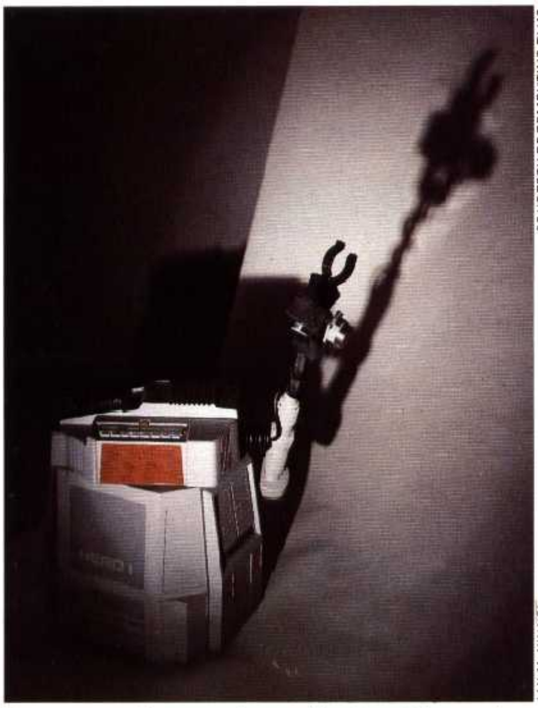
Battery-Powered Robot
The Hero-1 is a completely self-contained battery-powered robot that combines some of the functions of a turtle with the manipulative ability of a robot arm. Costing some £2,500 — or £1,600 in kit form — it might appear, at first glance, to be an expensive toy. But, it is in fact, a remarkably flexible computer system in its own right, with such advanced features as speech synthesis, light level sensors, auditory input and, (because it's mobile), an ultrasonic range finder that also doubles as a movement detector


COURTESY OF COMPUTING PLUS
IAN McKINNEL

Known as point-to-point positioning, this requires the datum point to move with the tool holder.

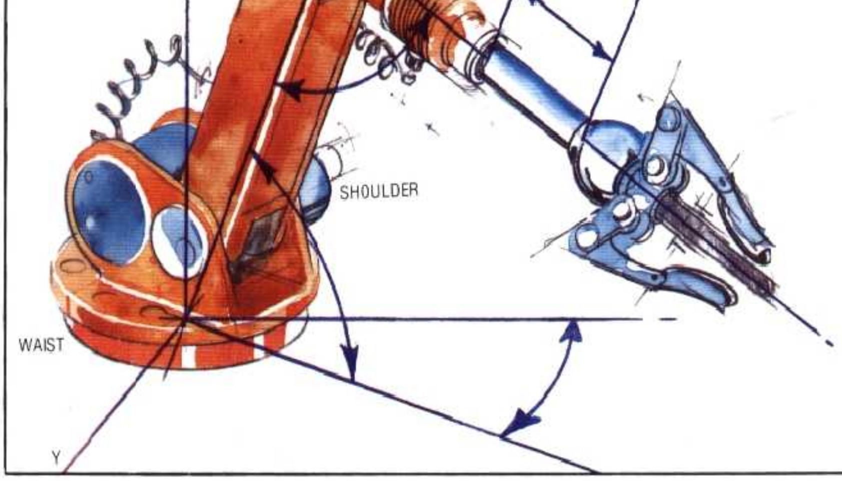
Typically, industrial robots are accurate to within one millimetre. Even the simpler models — available for a few hundred pounds and capable of being used with any home computer that has eight-bit parallel output — are accurate to within two millimetres. That observation in itself is interesting given that the cost differential is at least 50-1.

There are two generally accepted methods of driving robot arms. For those with a low payload, stepper motors (electric motors that move by a predetermined amount each time current is applied to them, as used in disk drives to position the read/write head) are sufficient. But for robot arms used on a production line, where heavier weights need to be manoeuvred, it is more common to employ hydraulic rams to move the various parts of the arm around their fulcra (the points around which they pivot). It is quite a simple matter to measure the volume of hydraulic fluid being passed into the rams, and to deduce from that the movement at the other end, to well within the operational requirements of accuracy.

Industrial robots invariably contain a purpose-built minicomputer (or a large capacity microcomputer in later models) that does nothing but control the arm, and run a programming language designed for that purpose. As there is no requirement to do more than indicate co-ordinates, and issue simple commands like CLOSE GRIPPER or OPEN GRIPPER, the programming language contains no instructions for handling text. Program instructions are entered through an enlarged numeric keypad attached to the computer by means of a long 'umbilical cord', so that the operator may move around the robot arm while entering the instructions. The more advanced versions of these 'pendant panels,' as they are called, include a precision joystick.

Another programming method, known as 'Follow Me', is especially useful in tasks that do not require particularly accurate tool placement, such as paint spraying. Here the robot arm includes a provision for the operator to grasp the tool holder, directly move it around the job, and have those movements entered directly into the computer's memory. The robot will then repeat those movements every time the program is executed.

In all these methods, the position being defined is that of the tool holder itself. The operator is not concerned with the relative positions of the individual sections of the robot. The



Angular Movement

One of the most difficult aspects of programming a robot arm is converting the geometry. We are used to specifying positions using Cartesian or x,y,z co-ordinates. What the robot needs are angles for the 'elbow' joint, the 'shoulder' joint, the 'waist' rotation, and the distance that the wrist must extend. In simpler systems the programmers must give the values for all four. More sophisticated robots can perform all the conversions from Cartesian co-ordinates

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