

Micro, Commodore Vic-20 and Sinclair Spectrum. The Neptune 2 has two different speeds of operation; this is useful as it can be made to move quickly when large arm movements are required and then slowed down for more precise work.

Powertran Cybernetics makes the Genesis P101, which has six degrees of freedom and sells for £750 in kit form. This model is hydraulically powered and comes with a controller box for programming the robot, together with a standard RS232 interface, which should enable it to be connected to most computers. This arm also comes preassembled and tested, but the price rises accordingly to £1,750.

An interesting mid-price arm is the Cyber 310 from Cyber Robotics. This is sold preassembled and costs £650. Versions of the robot are available for the BBC Micro, Jupiter Ace, Apple II, Commodore PET 3000/4000 and 8000 and the Hector HRX. It is powered by stepper motors and has a lifting capacity of only 250g, which makes it fairly lightweight, but the range of options it offers is impressive. As well as five degrees of freedom, it has user-controlled acceleration and deceleration of the speed of the arm, which means that it can simulate the way in which a human arm moves;

altering its speed constantly as the nature of the task changes and simulating the effects of inertia. All the joints may be moved simultaneously and the position of the arm specified either as a relative position (for example, by instructing the arm to move forwards x units from its current position) or as an absolute position (by specifying a move to some point with reference to a 'home' position). It can be programmed in BASIC and also in a version of FORTH, known as Robo FORTH, developed by Cyber Robotics.

Moving right up in price we come to the HRA933 and HRA934 from Feedback Instruments. These cost £2,195 and £2,726 respectively and are sold ready-assembled. Both are hydraulically powered arms with five degrees of freedom and are capable of lifting 1.35kg with a positioning accuracy of 3mm. As well as position sensors for the arm joints, the arms also have tactile sensors in their end effectors. These sensors indicate when they have picked something up and enable the arm to control the force applied when picking up objects. Control is via an RS232 interface and specific instructions are given for control using the Apple II, the Tandy TRS-80, Commodore PET, AIM 65 and the MAT385.

## STATE OF THE ART

The Hero-1 robot from Zenith Data Systems sells for £1,995 in kit form but offers some quite outstanding facilities. It is mobile and has an arm that makes use of a spherical co-ordinate system (see page 661) in which the arm is able to expand and contract telescopically. The Hero is equipped with a large array of sensors to detect movement, sound and light, including an ultrasonic distance sensor that helps it avoid collisions, and a speech synthesiser that gives the robot an unlimited vocabulary. It also has an arm with five degrees of freedom. The amount of assembly work involved in constructing the Hero 1 is considerable, so you may want it ready-made. In this case the price rises to a staggering £2,500.

All of these robots are, in some ways, little more than an expensive entertainment in terms of what they can actually do for you and, indeed, their main use to date has been to commercial firms who wish to use a robot for promotional purposes — handing out leaflets on exhibition stands, or product demonstration. However, they do represent the most up-to-date robotic technology available. They all use sensors in an intelligent fashion, move about intelligently and have intelligent arms. None of them has a vision system, but they can speak and they can hear acoustic signals and respond to them.

Needless to say, their price will prevent many people from buying them, but they do remain there as something to aspire to — something that you might perhaps be able to match by building a robot of your own. They also indicate the pace at which robotics is changing: a few years ago such robots would have been unthinkable — at any price.



CYBER 310



HRA933



HRA934

Arm	Arm	Arm
Educational	Educational	Educational
None	Ability to determine its position, gripper can sense how far it is closed	Ability to determine its position, gripper can sense how far it is closed
6: base rotation, shoulder rotation (which can bend through 180°) elbow, wrist elevation and wrist twist and grip	5: base rotation, elbow, wrist roll, wrist yaw and gripper	5: base rotation, elbow, wrist roll, wrist yaw and gripper
£650	£2,195	£2,726
Mains	Mains	Mains
BBC Micro, Jupiter Ace, Apple II, Commodore PET series and Hector HRX	Apple II, Tandy TRS80, Commodore PET series, AIM 65, BBC Micro, MAT 385	Apple II, Tandy TRS80, Commodore PET series, AIM 65, BBC Micro, MAT 385
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