Published in 1984 based on an undergraduate project supervised by the authors.
The name of the place this was published is lost (as is the name of the student)

A PORTABLE NAVIGATION AID FOR THE BLIND

Prof Ian Frestone, Dr Vic Callaghan

Department of Electronic and Electrical Engineering
University of Sheffield, Mappin Street, SHEFFIELD. S1 3JD, U.K.

SUMMARY

A microprocessor-based aid for the blind is described. It is portable, battery-powered and provides information to the user about urban walking routes using coded sounds to indicate what decisions to make. Depending on the length of route, 25 or more routes can be stored in the memory for as long as an estimated nine years. The routes stored, and the information about them, are particular to each user, and can be erased or modified if required.

INTRODUCTION

Among the aids to mobility available at present for a blind person are guide dogs, tactile maps, and the person's memory. This paper describes a microprocessor-based electronic aid which is essentially an extension of the person's memory. The electronic aid would be particularly useful for long or infrequently travelled routes.

A mobility aid such as the one to be described has to satisfy the following important criteria.

(a) It should be fully portable, of manageable size and weight, and independent of the operating environment. This implies battery powered operation.

(b) As far as possible, all wires should be inside the unit, as external leads limit the freedom of the user, could be conspicuous, and would be susceptible to damage.

(c) The aid should have a low capital cost.

(d) Operating and maintenance costs should be as low as possible.

(e) The aid should be uncomplicated to use, and the design should incorporate comprehensive protection against human error.

(f) The output signals to the user should be clear and unambiguous.

(g) As far as possible, the design of the aid should be flexible to permit improvements and modifications to be incorporated.

Not all these criteria are of equal importance, their significance may be different for different users, and to some extent they may not be self-consistent. Nevertheless this set of criteria was kept in mind during the design of the aid.

PRINCIPLE

The aid has two modes of operation, record and playback, and the playback mode has two directions, forward and reverse. The user selects one of these three possibilities by a switch.

In the record mode, the user walks the route of interest (under instruction of some sort), and the aid counts the paces taken by the user. When the user reaches a decision point, for instance a point at which the route takes a right turn, the user presses a key on the aid coded with a right turn instruction. This has two effects.

(a) The number of paces counted is stored in memory, and the counter reset to zero; and

(b) The right turn instruction is stored.

The user then walks to the next decision point, and the above procedure is repeated.

In the playback mode, forward direction, the aid again counts the number of paces taken by the user, and when this is equal to that stored in the memory for that particular section of the route, an audible signal is given to the user. The audible signal is coded to indicate what action the user should take at this point, for instance turn right. In the reverse direction, the procedure is exactly the same except that the route information stored in the memory is used in reverse order, and that left and right are interchanged.

From this brief outline of the principle of the aid, it is evident that the aid incorporates some essential hardware components such as a pedometer to count the paces, a memory, an audio output etc; these will be discussed in further detail in the next section.

At decision points, the user can make any of the following decisions :

1. Turn right
2. Turn left
3. Cross road
4. Cross road junction
5. Pedestrian crossing
6. Steps
7. Pause (Routing is halted temporarily)
8. Stop (end of route)

Each of these decisions has a separate key. In addition there are two extra keys available, which are undefined in the present software, but which the user could have available for their specific use.

The aid can store a number of routes, each of which is numbered, and can be selected using the same set of keys as for the decisions. In principle, up to 99 routes can be selected with this set of keys; in practice the number is likely to be set by the size of the available memory.

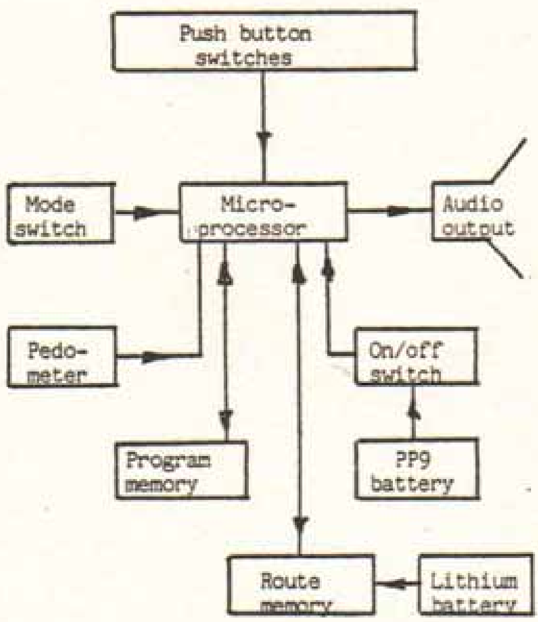

Figure 1 : Schematic Circuit Diagram

PRACTICAL DETAILS

A block diagram of the aid is shown in figure 1, and the important individual components used will be described below. Figure 2 is a line drawing showing the aid in its plastic case, of dimensions 120 x 65 x 40 mm, which is worn on the hip in order to register the user's paces.

Microprocessor

The microprocessor used in the aid is the 8-bit NEC μPD80C35, which uses CMOS technology. The low power consumption of CMOS technology is the determining factor in its favour; the particular processor used was chosen by the availability of hardware and software development tools.

Program Memory

The 80C35 has no internal program memory, and so an EMPROM was used to store the program. Again power consideration are paramount, and the National Semiconductor NMC27C16 EPROM was used. This is a static device with a memory size of 2k x 8 bits.

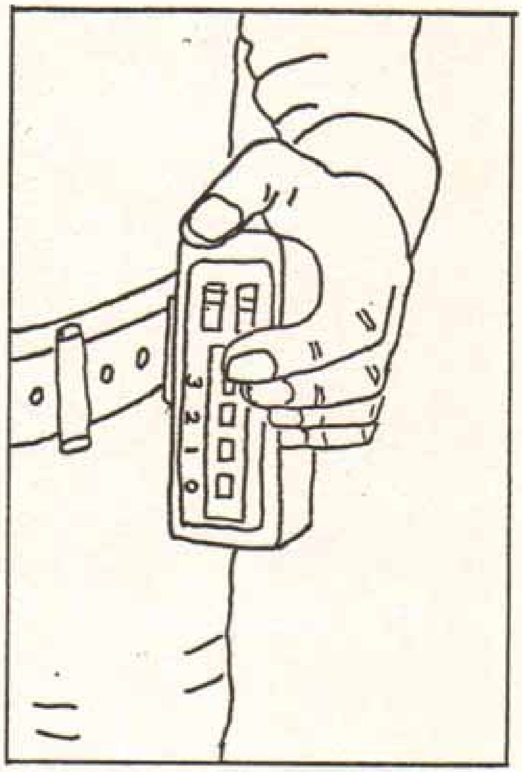

Figure 2 : The Navigation Aid in use

Route Memory

This memory preserves information about the route; it needs to do this even when the aid is switched off. But also the route memory needs to be able to be modified readily by data sent from the microprocessor, for instance if it is decided to delete or modify a route. After consideration of various alternatives, the NEC µPD-449 CMOS RAM (2k x 8-bit) was chosen. It needs a back-up power supply and a Tadiran lithium inorganic battery TL-5101 is used. The drain on this battery by the memory is such that the data could be stored in the memory for an estimated 9 years. It is not difficult to provide a means of reading out the data from the route memory should the back-up battery need to be changed. With this memory, it was estimated that about 25 typical urban routes could be stored.

Push-Button Switches

These switches enable the user to select routes, and to enter decisions. They are placed on the side of the case, and some of them can be seen in figure 2. It is of course possible to label these keys with braille symbols if it is thought necessary. A second version of the aid is being developed which uses a hexadecimal 4 x 4 key pad.

Audio Output

The audio output was a piezo-electric device, which was activated by pulses from the microcomputer. The output was coded to represent the different actions to be taken (e.g. right turn) using different frequencies, and modulations of the sound output. In the second version being developed, the possibility of using a voiced output is being investigated.

Pedometer

Various methods of counting paces were consiered, but that chosen on grounds of reliability, cost and simplicity was a mercury tilt switch. Each stride of the user causes a mercury blob in the switch to move, and hence to break contact. It is then straightforward to use this break in contact to indicate that a stride has been taken.

USE

The aid is straightforward to use. It is attached to a belt which is fastened around the user's waist. There is provision for a test to ascertain that the user's stride does break the contact on the mercury switch, and the angle of the aid on the belt can be adjusted to ensure this is so. The user then selects the route number, and the appropriate mode and direction. In the second version a repeat button is to be incorporated to enable the user to make the aid repeat the audio signal indicating a decision. This is to ensure that the user can be certain of the decision, if it is obscured the first time by, for instance, traffic noise.

The aid has been used on limited preliminary trials, but it is planned to carry out more extensive tests in the near future.

CONCLUSIONS

The aid is portable, simple to use, and relatively cheap. The component costs are less than $100, but no assessment has yet been made of construction costs.

One advantage of the aid is that the use of a record mode, means that the aid is automatically adjusted to the length of stride of the individual user. Another advantage is that routes can be erased or modified as the user wishes.

Although the aid has been designed to be self-contained and without external wiring, it is possible to use it in conjunction with headphones, particularly if voiced output is used. If this is done the aid could be designed to mimic personal cassette players (or indeed be incorporated within one) to avoid being conspicuous.