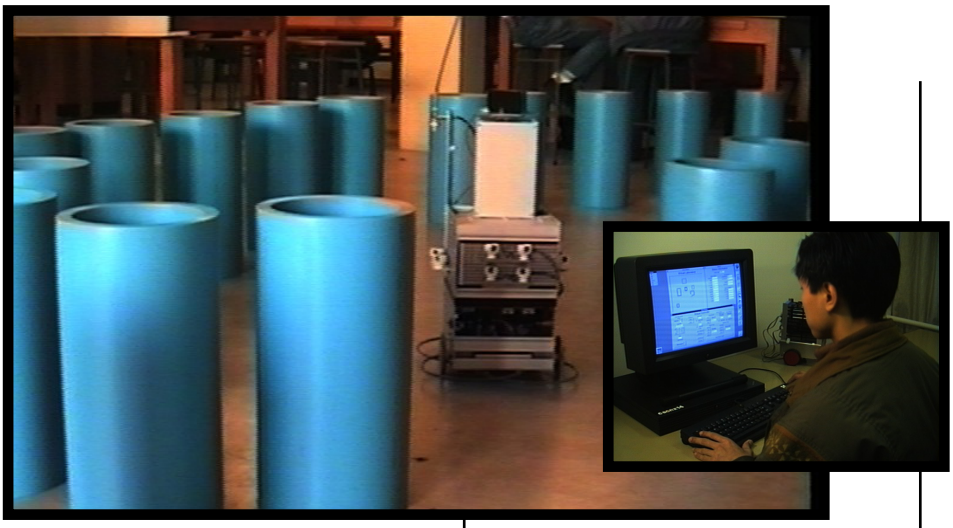
Department of COMPUTER SCIENCE

UNIVERSITY OF essex

The Brooker Laboratory for Intelligent Embedded Systems.

The Department has installed a new **robotics** facility to support practical work in **intelligent embedded systems**. It is available to students taking a wide variety of courses ranging from hardware to Artificial Intelligence.



Intelligent Embedded Systems

Embedded systems are products which have computers integrated into them. Robots, air & spacecraft, undersea exploration vehicles are typical of this type of system as are such domestic items as mobile telephones, video systems and even washing machines.

Intelligent embedded systems use Artificial Intelligence techniques to give them the ability to carry out sophisticated tasks unaided and in a changing environment.

The Laboratory

The facility provides an integrated environment for the development of intelligent embedded systems. As a part of many of their courses, ranging from hardware, via software to Artificial Intelligence, students can opt for practical projects using the new facilities.

In this way students gain invaluable experience of implementing in the real world the ideas they learn about as theories in the lectures.

Industry Standard

The software and hardware that we have adopted is used widely in industry in such hi-tech organisations as NASA, British Aerospace, The French TGV high-speed railway and Ford Motors.

The Robots

Some systems are mounted on mobile platforms to form simple robot vehicles (see photo).

Hardware Development

Having built, tested and debugged their boards and software on the workbench students can plug them into the robots to see how they behave in a working system.

The robots can communicate with each other and with other computers on the university ethernet network. They will soon even be able to do this via wireless radio links.

Thanks to generous support by our industrial partners students have free access to state-of-the-art CAD software which enables them to design and use in their hardware the latest programmable logic devices. These devices allow ever more compact designs often incorporating millions of individual transistors on a single chip

Programming

Software is developed on powerful workstations and downloaded to the workbench systems or the mobile robots for testing.

Testing can also be done via simulation on the workstations and in this and other laboratories using virtual robots in a virtual world.

Once programmed, the real robots are able to operate “intelligently”, independently and without reference to the workstations and the network cable can be detached if necessary

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Some Typical Projects

In addition to course assignments in the new laboratory students may choose to contribute either individually or in teams to on-going projects. Some examples and issues are presented below:

Graphical Simulation

Can a "virtual world" be built that simulates the behaviour of a group of real robots? How can the "virtual robots" be programmed so that they behave in a similar way to real robots obeying the same program?

Artificial Neural Networks

These simulate some aspects of the structure of the human brain. Can one be trained to summarise the input from several sensors and distinguish between "friend" and "enemy" objects?

Programmable Logic

Nothing is faster than dedicated hardware but historically it has lacked the flexibility of programmable systems. It is now possible to produce application specific devices (i.e. hardware) using programmable techniques. Could you design a vision engine for a robot?

Emergent Behaviour

Given a number of independent robots each of whose "behaviour" depends on that of other robots, what would be the "behaviour" of the group of robots taken as a whole?

Parallel Architecture

Many tasks require more computing power than a single processor provides. Could you design a multiple processor system?

Navigation and mapping

How can a robot plan, and then follow a path around a set of obstacles to a final goal - especially in a changing environment containing other robots doing the same thing?

Cooperative Behaviour

Design a group of robots that could cooperate to make a map of their surroundings, push a large ball along an uneven floor whilst avoiding obstacles or play team games such as RoBall, or RoboWar.

Computer Vision

If a small camera were mounted on a robot, can you write a program to recognise and respond to symbols printed on objects in its environment?

Speech Synthesis

Use the robot's speech synthesis card to design a debugger that speaks to you so that there is no need to have a terminal attached.

Language Processing

Program a robot so that it can respond to such commands as "Stop the blue robot from reaching the north-west corner unless it knows the password".

Operating Systems

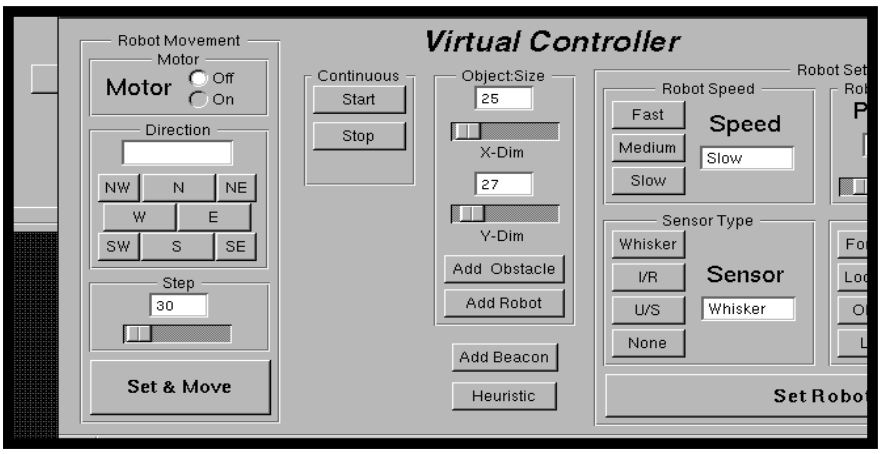
Use our operating system building tool to construct the smallest and most efficient robot operating system.

Data Communications

Design a network to enable robots to communicate? What sort of medium should you use? What kind of information should they pass?

Input-Output Techniques

The interface that allows information to be passed to and from computers is fundamental to enabling them to perform useful work. Could you design a Telepresence interface to allow remote-control of a robot? What input and output techniques would you use?



This facility gives students extra opportunities to gain experience in the implementation of complete systems in addition to the sound theoretical training that the Department has offered for many years.

As a climax to the year's work in this laboratory, we organise a competition which attracts a prize of £250 which has been generously donated by Wind River Systems Inc

We will welcome applications from students with imagination and vision wishing to work in this exciting new area which, we believe, will become increasingly relevant to the future needs of industry.