Mouse Manoeuvres: the IEE World Micromouse Championships 1994

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Each year the Institution of Electrical Engineers organises this competition and it attracts entries from around the world. The competition involves building and training a 'mouse' to negotiate a maze, learn the best route to the centre, and then make the fastest possible run from the start to the centre. The 'mouse' is a steerable motorised buggy with sensors fitted to enable it to detect the maze walls and to respond accordingly.

The competition has been the almost exclusive preserve of teams from industry and university departments, but last year a new teenage category was introduced, opening the competition up to school-based teams. In the senior categories the 'mice' are autonomous, microprocessor-controlled buggies of a high degree of sophistication, but the proposed teenage category rules allow for control by wire, either linked to manual control boxes or to microcomputers. This is an exciting challenge to school-based technologists which involves design, making, electronic, and IT skills.

Entry details and a full set of rules are available from the IEE (address below) and they also produce a technical information pack to help prospective mice manufacturers, but here are some basic details.

The maze consists of a 16 x 16 matrix of cells with removable walls that enable the complexity of the maze to be varied for the different categories of entry. The walls are 5 cm high, 1.2 cm thick and spaced 16.8 cm apart. The mouse must be able to negotiate the passages between the walls but may have sensors which overhang the walls provided the overall dimensions of the mouse do not exceed 25 cm x 25 cm. Figure 1 shows details of the maze construction and figure 2 gives an example of a maze layout. It will not be practicable, in most schools, to attempt to build a full-size maze to the specifications laid down in the rules — it measures over 3 metres square and is rather heavy! It is, however, worth while making a small maze section to experiment with. The photographs show the section my teams are using, which was made using MDF and simple dowel joints, not bothering with slotted posts at every wall intersection as used in the 'real' maze.

The mouse can be made in a wide variety of ways with a range of different materials, but for first ventures into mouse country I would recommend the use of construction kits. We were fortunate to enlist the support of Economatics (Education) Ltd who kindly provided a selection of Fischertechnik materials together with a Smart Box interface and Smart Move software. Fischertechnik construction kits enable pupils to experiment with different mouse designs and to produce robust prototypes for testing other aspects of the problem.

One particularly useful starting point is the Fischertechnik 'Kickstart' Buggy. This enables a two drive wheel buggy to be easily assembled and incorporates rotation counters on both drive wheels, which are essential for controlling distance travelled and monitoring the current position of the mouse in the maze. The basic buggy is not suitable for use as it is too large to negotiate the maze but can be modified quite easily to suit the purpose.

Once a mouse of some description has been built, some experimentation and tuning will be necessary to test its basic functions: it must be capable of travelling in a straight line and turn through 90° in the maze reliably! A simple manual control box for testing out basic mouse movements can be made cheaply and easily using two centre-off double-pole change-over

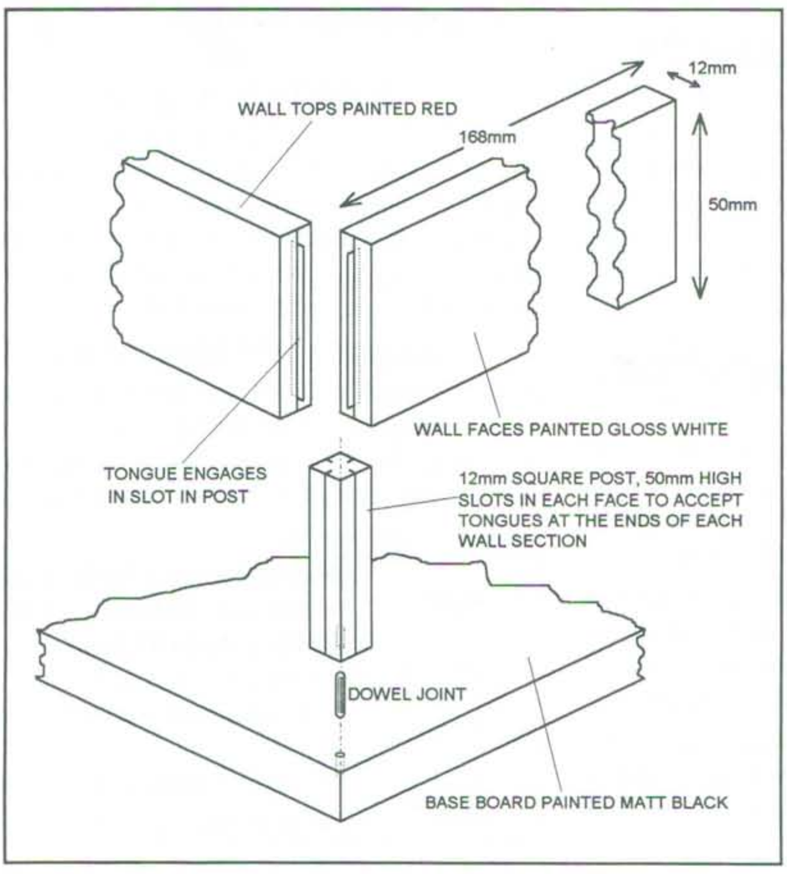


Figure 1: Basic maze construction

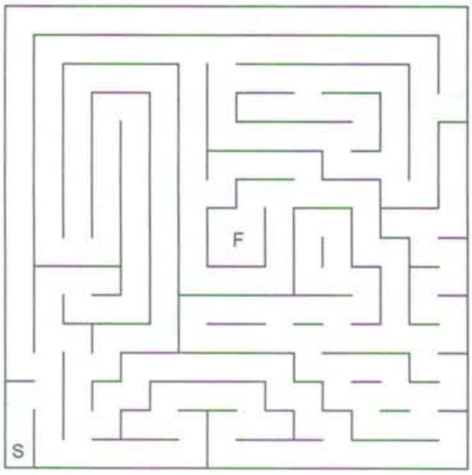
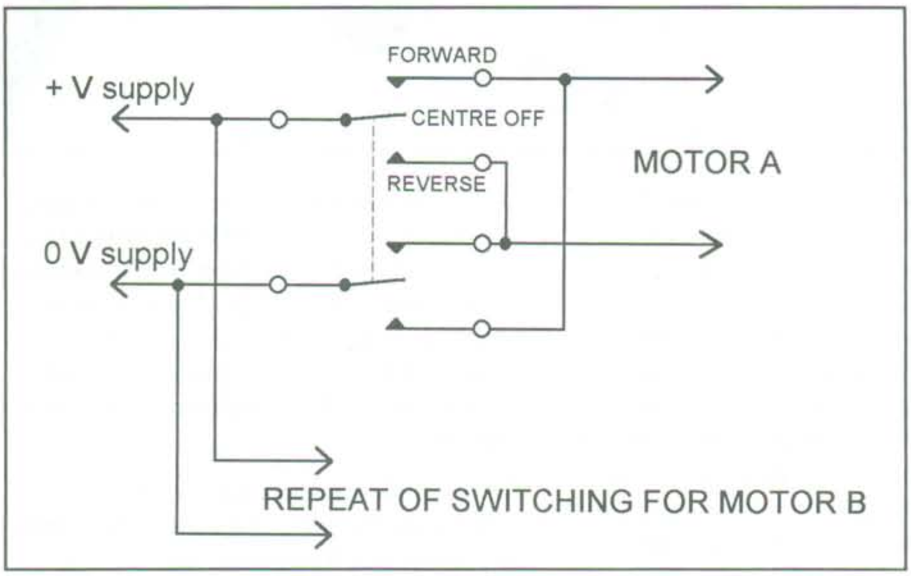
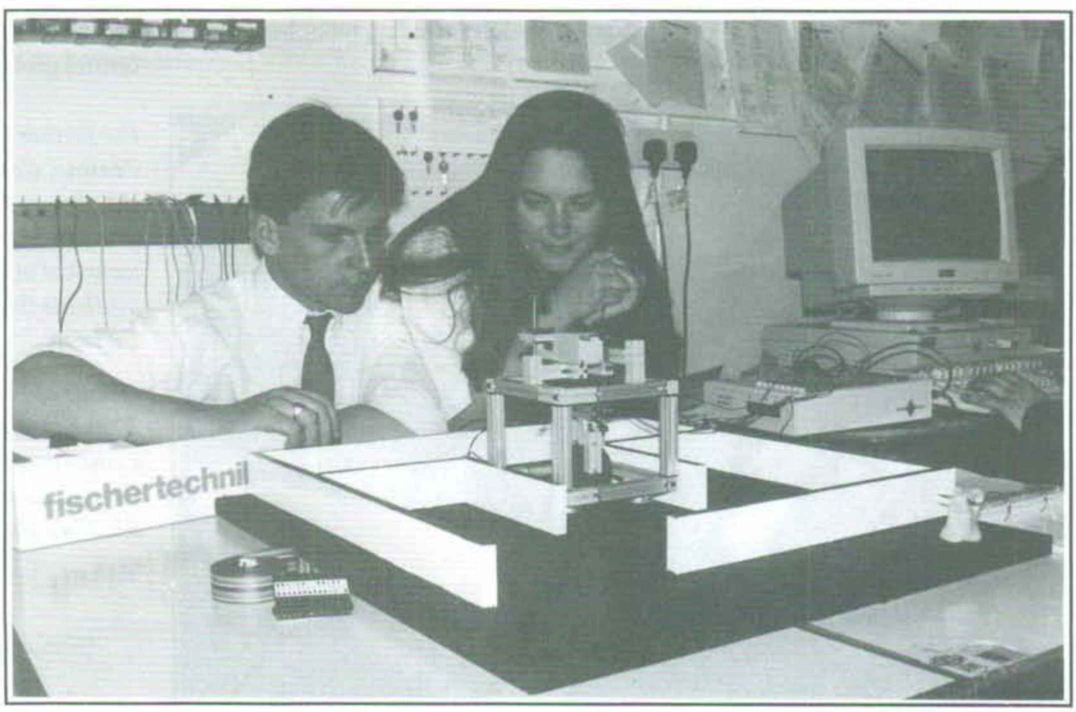


Figure 2: Based on a maze used in the 1981 London Final

Figure 3



Testing the steering system of the prototype mouse



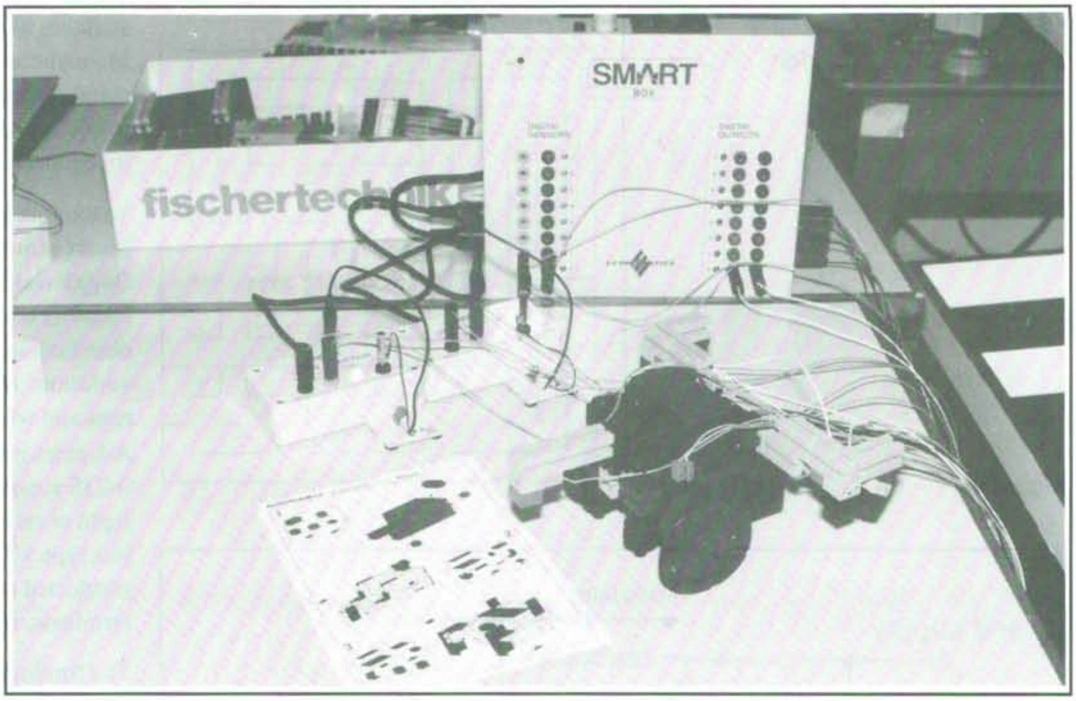
switches as reversing switches (see figure 3). Manual control could be refined by building simple electronic systems into the control box to effect right and left 90° turns and to respond to feedback from simple sensors.

To explore the potential of the Smart Box and Smart Move software the modified Kickstart Buggy was fitted with LDR (light-dependent resistor) sensors to detect side walls and obstructions in front. The LDRs respond to variations in light reflected from the red wall tops and when connected to Smart User Adaptors give a digital signal in the range 0-255 according to level. (The Smart Box has input ports for up to four analogue sensors of this type.) The two rotation counters were connected to two of the eight digital input terminals, and the motors to the motor outputs.

The Smart Move software is Logo-like and simple procedures can be written to control the mouse with ease. The documentation accompanying the Kickstart Buggy provides useful help in tackling basic maze manoeuvres. Once the basic principles have been mastered it is possible to develop more elaborate control procedures. We have attempted to break the programming process into stages, progressing from simple tasks to more involved problems.

The first stage is simply getting the mouse to perform the basic manoeuvres required to negotiate the maze: running in a straight line, 90° turns and 180° turns. The second stage is getting the mouse to respond to sensor inputs

The modified Kickstart Buggy with side and front sensors fitted, wired to the Smart Box via User Adaptors

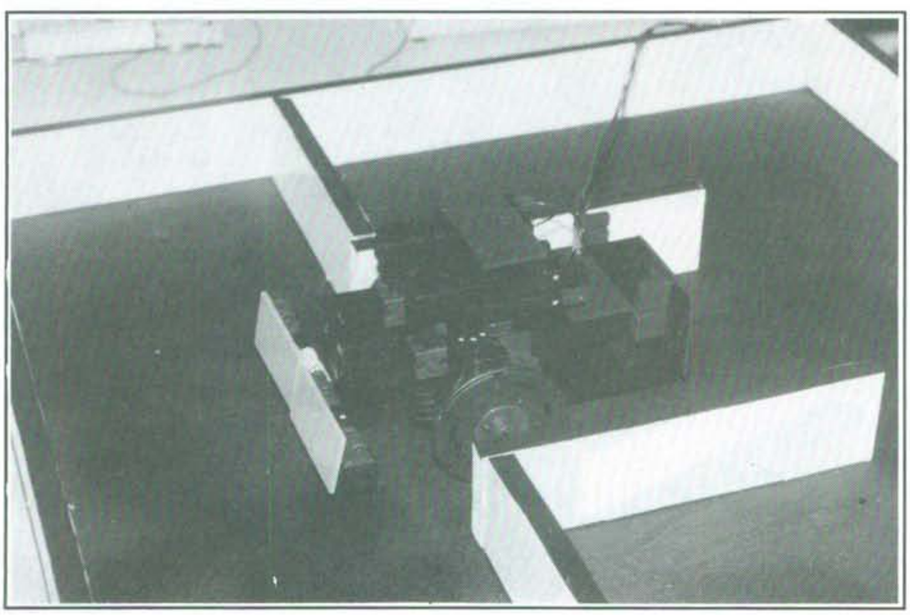


reliably. The sensors must determine when an obligatory manoeuvre is required, such as a 180° turn when a dead end is encountered (all three sensors indicate the presence of a wall), or a 90° turn when the front and one side sensor show the presence of a wall. The program must also keep track, using the counters, of the position in the maze relative to the centre. The third, and most challenging stage, is to develop maze-solving procedures so that the mouse seeks the centre when presented with choices in the maze.

We have also developed a quite different mouse design using a Fischertechnik Project 2000 kit but this approach has involved additional materials including roller bearings of the type that were used on the BBC Buggy. Development of this model is continuing. I am very impressed with the Economatics products we have used and, although they may not be adaptable to all the problems involved in mouse design, they certainly provide a good point of entry to the competition for beginners, like us!

There is still much work to be done and whether we will solve all our problems in time to participate in the Micromouse Championships at Bristol University on 11th July remains to be seen — watch this space! One thing is certain, however: that the pupils involved in this project are having a good deal of fun and gaining an excellent insight into control problems at the same time.

The basic Kickstart Buggy shown in the small maze section



For further information contact David Penrose, Computing and Control Division. IEE, Savoy Place, London WC2 0BL, tel: 071-344 5417, fax: 071-497 3633. The technical information pack, price £5, is also available from the IEE Computing and Control Division.

Details of Fischertechnik Kickstart and Project 2000 kits, and the Smart Box from Economatics (Education) Ltd., Epic House, Darnall Road, Attercliffe, Sheffield, S9 5AA, tel: 0742 561122, fax: 0742 439306.