Robin Sharp is prepared to supervise 3 of the following 4 projects.

Path following by a learning neural network controller
Project #: RS1

Previous research [1, 2, 3, 4] provides background information. Arising out of the application of Linear Quadratic Regulator theory, with preview of the task, to driving, we know a structure for a good steering controller and can estimate some of its parameters, see also [5] (which is a Formula 1 car application). Pierre Dandré, (M Sc 2002-2003), set up a suitable car/neural network steering controller model and arranged for the network to learn to systematically improve its performance, see also [6]. Hazrin Noor (M Sc 2003-2004) also made a contribution to the topic, following Dandré's work quite closely but also adding to it. Simulations were in MATLAB and the neural network toolbox was employed. That work needs further development to realise its full potential. A more complex vehicle, a more efficient control structure, faster learning and performance evaluations are all of interest. Most important is to try to obtain some understanding of how the network transfer characteristics adapt to the nonlinearity of the car in order to minimise the path error under limit conditions.

Implementation of a driver model in a car simulation
Project #: RS2

François Foussard (M Sc 2003-2004) studied this topic last year. His thesis [7] lays a good foundation for follow up work. He devised a speed controller in addition to the pre-existing steering controller and put the two together into a simulation framework. Further work is needed to increase the generality and performance of the simulation software. So far, speed and steering controllers are decoupled, so a main step is to combine the two in such a way that the vehicle "knows" to go fast on the straights and to slow down on corners. The target is to send a car round a circuit of known geometry and to have the "driver" keep to the intended path and to monitor the extent to which the tyre forces are utilised, on a continuous basis. If the tyre forces are not sufficiently used, the speed controller should increase the speed, maybe at the corresponding point on the next lap. If the tyre forces are over used and the car "ploughs" or "spins" the "driver" should slow down and recover directional control before resuming the previous "maximum" speed quest, rather in the manner of a real driver. Simulations will probably use SIMULINK and it is of interest to improve the existing bridge between our Multibody modelling software, Autosim, and SIMULINK models, so that we can link the "driver" to any general vehicle model, designed in Autosim.

A review of cooperative control
Project #: RS3

There is considerable interest in cooperative control and a review of present knowledge and involvement would be useful to our group, especially in relationship to our collaborative work with BAE Systems on Unmanned Air Vehicles. Several of us attended the Control Decision Conference in Nassau last December and many sessions there were concerned with some form of cooperative control. The style of work suggested can be gleaned by looking at the thesis of Gurmukh Neote (M Sc 2003-2004) on "The future of air traffic control: Conflict detection and resolution" [8] but the subject is new. However, it is not totally unrelated to air traffic control,

since an alternative to present processes, in which the ground based air traffic controller is in charge, is to allow the aircraft to look after themselves much more – through cooperative control.

Optimal linear preview control for cars and motorcycles
Project #: RS4

Using [1, 2, 7 and 9] as background, additional studies of optimal linear preview path following control applied to cars or motorcycles or both are needed. To represent a real driver, who will have relatively slow response capabilities (limited control bandwidth) the incorporation of a low pass filter along with the steering actuator is necessary. The main interest in this project is to find out the influence of the low pass filter properties on the optimal control scheme and the path following performance of the optimally controlled system. In the case of the motorcycle, weighing body lean control against steering torque control is also an interesting possibility, not yet fully exposed. Opportunities also arise to exploit the idea of "preview distance required for full control" which can be seen in [9], for the motorcycle case

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