

Computational Intelligence Techniques for Control of Complex Systems

Investigators: Prof. Simon G. Fabri and Ing. Marvin K. Bugeja

Objectives:

- To develop novel and advanced computer control schemes for complex systems
- Controllers to exhibit intelligent traits:
 - Adaptation, Learning, Exploration, Planning
- Experimental evaluation on robotic testrigs

Motivations:

- Modern technology demands engineering systems to exhibit higher levels of:
 - Complexity, Accuracy, Automation, Autonomy
- Applications include (but are not limited to):
 - intelligent robots, unmanned vehicles, robotic wheelchairs and fault-tolerant machines

Outcomes:

In this project, specific emphasis is placed on artificial neural network techniques for learning reliable control strategies aimed at guiding an autonomous mobile robot and for controlling the movement of a robotic arm, despite uncertainties or changes taking place in the physical structure of these robotic systems. A series of innovative adaptive control algorithms have been developed and tested both by simulation and on physical robotic test rigs designed and developed for the purposes of this project.

Novel contributions from this research, mainly results from the doctoral work of Ing. Marvin K. Bugeja supervised by Prof. Simon G. Fabri, have been presented at several international conferences and ten papers have been published in peer-reviewed conference proceedings, book chapters and journals, with a number of others to be submitted in the near future.



NEUROBOT: Our Intelligent Mobile Robot with an Artificial Neural Brain

Publications & Awards:

Book Chapter:

- M. K. Bugeja, S. G. Fabri, "Multilayer perceptron adaptive dynamic control of mobile robots: experimental validation", in Springer Tracts in Advanced Robotics, vol. 44, European Robotics Symposium 2008, H. Bruyninckx, L. Preucil and M. Kulich, eds., Berlin/Heidelberg: Springer, 2008, pp. 165-174.

Peer-reviewed Journals:

- M. K. Bugeja, S. G. Fabri and L. Camilleri, "Dual adaptive dynamic control of mobile robots using neural networks", IEEE Transactions on Systems, Man and Cybernetics - Part B, vol. 39, no. 1, pp. 129-141, 2009.

Peer-reviewed Conferences:

- M. K. Bugeja, S. G. Fabri, "Dual-adaptive computer control of a mobile robot based on the unscented transform", Proc. The Third Int. Conf. on Advanced Engineering Computing and Applications in Sciences (ADVCOMP 2009), Sliema, Malta, Oct. 2009 - **Best Paper Award**
- M. K. Bugeja, S. G. Fabri, "A novel dual adaptive neuro-controller based on the unscented transform for mobile robots", Proc. International Conference on Neural Computation (ICNC 2009), Madeira, Portugal, Oct. 2009 - **Best Student Paper Award**
- M. K. Bugeja, S. G. Fabri, "Neuro-adaptive dynamic control for mobile robots: experimental validation", Proc. 3rd International Symp. on Communications, Control and Signal Processing (ISCCSP 2008), St. Julians, Malta, Mar. 2008, pp. 1246-1251.
- M. K. Bugeja, S. G. Fabri, "Multilayer perceptron dual adaptive control for mobile robots", Proc. 15th Mediterranean Conference on Control and Automation (MED'07), Athens, Greece, Jun. 2007.
- M. K. Bugeja, S. G. Fabri, "Dual adaptive control for trajectory tracking of mobile robots", Proc. IEEE International Conference on Robotics and Automation (ICRA'07), Rome, Italy, Apr. 2007, pp. 2215-2220.
- M. K. Bugeja, S. G. Fabri, "Multilayer perceptron adaptive dynamic control for trajectory tracking of mobile robots", Proc. 32nd Annual Conference of the IEEE Industrial Electronics Society (IECON'06), Paris, France, Nov. 2006 - **IEEE-IES Student Scholarship Award**
- M. K. Bugeja, S. G. Fabri, "Neuro-adaptive dynamic control for trajectory tracking of mobile robots", Proc. 3rd International Conference on Informatics in Control, Automation and Robotics (ICINCO'06), Setúbal, Portugal, Aug. 2006, pp. 404-411.
- M. K. Bugeja, S. G. Fabri, "Multilayer perceptron functional adaptive control for trajectory tracking of wheeled mobile robots", Proc. 2nd International Conference on Informatics in Control, Automation and Robotics (ICINCO'05), vol. 3, Barcelona, Spain, Sep. 2005.

