

# EVALUATION OF A TROLLEY MOUNTED ROBOT - A CASE STUDY

Michael Hillman and Jill Jepson  
Bath Institute of Medical Engineering

## Abstract

The paper describes the evaluation of the Wessex trolley mounted robot. A case study of one user shows how the system was used, and features that the user would like incorporated. The case study is preceded by a brief overview of the background to the Wessex project and a description of the trolley mounted system. The conclusions focus the user's comments to provide ideas for modifications to the system and possible future developments.

## Introduction

BIME has been involved in rehabilitation robotics for a number of years. The aim has been to design a low cost multi-function robotic manipulator. The project has progressed from a workstation robotic manipulator (Wolfson) to the present manipulator mounted on a small mobile trolley (Wessex). This paper describes the reasons for moving away from a workstation system and a brief description of the current Wessex robot. The case study focuses on the experiences of one man using the robot over a period of time and highlights the outcomes from this evaluation which may influence the way forward for the project.

## Background

Following extensive trials of the Wolfson workstation system, the decision was taken to design a small, mobile trolley mounted robot. The people who used the Wolfson found that there were two main reasons why a workstation was impractical for everyday use:

- a desk mounted manipulator is too large for an average home setting,
- many of the tasks undertaken by individuals were personal care functions and they wished to perform these tasks in appropriate places rather than at a desk.

The Wessex project began to design a stand alone assistive robot which is mobile, yet low cost.

## Wessex Robot

The overall geometry of the manipulator was retained from the workstation system and mounted on a wheeled trolley. The upper arm consists of three vertical axes, all to a common design. None of the actuators act against gravity so low powered motors can be used, thus the manipulator is not powerful enough to harm anyone. It is able to carry a load of up to 2kg. A low powered motor is used to drive the vertical actuator. The wrist is a combined pitch / roll assembly and the gripper is a powered prosthetic hand

loaned to us by Hugh Steeper Ltd (London UK).

The manipulator uses an internal aluminium structure covered with a cosmetic vacuum moulded cover and the trolley has slide in side panels, this allows different colours and finishes to be investigated relatively easily. The current model is white and grey.

The user interface uses a scanning menu system on a LCD display. Various parameters of the scanning system and control can be varied to suit the individual user. The LCD display is attached to the trolley by a cable, and can be positioned as near to the user as required. The manipulator may be controlled directly in real time, or pre-set routines may be used from its "parked" position. These routines can be easily created by the user.

## **Evaluation Case Study**

### Case History

The participant (AW) is a man in his late twenties. He sustained a high level spinal injury (C4/5) twelve years ago, and has only enough dexterity in one hand to operate the keys on a palmtop computer. AW lives with his parents and his mother is his main carer. He chooses to use a self propelling wheelchair which he is unable to propel independently, thus relying on his parents to move him around. AW is very dependent on his mother and happy to be so, however he is confident using various technological equipment and regularly uses a Possum

Environmental Control Unit, a Psion Organiser palmtop computer and a personal computer.

### Timetable of Visits

#### Visit 1: 4 November 1994

AW was visited to demonstrate the Wessex manipulator. He tried using the device, learning the control method very quickly. He used a single switch and, at that time, a large monitor on a table with the scanning menu. AW attempted simple tasks such as picking up an empty mug and discussed various uses for which he would like to use a manipulator. He expressed great enthusiasm for participating in the project and it was agreed that the robot would be left with him when it was ready.

#### Visit 2: 23 October 1995

The Wessex manipulator was taken to AW for an extended period of evaluation. The main difference to the system initially demonstrated to him was that the large monitor had been replaced by a compact LCD display. AW needed very little further training in the control of the manipulator. Some possible tasks were suggested to AW but he was encouraged to try out any ideas that he had to test the range of possibilities. During this visit AW expressed that he would like to be able to set up different menu structures and change switch settings himself. It was felt that theoretically this could be done through his Psion computer but would not be possible for him during this evaluation.

Visit 3: 5 December 1995

A visit was made to check on AW's progress and gain interim feedback. He was using the manipulator regularly and successfully.

Visit 4: 15 January 1996

The robot was collected and the evaluation discussed with AW.

### Outcome of Evaluation

AW had successfully used the manipulator for a wide range of functions:

- taking his temperature,
- holding down the pages of a book,
- eating,
- operating a massage machine,
- cleaning his teeth using a battery operated toothbrush,
- pressing the shift key on his Psion computer,
- arranging his personal space i.e. moving things around his desk,
- operating a television remote control,
- opening Christmas presents
- drinking using a straw in a beaker.

He had tried unsuccessfully the following two tasks:

- picking up the telephone receiver and hold for calls,
- turning the pages of a newspaper.

During the first task he found that there were problems with the maximum height of the manipulator, and with the wrist movement and gripper. The second task was prohibited by the maximum range of the manipulator.

AW had used the manipulator in various rooms of his home according to the task he was performing, but he

generally used the same arrangement in each room i.e. the trolley flush to the side of the wheelchair so that he could utilise the space on his tray.

### User Recommendations

Top of AW's wish list was that the trolley should be powered so that it could move across the room to fetch something for him. The trolley should have a waterproof top in case drinks are spilt, and a drop leaf flap on the side of the trolley could add extra surface area when needed. The LCD could be mounted near the pillar of the robot using a multi-angle clamp.

The gripper needs to have a slower, more controllable movement on "close", together with a thinner jaw so that it can be pushed under objects. A suction or magnetic attachment on the gripper would increase the range of functions, and a second gripper or jig on the trolley would be useful. AW would like the gripper to have pitch movement and the wrist to roll through 360 degrees. The size of the arm is acceptable but AW is over 6 feet tall and would like to have extra reach and 10 cm more height. The arm should be more rigid especially at maximum extension.

A number of software suggestions were made. AW uses many very short routines and found that there was not enough catalogue space for these (the current limit is 36). He would like to see a number of modifications to the "routines" function to increase their usefulness. AW would like the speeds and other parameters to be selected by

the user via the menu system, and some minor modifications to the "park" routine.

AW was asked to score (out of 10) various pieces of equipment which he uses according to how useful they are to him. He assigned a maximum score to his wheelchair, with the robot graded alongside his PC computer. This score would increase if the mobile base was remote controlled.

## **Conclusions**

AW was generally happy with the system and had been able to use it successfully without technical back up over a three month period. He learned to control the device quickly and efficiently, very soon requiring more sophisticated user controls which were not available. AW used the manipulator for a number of diverse tasks which the project team had not imagined illustrating the multi-functional nature of the device. Most of all AW wished that the mobile base of the robot was remote controlled as this would increase its usefulness to him.

The project team were satisfied that the system worked efficiently in situ over a period of time without the need for continual visits. It was encouraging that the manipulator had been used for such a range of different tasks. AWs comments provided much food for thought. The gripper is already undergoing a programme of redesign to increase its function. The user control mechanisms should be looked at but

must not become so sophisticated as to deter new users. However, this evaluation and others have shown that users soon develop a high level of competency and perhaps a graduated system of control could be designed to grow with the user. The suggestion of a remote control mobile base introduces new challenges for future work.

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## **Address**

Mrs Jill Jepson Dip. COT  
Bath Institute of Medical Engineering,  
Wolfson Centre,  
Royal United Hospital,  
Bath BA1 3NG, UK  
Tel. (44) 1225 824103  
Fax. (44) 1225 824111  
email bime@bath.ac.uk