEE Int. Conf. on Robotics and Automation (ICRA) 2016
  - Acknowledgement in:
    - A. Arora et al., "An Approach to Autonomous Science by Modeling Geological Knowledge in a Bayesian Framework", IROS 2017
    - B. Hefferan et al., "Adversarial Patrolling with Reactive Point Process", ACRA 2016
    - H. Dorsett, "MOOS Chat Down Under", MOOS DAWG 2015
    - J. Lee et al., "Fast Path Planning for Precision Weeding", ACRA 2014

## ACADEMIC AWARDS AND SCHOLARSHIPS

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- 2014-18:
  - Australian Postgraduate Award (\$121k) (University of Sydney)
  - Vice Chancellor's Research Scholarship (\$35k) (University of Sydney)
- 2017:
  - Postgraduate Research Support Scheme (\$1.2k) (University of Sydney)
  - Michael Forrai (co-supervised) Best Honours Thesis Presentation (University of Sydney AMME)
- 2016:
  - ACRA 2016 – Best Student Paper Award
  - IROS 2016 – RoboCup Best Paper Award finalist
  - Charles Kolling Travelling fund (\$1.2k) (University of Sydney AMME)
- 2015:
  - Peter Nicol Russell Postgraduate Scholarship (\$5k) (University of Sydney AMME)
  - Charles Kolling Travelling fund (\$1.5k) (University of Sydney AMME)
  - Postgraduate Research Support Scheme (\$1k) (University of Sydney)
- 2014:
  - RS Components Award – academic excellence and best final year project (Monash ECSE)
- 2013:
  - Final Year Project Poster Competition, Academic Award – First prize (Monash ECSE)
  - Final Year Project Poster Competition, Peoples' Choice Award – Second prize (Monash ECSE)
  - 'Present Around the World' Victorian Finalist (Institute of Engineering and Technology)
  - Dean's Honour List (Monash Engineering)
  - Highest grade for FIT3042 Systems Tools and Programming Languages (Monash IT)
- 2012:
  - Alumni Scholarship (Monash University)
  - Dean's Honour List (Monash Engineering)
  - Travel Abroad Scholarship (Monash University)
- 2011:
  - Alumni Scholarship (Monash University)
  - Dean's Honour List (Monash Engineering)
- 2010:
  - Alumni Scholarship (Monash University)
  - Dean's List Fellowship (Monash Science)
  - Travel Abroad Scholarship (Monash University)

## COMMUNITY ENGAGEMENT

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- Robotics lab tour guide at The University of Sydney Open Day, 2015
- Mentor at Aboriginal Robotics Workshop, National Centre of Indigenous Excellence, 2015
- Invited talk at IET Present Around The World Victorian Final, 2013
- Tutor for High-School Introduction to Electrical Engineering, Monash ECSE, 2013
- Physics lab demonstrator at Monash University Open Day, 2009

## SOFTWARE

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MOST PROFICIENT:    MATLAB, Java, Python, C, C++, Linux, Robot Operating System (ROS), Latex

SOME EXPERIENCE:    Android, Perl, Verilog, VHDL, OpenGL, CAD packages

## REFEREES

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*References available upon request.*