



```

10 REM **** BBC BUMPERS ****
20 DDR=&FE62:DATREG=&FE68
30 ?DDR=15:REM LINES 0-3 OUTPUT
40 forwards=4;backwards=2
50 ?DATREG=(?DATREG OR 1) OR forwards
60 REM **** PULSE FORWARDS ****
65 count=0
70 REPEAT:PROCpulse:count=count+1
80 UNTIL(?DATREG AND 192) < 192
90 REM **** GO BACK TO START ****
95 ?DATREG=(?DATREG AND 1) OR backwards
100 FOR I=1 TO count
110 PROCpulse
120 NEXT I
130 ?DATREG=0:END
1000 DEF PROCpulse
1010 ?DATREG=(?DATREG OR 8)
1020 ?DATREG=(?DATREG AND 247)
1030 ENDPROC
    
```

Now that we have added microswitch sensors to our robot, we can write software that uses output through the user port to control the robot, and input to monitor external activities via the robot's sensors. The following simple program sends the robot forwards until an obstacle is encountered,

whereupon the robot retreats to its exact starting position. The logic of the program can be described as follows:

1. Set the data direction register to 15. This sets bits 0-3 for output and bits 4-7 for input.
2. Set the motor direction to forwards.
3. Pulse the motors until bit 6 or bit 7 goes low, keeping a count of the number of pulses made.
4. Set the motor direction to backwards.
5. Pulse the motors' 'count' times.
6. Set the data register to zero and finish.

In this program we have designated the forward microswitch pair as the pair furthest away from the patch sockets on the robot's lid and have connected these two microswitches to bits 6 and 7, using two patch cords between the two rightmost red and blue socket pairs on the lid. In future we shall always assume that the D plug is further forward than the patch socket system. If, when you run this program, you find that your robot appears to go backwards first (according to this convention) then simply take off the lid and replace it the other way round.

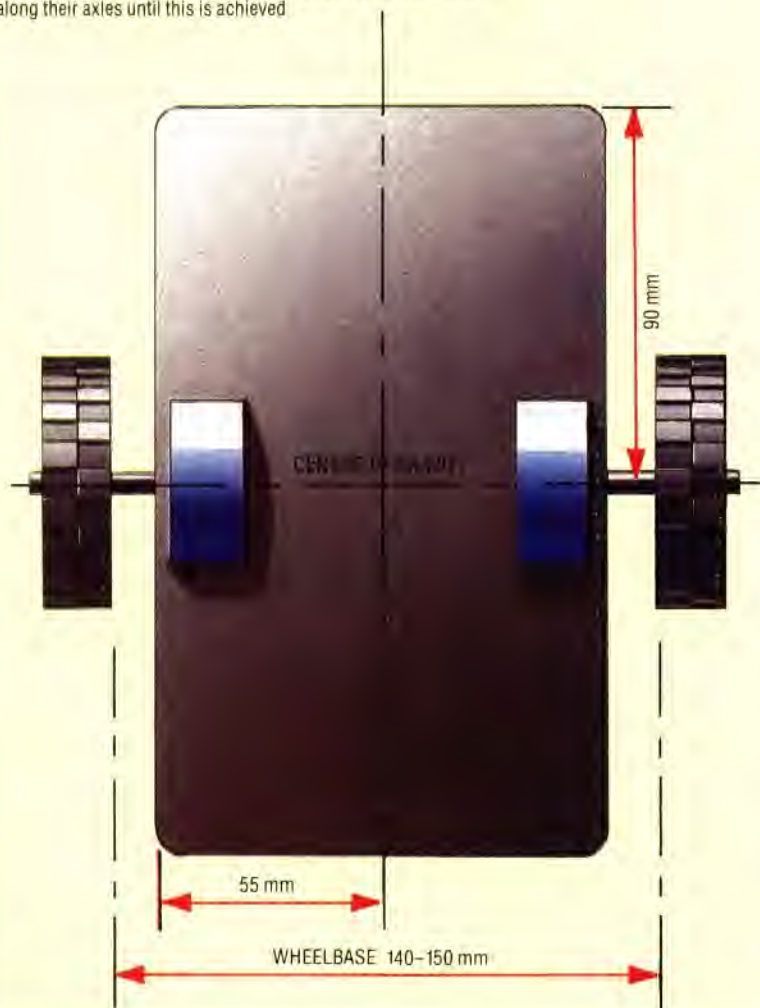
Of the four low data register bits that control the motor operation, bit 0 is the rest bit (normally set to one), bits 2 and 3 are the direction controllers for the right- and left-hand motors, and bit 3 pulses both motors simultaneously, causing them to turn through one step as bit 3 undergoes a low-to-high transition. Using the logical operators AND and OR allows individual bits to be turned on and off without affecting the other bits in the register. As the upper four bits have been set by the data direction register to be inputs, they are normally held high. When a microswitch closes, the corresponding bit in the data register goes low. Normally bits 6 and 7 would have the value 192 (128+64) if set for input. The repeating loop that sends the robot forwards at lines 70-80 is terminated on the condition that these two bits no longer have a value of 192. This can happen if either microswitch is closed (or if both are). If a count is kept of the number of pulses made to the motors in the intervening period, then the robot can accurately retreat to its starting point by altering the motor direction bits and pulsing the motors the appropriate number of times. The 7.5° step of the motors translates to a movement of less than one millimetre by the wheel — thus we can control the position of the robot very simply.

Finally, it is interesting to note that the robot moves forwards more slowly than it does when retracing its steps. Here we are limited by the speed of BASIC. The time between pulses in the loop that sends the robot forwards is longer than that for when the robot is retreating as additional work, such as keeping the count and testing for the collision, has to be done in the first loop but not in the second.

We now take a short break from the robot project to allow you to complete assembly of the robot. In the next two instalments we shall be taking a look at the control of servo motors.

Adjusting The Wheelbase

Before we start the calibration process it may be necessary to perform some preliminary adjustments. With the robot on its back, it is first important to locate the central axis about which the robot will turn. This can be done using the measurements shown. Mark the central axis with a small scratch or an indelible marker pen. Measure the distance between the insides of the two driving wheels. This distance should be between 140 and 150mm. It is important, if the robot is to pivot accurately about its central axis, that each wheel is equidistant from the central axis point we have just marked. The wheels may be slid gently along their axles until this is achieved



KEVIN JONES