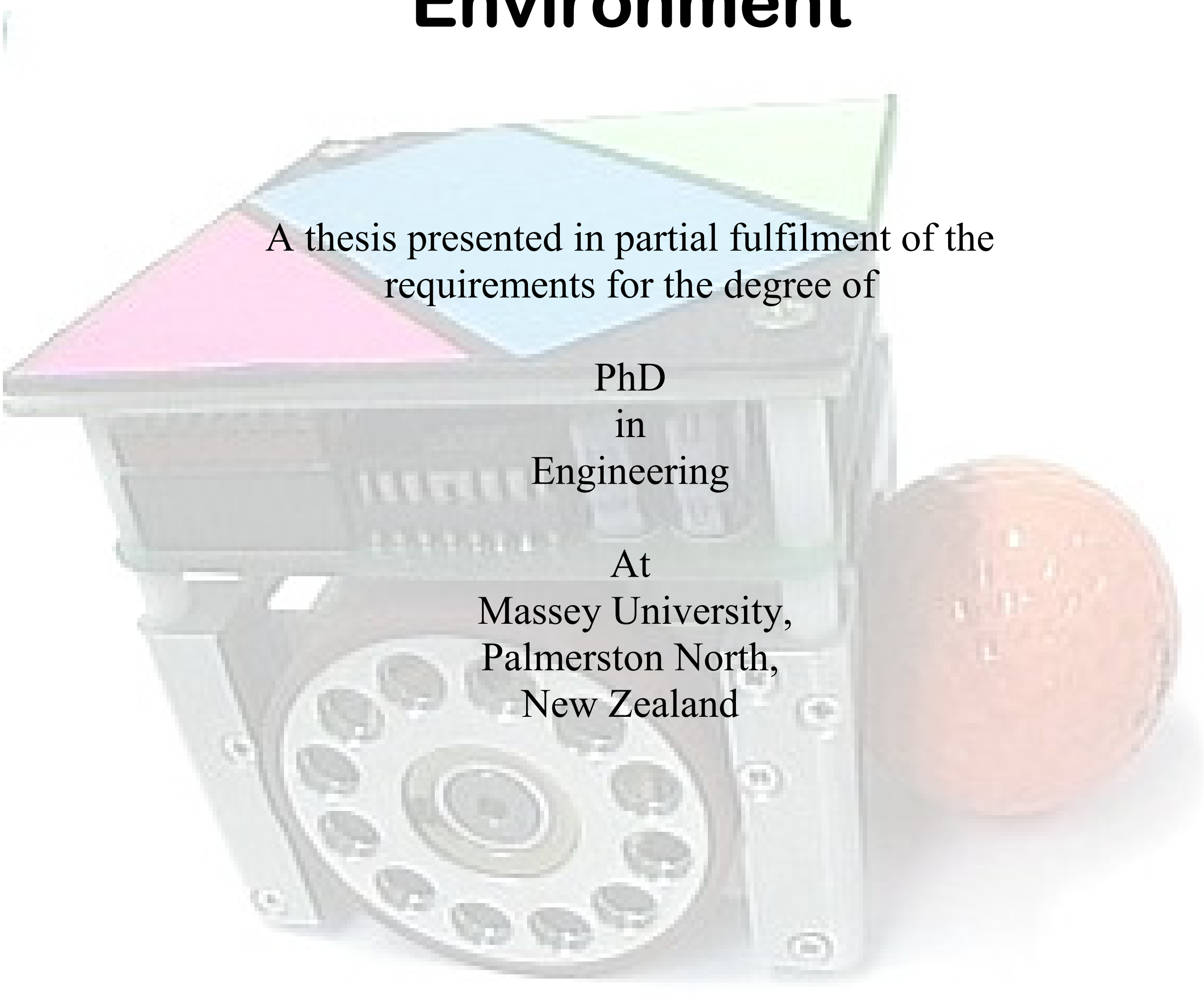
Autonomous Agents in a Dynamic Collaborative Environment



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Abstract

The proliferation of robots in industry and every day human life is gaining momentum. After the initial few decades of employment of robots in the industry, especially the automotive assembly plants, robots are now entering the home and offices. From being pick-and-place manipulators, robots are slowly being transformed in shape and form to be more anthropomorphic. The wheeled robots are however here to stay for the foreseeable future until such time as artificial muscles, and efficient means to control them, are well developed.

The next phase of development of robots will be for the service industry. Robots will cooperate with each other to accomplish collaborative tasks to aid human life. They will also collaborate with human beings to assist them in doing tasks such as lifting loads and moving objects. At the same time, with the advancement of hardware, robots are becoming very fast and are capable of being programmed with more intelligence. Coupled with this is the availability of sophisticated sensors with which the robots can perceive the real world around them. Combinations of these factors have created many challenging areas of research.

Several factors affect the performance of robots in a dynamic collaborative environment. The research presented in this thesis has identified the major contributing factors, namely *fast vision processing*, *behaviour programming, predictive movement and interception control,* and *precise motion control*, that collectively have influence on the performance of robots which are engaged in a collaborative effort to accomplish a task. Several novel techniques have been proposed in this thesis to enhance the collective performance of collaborating robots.

In many systems, vision is used as one of the sensory inputs for the robot's perception of the environment. This thesis describes a new colour space and the use of discrete look-up-tables (LUT) for very fast and robust colour segmentation and real-time identification of objects in the robot's work space. A distributed camera system and a stereo vision using a single camera are reported. Advanced filtering has been applied to the vision data for predictive identification of the position and orientation of moving robots and targets, and for anticipatory interception control.

Collaborative tasks are generally complex and robots need to be capable of exhibiting sophisticated behaviours. This thesis has detailed the use of State Transition Based Control (STBC) methodology to build a hierarchy of complex behaviour. Behaviour of robots in a robot soccer game and features such as role selection and obstacle avoidance have been built using STBC.

A novel methodology for advanced control of fast robots is detailed. The algorithm uses a combination of Triangular Targeting Algorithm (TTA) and Proximity Positioning Algorithm (PPA) to position a robot behind an object aligned with a target. Various forms of velocity profiling have been proposed and validated with substantial test results.

The thesis ends by looking at future scenarios where robots and human beings will coexist and work together to do many collaborative tasks. Anthropomorphic robots will be more prevalent in future and teleoperation will gain momentum.

Throughout the thesis, the engineering applicability of proposed algorithms and architectures have been emphasised by testing on real robots.

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