GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT INITIATION

Date: April 10, 1980

Project Title: A Cooperative Rehabilitative Engineering Program

Project No: A-2570

Project Director: Gary W. Kelly

Sponsor: Veterans Administration Medical Center

Agreement Period: From January 25, 1980 Until January 24, 1981*

Type Agreement: Contract No. V508P-587 dated 1/25/80

Amount: $139,413 (includes $5,118 in subproject E-25-631 and $5,881 in subproject E-21-612)

Reports Required: Quarterly Reports; Final Report

Sponsor Contact Person (s):

Technical Matters

Mr. Frank Coombs
Contract Coordinator
VACO
Rehabilitative Engineering R&D Service
610 Vermont Avenue, N. W.
Room 644-A
Washington, D. C. 20520
(202) 389-5177

Contractual Matters
(thru OCA)

Barbara C. Maloney
Contracting Officer
Veterans Administration Medical Center
1670 Clairmont Road
Decatur, GA 30033
(404) 321-6111, Ext. 314

Defense Priority Rating: None

Assigned to: TAL/AED (School/Laboratory)

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*No work to be performed after 9/30/80 unless and until notified in writing by Contracting Officer.

CA-3 (3/76)

GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SR421
2-

SPONSORED PROJECT TERMINATION SHEET

Date 1/11/82

Project Title: A Cooperative Rehabilitation Engineering Program

Project No: A-2570 (sub under B-10-A00)

Project Director: Gary W. Kelly

Sponsor: Veterans Administration Medical Center, Atlanta, GA

Effective Termination Date: 2/16/81

Clearance of Accounting Charges: _____

Grant/Contract Closeout Actions Remaining:

None

- ☐ Final Invoice and Closing Documents
- ☐ Final Fiscal Report
- ☐ Final Report of Inventions
- ☐ Govt. Property Inventory & Related Certificate
- ☐ Classified Material Certificate
- ☐ Other _____

Note: Subproject terminated at request of Dr. S purlock. Funds transferred from main project to offset negative balances.

Assigned to: TAL/AED (School/Laboratory)

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FORM OCA 10:781

A-2570

QUARTERLY PROGRESS REPORT
February 1, 1980 to April 15, 1980

COOPERATIVE REHABILITATIVE ENGINEERING PROJECTS

Contract No. V508P-587
Research Project A-2570

Prepared For
Atlanta Veterans Administration
Medical Center
Atlanta, Georgia

by
THE ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY
Atlanta, Georgia

April 22, 1980

Introduction

The six projects within this contract have all started and continued approximately on schedule. There have been modifications to the schedule which have resulted in some subtasks being further ahead and some slightly behind the original time table. Each project will be briefly discussed.

1. Coordination and Administration Project

   This project had no specific time table but the efforts to date have resulted in immensely improved communication between Atlanta Veterans Administration Medical Center and the Georgia Institute of Technology. Coordination with Dr. Robert Kolodner has resulted in the development of a larger program plan for the future and a better directed effort at submission of proposals for the near future. This effort is expected to continue in much the same way over the next quarter.

2. Graduate Feasibility Studies

   This project has evolved into two graduate feasibility studies. A third was planned but a suitable student has not been located. We are presently considering revising the third project to continue as a function within one of the remaining two. The two projects presently underway are project R2D2 and the Development of an Alternate Transit Vehicle for the Severely Handicapped.

   In Project R2D2 a graduate electrical engineering student is programming an Apple II plus microcomputer equipped with an ALF Music Card to produce musical tones for each ASCII character. This will allow the Apple to be utilized as a musical terminal. The software was designed to meet specific human factors requirements and the project will involve user development of the actual language. Remarkably enough the first version of R2D2 is now available and testing is expected to commence within the next month. We are considering extending this project with a greater effort in general terminal development for the physically handicapped.

The second project concerning the development of an alternate transit vehicle for severely handicapped is an attempt to design an alternate to the powered chair. A graduate mechanical engineering student has chosen this for a thesis topic and we have met extensively with Mr. Gorden Stout of the Biomechanics Laboratory at the University of California, Berkley. We hope to cooperate with him in the development of this vehicle which is designed to be more than a wheelchair and less than a golf cart. Work is on schedule and the information gathering phase is almost complete.

3. Electronic Typewriter for the Visually Impaired

This project has shifted direction twice since beginning. There was a trade-off between the desirable human factors and the available hardware. Also within the last month the microprocessor was changed. We now intend to utilize an RCA 1802 microprocessor. The size of the device is somewhat larger and heavier than we had hoped for but reduction in size will have to be a product of further research. The device is intended as a large-print equivalent of cassette braille machines. Conceptual hardware design is well underway and the human factors survey has now been written since the decisions have been made that will outline the overall configuration. We will complete the survey in the next month and construction will begin approximately one month behind. This is not expected to substantially delay the project.

4. Sonic Orientation and Navagational Aid (SONA)

Project "SONA" is the new name for the sonic finder and a more descriptive title. The Sonic Orientation and Navagational aid for visually impaired persons have moved along ahead of schedule in securing hardware. We have had good industrial support and will be able to utilize low cost digital transmission equipment utilized in garage door openers. The survey has been written for this project and will be given over the next month. No delays are expected due to the early solution of many of the contemplated hardware problems.

Since the presentation of this concept in the Triagency Conference on Rehabilitative Engineering in Atlanta last August, there have been many favorable comments and suggestions.

A great deal of progress has been made and we expect to continue with similar progress over the rest of the project due to the extensive cooperation we have received from industry. The companies manufacturing radio controls have been most cooperative in their support of our efforts. With their assistance we expect to construct a readily manufacturable item at low cost.

5. Communicator for the Speech Impaired

This project is now ahead of schedule in that construction of a prototype has begun. The survey was delayed until certain basic information could be gathered concerning engineering options available in a prototype. Work may now proceed on a survey and a lab prototype is under construction. The display for this unit has been the greatest problem to date. The problem can be solved but tradeoffs will be necessary.

6. A Manual Wheelchair with Anti-Rollback

This project is now entering a final design stage. Considerable progress has been made in the design, and final design awaits the results of the human factors survey. This survey has been developed and pretested. It is now being given and will be processed over the next few weeks. It is anticipated that the results will allow final design decisions and construction will begin immediately thereafter.

No problems are anticipated for the construction phase. At this time we believe that the project will run ahead of schedule allowing more time for user evaluation.

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Second Quarterly Report

THIRD QUARTERLY REPORT

Atlanta Veterans Administration Medical Center/Georgia Institute of Technology Rehabilitation Technology Program

October, 1980

INTRODUCTION

This is the third quarter report for the cooperative Rehabilitation Technology Program for the Atlanta Veterans Administration and the Georgia Institute of Technology. Progress has been substantial and will be detailed by project in the following sections. All projects are on the proposed schedule and will finish within the contract period.

SONA, SONIC ORIENTATION AND NAVIGATION AID

This device now exists in three prototypes and is multiplying rapidly. Problems of keyboard interface with the transmitters have been overcome. It is anticipated that at least three transmitters and twelve receivers will be available for testing by December 1st. An administration decision was made to delay the completion by one month to allow student participation in the packaging of this and two other devices. The projects are being assigned to an undergraduate class of Industrial Designers to develop housings that will meet human factors criteria as well as production criteria. The class will design and construct the casings for SONA during the fall quarter. All other technical problems appear to have been overcome and preliminary evaluation for utility will commence in December.

ELECTRONIC TYPEWRITER FOR THE VISUALLY IMPAIRED

This device is now nearing completion also. Technical problems of interfacing and securing hardware that met the user needs found in the initial surveys have all been solved. Software needs are still being met. The next month will see the development of the first complete prototype for evaluation and testing.

Again the actual evaluation will be delayed one month to allow Industrial Design students the experience of designing a housing for the device that meets the criteria set forth by the users.

ELECTRONIC COMMUNICATOR FOR THE SPEECH IMPAIRED

This project is actually in a second generation prototype status. The first prototype, while fulfilling contractual requirements, lacked a low enough production cost and had some human factors limitations. The decision was made to move quickly on a second prototype that would meet more of these needs and cut production costs in half. This will be accomplished. The second prototype is under construction now and will be packaged by December 1st.

A one-month delay was encountered to allow undergraduate Industrial Design students to participate in the design of the housing for this and the other two devices. This delay was necessary to coincide with the school quarter system. The evaluations will begin in December.

WHEELCHAIR WITH INTEGRAL ANTI-ROLLBACK CAPABILITY

Gary W. Kelly, Research Scientist
Kenneth S. Morgan, Graduate Research Assistant

A complete set of designs have been developed and two working prototypes have been fabricated. Preliminary examinations and tests have uncovered several minor design flaws which are currently being corrected. User tests will be conducted as soon as these corrections have been completed.

FEASIBILITY STUDIES

The musical terminal (Project R2-D2) is a reality and one blind student is now learning to use the language. He has attained speeds in excess of 120 W.P.M. on a limited Cobal vocabulary. He is learning to become a programmer in Cobal and has aided in selecting the vocabulary that he is learning.

Modification of the program is now underway to allow it to function with a micromodem as well as with an RS-232/C serial interface card. This project is ahead of schedule. Further evaluation will continue.

The second feasibility concerning the alternate transit vehicle for

severely handicapped is continuing on schedule.

ALTERNATE TRANSIT VEHICLE FOR THE SEVERELY HANDICAPPED (Graduate Feasibility Study)

Gary W. Kelly, Research Scientist
Kenneth S. Morgan, Graduate Student Assistant

A variety of general vehicle designs have been studied as well as variations of certain mechanical subsystems. One of the most promising configurations yet developed is a rear-wheel drive vehicle with a simple two-speed transmission and electro-mechanical steering. Also included is a non-powered curb-climbing mechanism for the front wheels and a simple powered mechanism for the rear wheels. The investigators also hope to include state-of-the-art advances in battery, electric motor, and controller technology in this design.

COORDINATION AND ADMINISTRATION

Efforts at developing a formal affiliation among Atlanta Veterans Administration Medical Center, Georgia Institute of Technology, and Emory University continue. These efforts are meeting with considerable success with the recent participation of Dr. Robert Kolodner at Atlanta Veterans Administration Medical Center to the program. Efforts are now being made to increase communications with Emory and promote staff development at Georgia Tech. New projects are being developed with Atlanta Veterans Administration Medical Center.

These efforts, as well as day to day management of the contracts, are expected to continue through the remainder of the contract.

ADVANCED CONCEPT DESIGN OF A HIGH-PERFORMANCE INDOOR-OUTDOOR VEHICLE FOR THE PHYSICALLY HANDICAPPED

Gary W. Kelly, Research Scientist

Kenneth S. Morgan, Graduate Research Assistant

The initial phases of this program have been devoted to studying the current state-of-the-art of powered wheelchair design and an attempt to gather as much information as possible about wheelchair users, their wheelchairs, and the way they use them. To this end, an in-depth survey of powered wheelchair users in the Metropolitan Atlanta area is being conducted. The results of this survey will provide a detailed account of what powered wheelchair users do and don't like about their wheelchairs, and what changes and trends they would like to see implemented. The investigators will then attempt to incorporate some of these ideas in a vehicle design of their own.

The design study began with an examination of several commonly available powered wheelchairs as well as some prototype models from U. C. Berkeley's Biomechanics Lab and two extremely sophisticated production models from Permobile of Sweden. The investigators have also been investigating the feasibility of full and partial tracked vehicles as well as more conventional three and four wheel configurations using either front or rear wheel drive.

PROTOTYPE WHEELCHAIR WHEEL WITH INTEGRAL ANTI-ROLLBACK CAPABILITY

Gary W. Kelly, Research Scientist
Kenneth S. Morgan, Graduate Research Assistant

The goal of this project is to develop a wheelchair wheel with an integral anti-rollback device that can be substituted for existing wheels without requiring any modifications or additions to the wheelchair frame. This device is intended to aid people who are confined to manual wheelchairs to climb ramps, hills, or other inclines without fear of rolling backwards.

The design of this wheel (two prototypes will be built later this year) has evolved over the last six months from a rather conventional looking wheel with a hub mounted clutch unit to device that more closely resembles a rolling element bearing.

The centrally located hub/bearing unit and the troublesome wire spokes have been replaced by a circular track supported by the struts and a mounting bracket that utilizes the existing axel bolt and mounting hole in the wheelchair frame. The tire itself will be fitted to a machined rim that will also support three interior mounted roller modules spaced at 120 degree intervals which will in turn ride on the outside of the circular track.

These roller modules contain the key elements of the anti-rollback device. Each V-groove roller (which rides on the track) contains a small roller-clutch/bearing unit that rides on a bearing supported axel mounted to the module housing. The axel also has several regularly spaced radial holes at one end to accept the tip of a spring loaded plunger, which is mounted to the side of the module housing.

In operation, the tire/rim assembly will rotate freely on the track when moving forward and will lock when rotating backward. This locking is accomplished by having the roller-clutch lock on the shaft and locking the shaft with the

plunger. Should the wheelchair user want to roll backward, the plungers on all three modules may be disengaged simply by pulling back on the pushring, which retracts the plungers using a simple linkage. When the pushring is released, the plungers are automatically re-engaged by spring action.

The advantage of this system compared to those anti-rollback devices currently on the market is that this device is completely controlled by moving the pushrings forward or backward. Existing devices require the wheelchair user to remove his/her hand from the pushring to manually engage or disengage the device, thereby risking a temporary loss of control of the wheelchair. This new device will also permit the wheelchair user to execute normal turns (by moving wheels in opposite directions) when climbing narrow ramps and inclines.

It is expected that future work utilizing this wheel configuration will result in a wheel with integral anti-rollback and a braking system as well as the possibility of developing a family of wheels with various degrees of mechanical force reduction. This last concept should be particularly useful to those wheelchair users that have some use of their arms but not enough to be able to handle a standard manual wheelchair and are subsequently confined to powered wheelchairs.

THE SONIC ORIENTATION AND NAVIGATION AID

G. W. Kelly, Research Scientist
R. D. Atkins, Research Engineer

Background

The sonic orientation and navigation aid, Sona, is a new concept in mobility and orientation of the blind. Over the past twenty years there have been several notable attempts to develop electronic mobility aids. The majority of these have met with little or no success. The present device does not pretend to be a mobility aid but an orientation aid. The transmitter is carried by the blind user and the receivers are mounted at key places in the environment such as restrooms, entrances, emergency exits, elevator call buttons, and similar important landmarks.

The user enters a code for that location, such as 911 for an emergency exit. The receiver upon recognizing this digital code replies with a sound. The traveler may now orient with respect to the sound and use a cane or dog to progress to the exit in a normal manner.

The device is based on existing garage door opening devices with a modified transmitter to allow input through a touch-tone keypad. The transmitter is approximately the size of a package of cigarettes, and battery powered. The receivers are permanently mounted and can be run at low cost from existing 110 volt electrical supplies.

Hardware

The transmitters and receivers are identical to those used in garage door equipment. Several devices have been purchased and tested for range, coding, power requirements, and reliability. They are highly satisfactory with ranges of 75 feet nominally, and as much as 150 feet. Signals do not penetrate between

floors in buildings where this has been tested and no antenna is required on the transmitter. The circuits are CMOS low power circuits and as many as 512 addressable codes are available. This is more than enough for our purposes. We are now developing a variety of tone output circuits from an available synthesizer chip to improve tonal variety that will be feedback to the user that he is getting a correct response for his entered code. An example would be a bass note for the men's room and a higher note for the ladies room.

Software

Fortunately no software is required. The modification of the transmitter to accept entry from a keypad rather than the setting of dipswitches is entirely a hardware modification.

The receivers require only a voltage and a circuit to turn on or off instead of an electric motor.

Future Research

It is anticipated that several transmitters and as many as 40 receivers will be operational this fall. Initial tests of the utility and reliability of this system will be conducted. It is hoped future tests will be encouraged at other facilities and research conducted into improved packaging. The present projected costs are about $25 per transmitter, and $30 per receiver for modified units. Units constructed for this purpose should be lower cost in larger quantities.

Future research will be based on broader applications for the device such as voice output from the receiver for utilization in bus systems. The bus could answer the transmitted beam with its destination. Also,applications in elevator control systems to avoid panel modification for those confined to wheelchairs will be explored. This system would allow floor entry by a portable panel. When used by the blind the elevator could signal the proper floor upon arrival by knowing that the transmitted code for that destination was entered from a transmitter and not the usual panel.

ELECTRONIC TYPEWRITER FOR THE VISUALLY IMPAIRED

G. W. Kelly, Research Scientist
L. J. Moriarty, Research Engineer

Background

There are now three different manufacturers of cassette braille machines for the blind, but there is not yet a machine that reproduces large print for visually impaired with usable vision.

The present project is to develop a device suitable for use by persons who would normally use large print if it were available. Many of these persons would now be using CCTV systems with limited success and no portability. They are confined to doing their reading in one place and may encounter difficulty in using CCTV for any serious long term reading. Too many of these persons are forced to utilize recorded materials which have the same limitations for them as the totally blind person.

The electronic typewriter is analagous to cassette braille machines except that the entry method is a normal typewriter keyboard. Material is stored electronically in the machine and when the memory unit is filled the information is stored on a standard cassette. This material may be recovered at a later time and displayed on the one line 40 character self-scan display. The characters are .2 inches high or approximately 20 point type. The characters fill the screen from right to left and continue scrolling across at a rate determined by the user.

An optional CCTV output is provided to allow coupling to a television monitor such as used on CCTV's. The format would be 40 characters, 24 lines.

Hardware

The prototype under construction will consist of a keytronics keyboard, and American printing house modified 4 track monoral cassette recorder, a digital electronics corp. vacuum fluorescent display, and RCA 1902 microprocessor. The device will have 8K bytes of memory for storage of information and a battery pack capable of providing an operation time of four hours before charging.

The electronic typewriter is designed to be the size of an attache case and weigh about ten pounds. This could be smaller with production packaging.

The device is equiped with RS232C interface for use with a computer or a printer. An aditional output will allow interface to a video monitor.

Software

Software consists of programming that allows the device to operate with many of the same functions as cassette braille machines. Additionally, of course, it must control the self-scan display.

The software and hardware does allow the cassette unit to be used independently as a cassette recroder. The American printing hour unit was chosen so that the consumer would be familiar with the unit.

Future Research

The unit is expected to be completed this fall. Short term evaluation and testing will follow. It is hoped that funding will be available for an indepth evaluation and the development of improved units.

Additional features that should be added in later models are: a calculator, speech compressor, and BCD inputs for other digital devices. Investigations into multi-line displays, improved software, and better packaging would carry the device closer to a production model.

RESEARCH ON MICRO-COMPUTER/COMPUTER TERMINAL CHARACTER-TONE OUTPUT FOR THE BLIND

G. W. Kelly, Research Scientist
D. A. Ross, Graduate Research Assistant

Introduction

An attempt at character recognition through the use of tones has been done in the creation and sale of the stereo toner a number of years ago. The use of this idea seems to have been all but forgotten over the years, yet appears to be an inexpensive solution to the problem of "displaying" computer output to the blind.

The purpose of the present research is to develop tone generating software for a low cost micro-computer which is capable of acting as a computer terminal.

Hardware Choices

A number of micro-computers were looked at in terms of flexibility, ease of software development and support, and cost. The Apple II was found to be very flexible in terms of both hardware adaptability, and software development. Also, the entire system needed for the above project costs less than $2500.

The system purchased was an Apple II with 48K of random access memory and a five inch floppy disk drive. An Alf music board capable of producing three simultaneous tones was also purchased. This board was designed by Alf Corporation to plug directly into one of the I/O ports on the Apple and produce tones within a six octave range when properly poked by the Apple II processor. The other items purchased were an RS232C interface and a DC Hayes modem which enable the Apple II to be hooked by phone or cable to a main computer.

Software Development

The basic software which has been developed assigns one to three pitches to each of the possible 128 ASCII characters. Each letter of the alphabet is assigned a single discrete tone. Significant effort was made in the assignment of these tones to assure that they would be musically pleasing to the ear for a large number

of commonly used letter and word combinations. Each of the other ASCII characters has been assigned a combination of two or three tones which give them a unique, and easily recognized sound.

In addition to the above basic software, playback, list, and search software is also in its completion stages. This software will allow the used to get an "instant replay" of the information he has just received from the main computer. The played back material may be listened to at any chosen speed as selected by turning a game paddle potentiometer attached to the Apple II. The search feature will allow the user to find and list (with tone output) any part of his transaction with the main computer and the main computer's responses.

Future Developments

It is conceivable that this software could become the basis of a new "musical language" for the blind. The software could be translated into simple hardware which would be independent of the Apple II. This hardware, then, could be interfaced to a number of possible electronic readouts such as digital voltmeters, digital clocks, etc.

It is also possible to use this new "language" to store and retrieve "talking books" directly from computer storage. Finally, in conjunction with a print recognition program, it could be used to directly translate the printed page into a "musical language" for the blind at an affordable cost.

COMMUNICATOR FOR SPEECH IMPAIRED

Electronic Communicator for the Speech Impaired

G. W. Kelly, Research Scientist

J. Wallace, Electrical Engineer

Background

The purpose of the electronic communicator is to enable the speech impaired to manually key in information to a device which then displays it for someone else. There are presently some devices on the market which are in use. However, there are a number of problems with them. There are some that have voice output, but they are expensive, and not very portable. There are less expensive devices which are small and quite portable, but their alphabetic keyboard is also small and awkward if not impossible to use since many who are speech impaired also have other physical impairments.

The communicator being designed in our current project is small, portable, low cost, and has single key entry. This single key allows even those who have only gross hand control to enter and display their messages easily. The only drawback is that the user must know morse code which requires some training, but the training of morse code has over the years been reduced to a simple routine for anyone with the motivation to learn it. Also, the key used for entry is semi-automatic, making the entry of dots and dashes dependent on the direction in which the key is pushed (either left, or right).

Hardware Used

The device has basically three parts: 1) a two-way key for entering the morse code. 2) a micro-processor which interprets the entered code and places the entered code on the display, scrolling the characters across the screen as they are entered. 3) a sixteen character alpha-numeric display.

In addition to the above, there will be a small speaker in the device to provide audio feedback to the user. Also there will be switches allowing the user to select automatic repeat and speed control if the user has the dexterity to use it.

The micro-processor is an Intel 8748 which has its own programmable read-only memory on board. The device will operate for four to six hours from a pack of rechargeable nickel-cadmium batteries. The display has sixteen 0.5-inch LED characters.

Software

The software written for the processor updates the display every 80 micro-seconds, scrolling it as each character is decoded and adding the decoded character to the display. Between updates it decodes the key entries as the user enters them. It also looks for key closure and outputs a one thousand Hertz tone while the key is closed. If the device is switched to the repeat mode, the software will automatically repeat whatever key entry the user has made until the key is released. For each repeat, the tone is also repeated. The repeat rate may be either fast or slow, depending on the setting of a repeat rate switch.

The above software has been completely developed, but has not been tested as of yet on the actual hardware to be used. A primitive prototype has been produced using other hardware, and does function properly.

Continued Development

The final prototype will be finished this summer and be subject tested beginning in late summer. There are possibilities of continued development of the device for the manually impaired. The single key could replace keyboard entry on computer terminals, enabling easy use of these terminals by the manually impaired.