New Machine Learning Paradigms for Robots Operating in a Dynamic Team-based environment

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Introduction

This project will address the general problem of cooperative learning for a team of independent robots attempting to satisfy a common performance objective. The focus of the work will be on characterising the effect that a low power ad hoc network will have on the performance of a collective task. In particular the project will investigate how loss of sensor information or sensor malfunction impacts on robot performance in the pursuit of the objectives at hand.

Aim

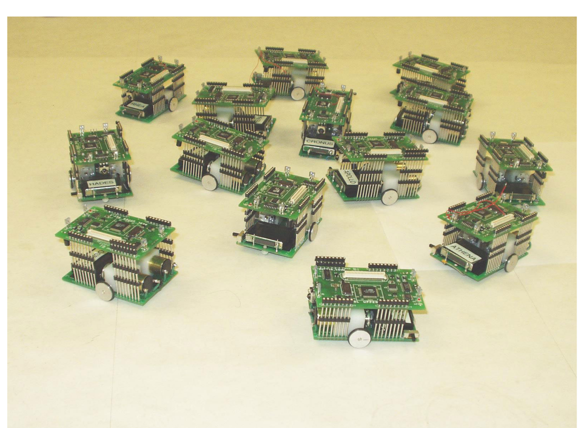
This research project investigates the problem of sensor information loss in a collaborative robot environment with an aim towards developing new paradigms or algorithms to offset the problem of sensor malfunction or information loss within the network.

Research Methodologies

Initial research will focus on

Robust Networked Vehicle Control: -

Working with a discrete-time linear system model of an autonomous robot platoon, we will model our vehicle convoy as a networked control system (NCS) and determine limits of robust performance for the system. The controller design will utilise a range of $H\infty$, Structured Singular Value, and/or Quantitative Feedback Theory Analysis tools during the realisation stage. All control laws will be critically assessed over a range of real world robotic network applications. Moreover, a a stochastic packet loss model will be explicitly incorporated at the design stage to mimic sensor loss or malfunction...



Power Consumption vs Quality of Service (QOS) Analysis:-

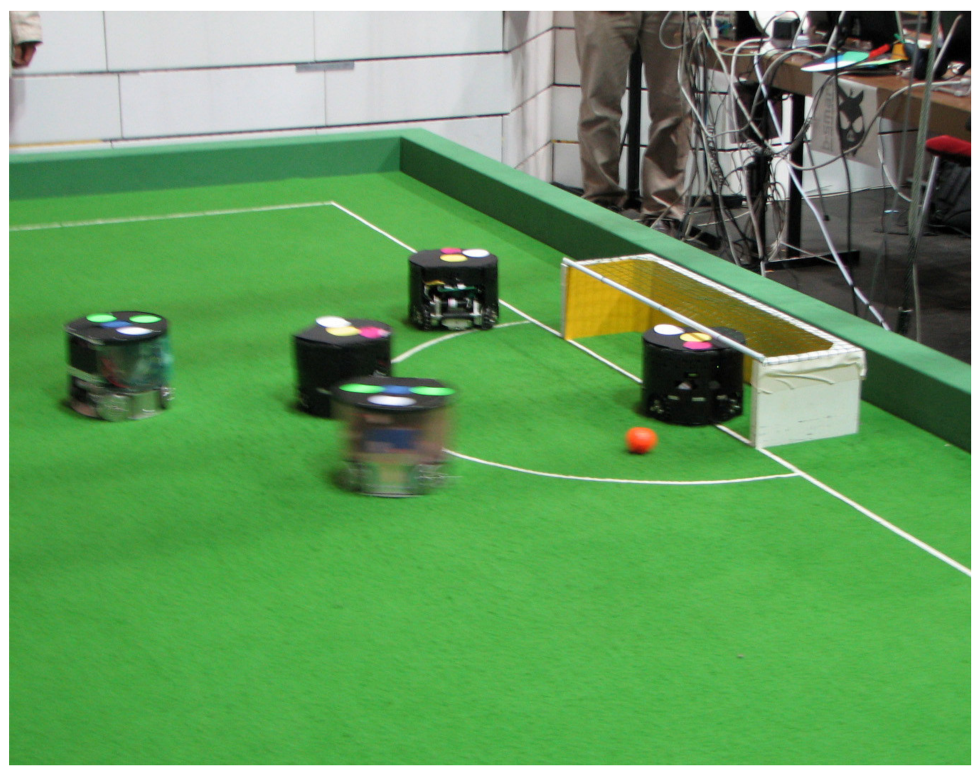
The second initial focus of the work will be on characterising the effect that a low power ad hoc robot network will have on the performance of it's collective task. In particular the project will ask how can energy consumption across the network be optimised when certain (numerically well defined) doubts exist on the accuracy of the sensor feedback data.

Potential Application Spaces

For the purposes of this research, a number of different collaborative robotic applications can be considered, among them the following: -

Autonomous Vehicle Following and Control:- for a platoon of multiple vehicles under autonomous robotic control, control of the platoon vehicles involves ensuring that they all remain travelling in the desired direction and that the prescribed fixed distance between vehicles is maintained at all times.

RoboCup Soccer Small-size Robot League:- Small robots of no more than 18 cm in diameter play soccer with an orange golf ball in teams of up to 5 robots on a field with the size of bigger than a ping-pong table. The collaborative objectives will include implementing high level defensive (i.e., pressure cover balance) strategies in a robot team framework, and hopefully winning a game or two.



Development Methodologies/Platforms

Possible development platforms currently being looked at for future stages of this research include the following: -

Lego Mindstorms NXT Development System:- Next generation of the LEGO Mindstorms kits, the NXT robotic controller comes fully equipped with input (sensor), output (motor control) and programming capabilities (fully LabVIEW compatible) for a variety of applications.

SHIMMER (Sensing Health with Intelligence, Modularity, Mobility, and Experimental Reusability) are mote replacements designed by Intel and utilising the TinyOS system from Harvard University is one potential platform for implementation of a controlled robotic ad-hoc network.

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