**WORKING NOTE AC61**

Alan Creak
23 December 1986

# STEPS TOWARDS A ROBOTIC TABLE ATTENDANT

## BACKGROUND.

In searching for a fruitful way to use simple robots to augment the capabilities of people subject to various sorts of physical limitation on their movements, one particularly important principle was seen to be disabled people's need for independence. This is not simply a matter of convenience. It is certainly easier for helpers if the disabled can look after themselves; but it is more important to consider the loss in self-esteem consequent on relying on other people for the performance of simple tasks which most people carry out for themselves as a matter of course.

An example of such a task which arose in the consideration of one particular case is eating. Transferring the contents of a plate of food to the mouth is, for most people, a task which hardly requires thought; but for someone with only limited control of the arms and hands it can be an impossibility.

It therefore seemed that to aim towards the development of a robotic assistant which could help a disabled person to eat in as close to a normal way as possible would be worth while.

## THE PROBLEM IN MORE DETAIL.

The difficulty of the task depends on just how one interprets the phrase "as normal as possible". At one extreme, one could aim to develop a robot which used a knife and fork in any approximation to normal human usage; that would be very difficult indeed. At the other extreme, simple machines are already available: for example, the "Automaddak feeder" lowers a spoon to the centre of a plate, pushes it to the edge, and lifts the spoon to mouth height – though it can hardly be called a robot, it is a useful device, and better than nothing.

Possible intermediate goals can be imagined ad lib. A fork is better adapted to dealing with certain foods than is a spoon, but would probably need a simple force sensor for effective use; and some sort of gripper – which one can imagine as a combination fork and spoon – could be a useful general purpose piece of cutlery. ( It is certainly effective : it has been tested by millions of people over many thousands of years in the form of chopsticks. ) It seems likely that a gripper could be constructed by a simple modification to a standard robot gripper manipulator. At the other end of the process, some flexibility in the geometry of presenting the food to the eater seeems likely to be valuable. It is certainly true that different pieces of cutlery are subject to different constraints – a morsel speared by a fork is likely to be more tolerant of varying orientation than a spoonful of soup. In the long term, it is realistic to think of the machine as recognising the person's mouth, and of guiding the food to a convenient close position.

An important consideration in planning such a development is the question of how the machine is to be controlled. A purely automatic feeder, which simply scooped up food from the plate and fed it to the user until the plate was empty, might be an aid to independence, but would obviously be far short of the ideal. The person using the machine should be able at the least to select which morsel of food to eat next, and perhaps how it should be presented. Obvious extensions would make it possible to compose a mouthful of food from several selected morsels – that's certainly what I do when I eat. Just how the person should select the next operation to perform must depend on what body movements are available to work switches, joysticks, or other appropriate devices.

## A POSSIBLE LINE OF APPROACH.

It is a good deal easier to write down these thoughts than it will be to put them into practice. It is also a good deal safer; and for that reason we believe that it would be better not to begin work on a feeding assistant but on some less sensitive application where programming errors run no risk of jabbing forks into people's eyes. There are three levels of complexity in the task : first, to cause the robot to perform simple standardised tasks on request; then to learn how the disabled user can guide it through less well defined ( but safe ) operations, such as picking up and moving arbitrary objects on command; and then finally to adapt it to the more sensitive, because potentially more dangerous, task of feeding. We identify three subgoals which lead us by suitable stages to our eventual aim.

- **A floppy disc changer.** The operation of picking a floppy disc from a disc store and inserting into a disc drive ( and also the reverse operation of unloading the disc drive ) is simple and well defined. There is an element of selection, requiring the user to choose which disc to load, but the positions and actions are then precisely defined. In this stage we get to know the robot's capabilities, and how to use it.

- **A simple manipulator.** The next step is to introduce more continuous control, giving the user a way of moving things about. In this stage we explore what sort of primitive operations will be useful, and how the person will be able to control the machine.

- **The feeding assistant.** In this stage, we can concentrate on safety.

We believe that this development plan offers an orderly programme of work which does something useful at each stage, and eventually builds up to the assistant at which we aim. We are not ready to assert that the plan will be completed within the time available for the current project; but we would certainly expect to complete the first stage, and to make good progress on the second.

## EQUIPMENT.

The essential equipment needed for this project is a simple robotic arm, and a microcomputer with which to control it. The arm mechanism must be reasonably precise and reproducible, but extreme accuracy is not needed. It should approximate the human arm in dexterity, so a conventional 6-axis robot is desirable, though some progress would be possible with a rather more limited machine. The arm must be servo controlled, and should for preference be equipped with its own low-level control circuitry so that only the set-points for the various control loops need be specified by the computer. It is also essential that the computer be able to read out the joint coordinates.

The type of computer used is not very important, provided that it has the facilities to communicate with the robot ( which probably means that an 8-bit parallel input-output port is required ). Many – though not all – common brands of microcomputer satisfy this criterion.

Without the robotic arm, it would be possible to make some progress on the first part of the proposed programme using comparatively inexpensive electric motors and a Meccano set; but to do so would not, of course, contribute at all to the later stages of the project.