A Review of the Colne Armdroid I

Derek F. Stubbs
PO Box 155
Vicksburg, MI 49097

The Armdroid I, made by a British company called Colne Robotics, is available from the U.S. distributor, D&M Computing, Inc., Box 2102, Fargo, ND 58107. The company founder is John Reekie, who is sometimes referred to as "the Henry Ford of robotics" because of his dedication to low costs and his prolific product line. The Armdroid II is a $4000 industrial robot, while the Zeaker is a mobile, turtle-type robot selling for less than $200. A video-guided mechanical arm is soon to be available.

The Armdroid I is a programmable robot arm which can be driven by inexpensive, readily available microcomputers. I controlled mine with a Timex/Sinclair 1000.[TM] Although the T/S 1000 is no longer being manufactured, they are easily found at computer meetings and yard sales. You can buy boards to control the arm with other computers, such as the Apple II.[TM]

The arm can be purchased either assembled or in kit form. Available accessories include a 110 VAC to 13.8 V transformer, an RS-232 interface, a cassette program, two manuals, and all necessary cables. I opted for the ready-assembled version. It plugged together with no problem (I found no instructions, but it was quite obvious). The cassette loaded in a few minutes, and I was ready to learn how to manipulate and program the arm. Frankly, I was surprised

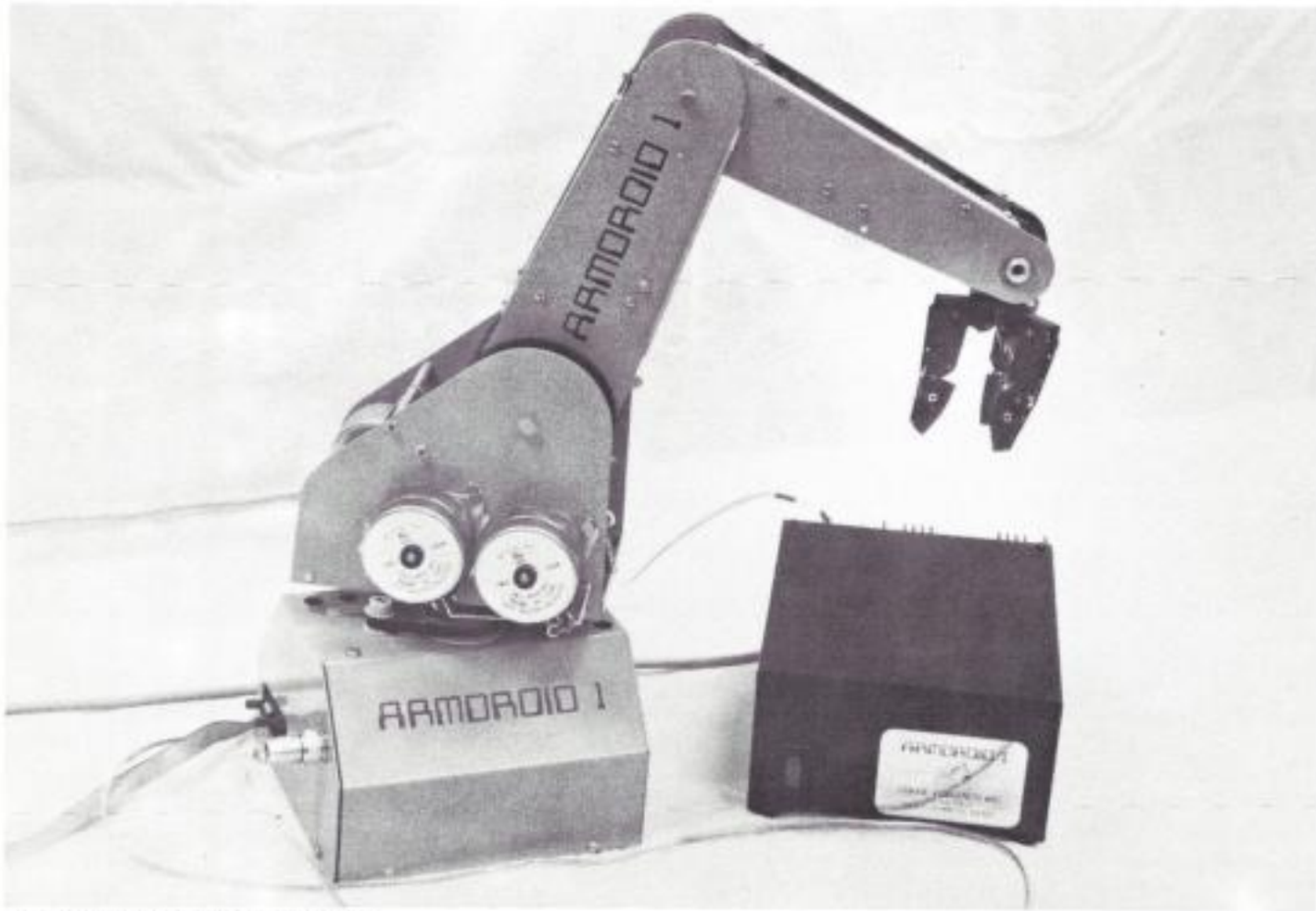

Photo 1. Overview of the Colne Armdroid I

at how easy it all was. Then I stepped back to ask myself, "Now what can I really do with this, and what is it?"

THE ARM

The arm has a shoulder, an elbow, a wrist, and a gripper. These joints are driven by six motors which activate a rubber belt–driven gear array. The gear array, in turn, manipulates the joints using string cords. The shoulder rotates 360 degrees in the horizontal plane upon a sturdy base. You are unlikely to tip the base over before you overload the gears and motors; however, the base should be anchored for safety. When a joint reaches its limit, or the pickup weight is too great, the cord drives start to slip. This reduces the chance of damaging the arm.

The shoulder can rotate the upper arm from 45 degrees below the horizontal to 45 degrees beyond vertical—a range of 180 degrees. The shoulder-axis-to-elbow-axis distance is 19.5 cm. The forearm rotates in the same vertical plane as the shoulder in the arc-range 135 degrees to 225 degrees. Thus it mimics the human forearm in flexion on the upper arm, but is more flexible, by 135 degrees, in extension. The elbow-axis-to-wrist-axis distance is 16 cm. The wrist axis is 10 cm. from the gripper tip. The wrist can be rotated 360 degrees about the long axis of the forearm. It can also be flexed 135 degrees onto the forearm or extended 90 degrees—both movements being in the same plane as the shoulder and elbow.

Thus the Armdroid I can reach an outer envelope, which is a hemisphere of radius 46.5 cm. with the center pivot as its center, and a circle on the table top with a radius of 45 cm. (The base of the shoulder rotation plane is 12 cm. above the table top). The gripper tips can touch anywhere within this region, except the central volume occupied by the base.

The gripper has a very interesting design. There are three fingers, each with a proximal phalanx of 3.5 cm. upon which a distal phalanx of 3 cm. flexes and extends. The gripper will close entirely or open to grip an object up to 10 cm. in diameter. It picks up a full wine glass, 7 cm. in diameter, with no problem. Each finger is fitted with a rubber pad to aid in gripping slippery and fragile objects. The gripper can easily hold an egg—although it is strong enough to break it. (I do not recommend testing this second benchmark —it gets to be messy.) A pencil can also easily be held.

The cords which drive the arms are all attached with springs. This ensures that a suitable tension is maintained, and no *relaxation* occurs as the arm operates.

The motors run a little hot, and I smelled burning paint for the first few hours. A call to Colne Robotics assured me not to worry about this. You can turn the motors off from the keyboard, or simply switch off the transformer during rest periods.

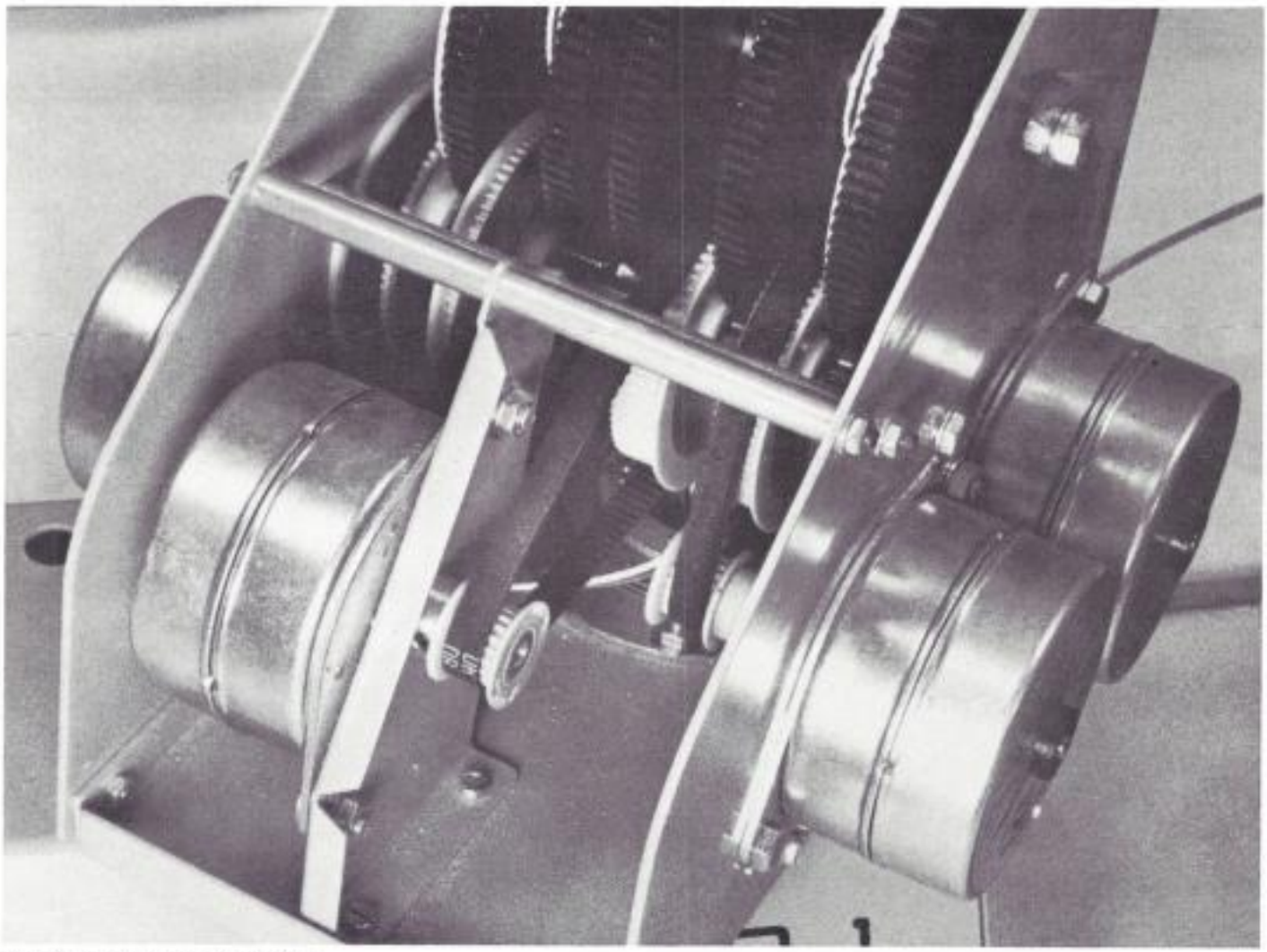

Photo 2. Rubber Belt-Driven Gear Array

DOCUMENTATION

The 78-page main manual is a well-produced and clear document on construction and operation. There are many fold-in diagrams to help in building the device. As I said, I did not construct my Armdroid, so I do not know how good those instructions are. I read them and they seemed clear enough. Some special hex wrenches are supplied for adjustments, but I have never needed to use them. The manual contains source code routines for operating the Armdroid.

The second manual is 39 pages long and describes how to use the Armdroid with the Timex/Sinclair 1000. A complete listing and explanation of the driver program is given. I found this very useful and well written. However, with regard to applications, you are on your own; I would have liked some examples. I understand an upgraded manual is to be released shortly.

OPERATING ARMDROID

After loading the cassette tape, I immediately saved the program on my Aerco disc, so that I could load it in seconds in the future. The Armdroid interface did not interfere with the areas in memory that are used by my Aerco disc system or my Memopak Centronics[TM] interface, so I was able to list the program, write, and copy programs while the robot interface was connected. I was also able to copy menus in the program for use as reference cards.

You can operate the robot remotely from the Timex/Sinclair 1000 keyboard. Pressing any one of 16 keys activates one of the joints and sends it through its range of motions. I recommend you play at this activity for some hours, so that you can get a feel for the individual movements necessary to accomplish an overall movement. Learning to pick up an object and put it down in another place may require several hours. Still, it took you over a year to learn how to do this with your own arm. To accomplish a particular movement, a series of motions must be activated, each for a certain length of time.

Your second project should be to read carefully through the entire manual. I was equally impressed and daunted by the complexity of the software. Many useful subroutines have been provided, so you do not have to reinvent the wheel. You can execute motions with the Armdroid, and the program will remember the kind and speed of the motion.

The Armdroid software makes it easy to perform a movement sequence. You first reset the program and drive the robot to the point where you want to start the sequence. You then drive the arm to points two, three, and so on, and press *P* to save each point location. Then, going back to the menu, you have a number of choices. The program has stored the points and can

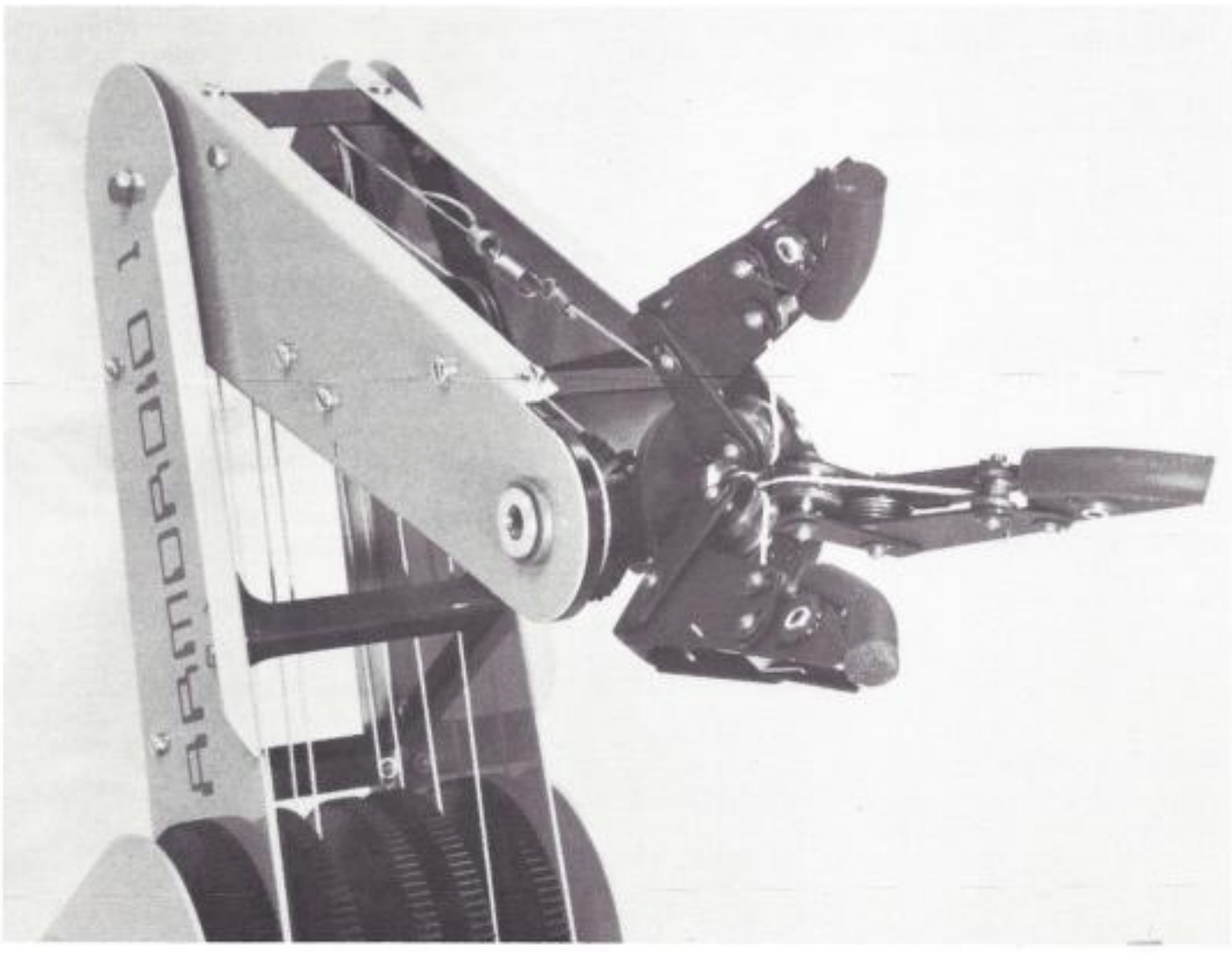

Photo 3. Gripper Showing Three Finger Arrangement

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get to each one from the previous one in the most economical way. You can *home* the arm; get it to go through your sequence of points, once or as many times as you wish; and you can even alter the sequence of points. All of these actions are accomplished by simply touching an appropriate key. There is no need to use the enter key or any multicharacter commands. From the user's point of view, learning and operational ease and the menu-driven features make this machine an excellent teaching tool. Three children, aged six to ten, learned how to operate it in a few minutes. "User friendly" is a very overused phrase, but it certainly is appropriate in the case of the Armdroid 1.

I tried out the Armdroid with two practical movement sequences. Both took only a few minutes to program. In the first movement I had the arm pick up a ping-pong ball and drop it in a box in another position. The movement usually succeeds, but not always. Moving any of the arm joints causes some small motion in another joint. Thus, you need patience, practice, and minor adjustments for such movements to work. The finer the movement, the more difficult it is to repeat.

One solution to the problem is to move rapidly to the general area where the object to be grasped is located. A series of small movements would then be necessary to orient the gripper precisely. The arm could then move in and grip the object.

The second movement I tried turned out to be easier than the first. I put a rubber stamp in the gripper and programmed the arm to repeatedly ink the stamp and stamp a piece of paper. Again, this cannot be done in one movement —this time not due to joint slippage, but due to the efficiency of the program. The control program moves the arm from point A to point B in the most direct fashion. You must emulate the human action of down-up, move laterally, down-up, move back, down, etc. The quality of the result was not great, but I was impressed by it. The six-point movement was executed smoothly and accurately over hundreds of sequences. I raised the ink pad and the paper slightly, so that the arm pressed down firmly on both objects.

My third test movement turned out to be quite easy, once I had learned the lessons from the previous two movements. I programmed the arm to pour water from one paper cup into another one. Then it poured the contents of the second cup back into the first cup. It can do this a hundred times without spilling a drop.

As I mentioned, movement repeatability is quite good. I had the arm hold a fiber-tipped pen, dab on a piece of paper, pick up the pen, rotate the whole arm through 360 degrees, and repeat the movement. Most of the variation in the mark on the paper was due to the pen slipping in the gripper. The series of dots, however, occupied a space no larger than a quarter (2.5 cm. diameter).

Although the brochure from Colne Robotics shows the Armdroid writing its own name, it would take many hours to accomplish such a programming feat.

The Armdroid manual explains how you can write your own movement control program by activating the motors in any desired sequence and for any duration. You can do this by suitable machine-code subroutine calls. The main program, of course, does this at a high level. If you want practice writing your own arm-control programs from scratch, then the software provided is an excellent laboratory from which to start. I must confess that I found this process straightforward, but tedious. This has nothing to do with Armdroid, but rather is a fact of life. I think that it would be good practice for programming other devices that are not equipped with a high level command program. For example, it is possible to write a classical robotic program line such as, *turn wrist 10 degrees*, from the software instructions provided.

SUMMARY

So what good is the Armdroid? It is mainly an educational tool. It helps you explore arm mechanics and movement sequencing. You can learn about interfacing and how to create programs to accomplish complex activities. Since you can immediately see the results of your work, the process is quite rewarding.

The Armdroid I is a well-made piece of hardware that comes with a user-friendly manual and control program. It is an easy-to-learn, inexpensive, educational or experimental robot arm. □

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