Telephone Access:

Proposed Designs for Handicapped Telephone Operation

BME 201
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Table of Contents

Abstract:

Current devices available to help individuals with disabilities use the telephone only address one ailment. Individuals with multiple disabilities who need the aid of two of these devices often find them to be incompatible with one another. Another large disadvantage is that these devices have a limited capacity for storing telephone numbers. This project is aimed at creating a way to provide an individual, who has multiple physical and communicative disabilities, with sufficient means to both receive and place telephone calls from an extensive phone list. This project will focus on modifying and combining existing products, as well as creating new ones in an effort to solve this problem for a specific patient. In the long run, however, it could be adapted to help others suffering from similar ailments.

I. Introduction/ Background

The targeted client suffers from hearing, visual, and physical impairments, however; the client is very mentally aware. The client wears hearing aides and suffers from tunnel vision. The visual impairments allow the client to read the text of a newspaper at a distance of approximately two feet, but prevent the client from being able to read the headlines. This type of visual impairment is not very common, but typical for patient's of tunnel vision. The client's physical ailments resemble that of a patient with multiple sclerosis and confine the client to a mechanized wheelchair. The client also suffers from the loss of fine motor control of the extremities. These ailments prevent the client from being able to initiate a telephone call independently. Currently, in order to place a telephone call, the client must summon a nurse on duty to place the call. The

client is able to answer telephone by pressing a button that hangs from their neck. A speakerphone is used instead of a hand held phone to communicate.

Motivation

If successful, our design would allow our client to initiate telephone calls without relying on others, which would provide our client with a sense of freedom and independence. This ability would help relieve the frustration of relying on others because the client is very mentally aware but physically dependent. The telephone is the client's main source of contact with family and friend. Our design would also increase the productivity of the nurses who help our client place calls because our client would be able to make calls at their leisure. It would also eliminate the issue of someone's line being busy and coordinating with the nurse several attempts to place one call.

This problem likely applies to many people who suffer from similar symptoms as our client. A successful design would be adaptable for other individuals who suffer from multiple disabilities. Specific numbers quantifying of the number of patients this product could apply to could not be found.

II. Previous Work

Several solutions have been tested and employed by Dr. Veronica Heide, AuD. The first solution attempted was using a voice activated calling device, Vocally Freedom In-line Voice Activated Dialer by G.G. Electronics. This solution was unsuccessful due to the client's inability to speak in a commanding tone and the noisy ventilation system present in the patients room that interfered with the device ability to recognize her voice.

A cordless phone with large numbers was also tried. The weight of the phone and the arm rotation necessary to place the receiver next to the ear were detrimental to the client. A wireless headset was also tried. This interfered with the client's hearing aides because in order to use the headset, the hearing aides could not be worn. The speakerphone currently in use is the RC200 by Clarity. Despite the exceptional noise-canceling speakerphone and remote control that helps the patient answer incoming calls, the phone has several drawbacks. First of all the telephone only has the capacity to store ten phone numbers in its database, which is difficult for the patient or aides to update readily. Another drawback is the patient must remember the people that correspond to the 10 preset buttons.

Our group made an on site visit in order to gain first hand knowledge of the extent or our client's disabilities and gain valuable insight for our design. Our research included digitally sampling our client's voice and evaluating the client's ability to manipulate a television remote. Various font sizes and color combinations were also tested to come up with the most readable combination. The client's room dimensions were taken, the placement of her wheelchair in the room was assessed in relation to other structures and the room was photographed. This information was vital in formulating the most efficient and practical design.

III. Client Information

Audible Difference is a company in Madison Wisconsin that provides audiological care. Veronica H. Heide, Au.D. is an experienced audiologist who works closely with her patients to identify, assess, and help them manage their various auditory,

balance, and neural disorders. Another goal of the company is to work with existing technology and foster new technology that will help these individuals in their daily lives. Dr. Heide's close relationship with her patients provides for excellent means to focus on each individual's specific needs and come up with the best solution possible. Dr. Heide is currently working with a patient who suffers from multiple impairments and cannot independently place outgoing telephone calls. The patient is able answer phone calls but has had no luck with current methods and technologies used to place outgoing calls. Dr. Heide presented us with this problem so we could help design a device that will provide her patient complete telephone access.

IV. Client Design Constraints

Since this product is being tailored for a particular individual, it must accommodate the patient's specific room and individual needs. The main focus of our project is to allow our patient to place outgoing calls independently. Due to the large number of individuals the patient wishes to call, our product must be capable of storing 80+ phone numbers and should be easily updated by an attendant or family member. Likewise it is important for the numbers to be organized in a logical manner and the patient should be able decipher the name of the person being called. Testing has suggested that mid-sized white fonts on a contrasting black background are easiest to read.

The room that the patient currently occupies is limited in size and available space, so the display must be small enough to fit in one of the cubby holes on a room wall or on the patient's side cart; cubby holes are pictured in figure 1. Similarly, the input control should be no larger than 3x4inches, as space is limited on the side cart. However the buttons on the controller must be large enough and well spaced so the patient can make selections with ease. In addition, the input controller must be ergonomic and lightweight so that she has no problem lifting or using the control. Optimally, the input will be wireless so it poses no safety hazard when she moves around in her motorized wheelchair

Figure 1: Cubby space in patients room.

V. Programming and Database

The input, display, and output will all be connected through a computer program we will create using Visual Basic. This program will serve as an intermediate between a computerized telephone program and a database containing the telephone numbers of the individuals our patient wishes to call. By creating our own program we will be able to tailor the display to our patients needs, specifying the size, color, and type of font that appears on the screen. We will also be creating a program that is simple to navigate and provides at confirmation screen to confirm the number the patient is calling. Another

important quality of our program is that it will connect to an existing database program, such as Microsoft Access, which will make it easy for an attendant or family member to update the telephone number list. This database program also has the capacity to the 80+ phone numbers, a drastic increase from the currently available products that can only hold approximately 10 numbers. Since the program dials through the computer modem and can be connected any phone, the patient will be able to use her current telephone that she if familiar with.

VI. Input Methods:

a. Button Input

The first input being considered is a remote similar to that of a television remote. The design would consist of a rectangular box, likely to be made of plastic, which would house four large buttons. The buttons would each serve a unique purpose that would make navigating the database of numbers a quick and simple process. The two arrow shaped buttons would permit the user to scroll up and down on the menu one item at a time. Another of the buttons would act as an enter key, allowing the user to confirm a selection, or proceed to the next menu. The final button would allow the user to go back one menu. To make the design easier to use for the intended audience, who may have a below average reaction time, the buttons would be digital switches that would need to be pressed every time an action is needed,

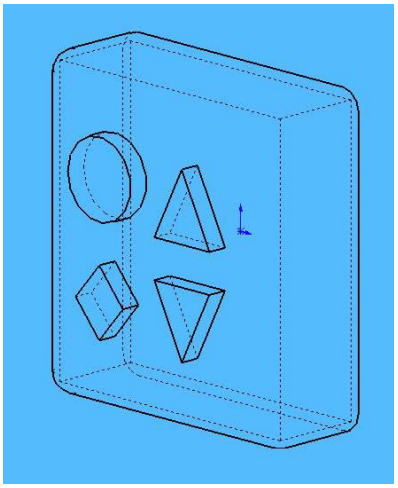

Figure 2: Proposed design of button input

rather than being held down for a continuous response. Although this may be more tedious, the use of sub-menus in the computer program will eliminate the need for excessive scrolling. Another simple feature would be the use of logical color coding and shaping of the buttons. The enter button will green; the back button red. These are common associations that should make the array simpler to operate for the user. Simple button inputs such as this exist on the market, however, finding one that caters exactly to these needs may be difficult. Because of this, an existing product would need to be altered, or an entirely new product created.

b. Joystick Control

The second input being considered is a joystick. This design could be considered similar to the button input, with one large exception. Rather than using two buttons for scrolling, the user would operate a small joystick that would be limited to moving in the up and down directions. This design is quite logical, because the intended user is already capable of using an automatic wheelchair, which utilizes a similar control. The design would also include an enter button placed at the side of the joystick. Also, a back button may be added, or possibly incorporated as a third direction in the joystick's range of motion. This would give the joystick the same control capabilities as the previously listed input idea. As with the buttons idea, such a product does not currently exist on the market, and would need to be modified from an existing product or built from scratch. If the control were to be built from scratch, it would likely be made of a

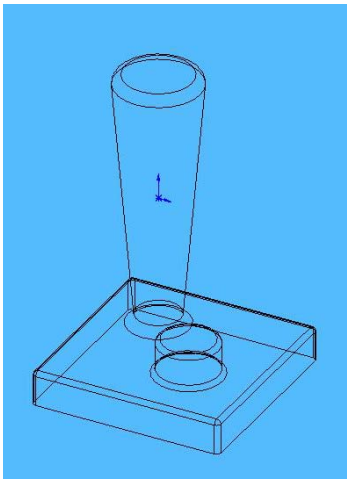

Figure 3: Proposed design of joystick control

plastic housing, with the joystick possibly being made of metal. Durable materials are not necessarily needed due to the non-volatile environment it is being designed for.

c. Touch Screen

The third and final input being considered is a touch screen. The main advantage of this solution is the elimination of a separate input and display. The type of touch screen likely to be used would be a resistive touch screen. Briefly, these operate by sending a slight current through the face of the display, and when an object such as a finger interrupts this current, the device calculates the location of interruption and reacts to this. A program would be written for a PDA that would be interfaced with a telephone. Following a series of commands entered by the user using his finger or a stylus, the PDA would initiate the outgoing call. Although this design is the most simple and seemingly most effective, a few problems arise. Firstly, the display on a PDA is limited in size and may not be capable of displaying a font clear or large enough for the intended audience. Also, touch screens can be difficult to work with, and may not always produce desirable results. From a technical standpoint, it is likely to be more difficult to program for a PDA than it would be for a laptop connected to one of the other input devices. Finally, a touch screen system would be far more expensive to produce than the other two.

Figure 4: A Resistive Touch screen with a hefty price tag.

VII. Display Methods:

a. Laptop Computer

The first display method that is being considered is a laptop. Due to the simple nature of the program that is likely to be written, an old computer will meet the requirements of the client. For this reason, the use of a laptop as a display would be quite cost effective. The database and program would be written directly onto the computer, and an input device would be connected to the computer. Due to the laptop's size, it could be placed at almost any distance that is comfortable for the patient. The input would then be placed near the patient, via either wire or wire-free connection. This simple setup would allow the user to place a phone call in a relatively customizable setting. A slight downside is that the laptop's size is larger than the other devices being considered.

b. Television Screen

This concept may at first seem larger than the previous design, however, the patient already has a television installed at a distance that can be viewed comfortably. This idea also involves the use of a laptop. The laptop, however, would not need to be visible, and could be tucked away in a convenient location. The display from the laptop would be sent via a video-out cable to the television. This would then display on the television exactly what is being shown on the laptop. This display's success is dependent on whether or not the patient is capable of reading what is displayed on the TV, because the customizability is limited.

c. Touch Screen

The final idea ties directly into the final input idea. As was stated earlier, the use of a touch screen input eliminates the need for a separate display and input interface.

Once again, the downsides to this idea are the limited size capabilities and the expensive price tag.

VIII. Design Matrices

To analyze our proposed designs, two design matrices were created: one for the three possible input methods under consideration and one for the three possible display methods. Each matrix includes four different categories, cost, ease of use, compatibility, and size upon which we ranked the individual display and input methods. For the inputs we placed more weight on the ease of use and compatibility categories by using a scale of 1-10 instead of 1-5. We believe that client's ability use the input device and the compatibility of the input with the display are the most important aspects of the input design. In our display matrix more weight was placed on the cost, compatibility, and size categories as these were ranked from 1-10 and ease of use was ranked from 1-5. The logic used to rank both inputs and displays are as follows:

Input Method	Cost (1-5)	Ease of Use (1-10)	Compatibility (1-10)	Size (1-5)	Total(4-30)
Buttons	5	7	8	5	25
Joystick	4	9	7	5	24
Touch Screen	2	6	6	3	20

Figure 5: Input design matrix

Both cost and size were ranked similar for the button pad and joystick, where as the touch screen received a lower rating because it is more expensive and would take up more space on the patient's side cart. Since the client is accustomed to using a joystick and the proposed joystick would be similar to that of her wheelchair it received a high

score for ease of use. The button pad also received a high ease of use score because the patient is currently capable of manipulating a television controller and only minor adjustments would need to be made. On the other hand a touch screen, such as on a PDA, would be a completely new technology for the patient to adapt to. In addition, touch screens are often difficult for fully functioning individuals to use so it received a low rating in this category. While the final rankings for the joystick and the button pad were similar, the determining factor was the more compatible design of the button input.

Display Method	Cost (1-10)	Ease of Use (1-5)	Compatibility (1-10)	Size (1-10)	Total(4-35)
Lap top	8	4	8	7	27
PDA	7	4	5	9	25
TV Screen	8	3	7	8	26

Figure 6: Display methods design matrix

The television and laptop were ranked the same for cost, where as the PDA had a lower ranking since no PDA is currently available for our disposal.

Based on the outcome of our display matrices we identified the two most reasonable designs components. These components were determined by the highest overall point totals. The button control and laptop had the highest point totals for the input and display respectively.

Future Work

The next step in the design process will be for our group to decide on a final input and display method. Once chosen these components will need to created or modified and

integrated together to produce a working design. The first step of this process will be creating an input device, such as a button pad, that is capable of connecting to the display. Building our input will be accomplished through large amount of research and trial and error. Taking apart computer mice and keyboards and looking into circuiting and programming will be a couple of the research activities needed to create the most efficient input device. The TRACE center will be an integral resource for this part of our project as they specialize in assisting disabled individuals with everyday activities such as using a telephone. A solid input control will allow us to easily connect it to our chosen display. Integrating the two is a huge obstacle that we hope to solve through writing a unique program using Visual Basic. We will begin creating our program, using Visual Basic, which will take our client through a simple stepwise process in order to place a telephone call. All components listed in the design specifications and other specifications as determined on our onsite visit will be incorporated into our final program and design. Once the program is written and all components are integrated we will need to make sure that the design works for her. This will include additional testing that will involve our client. We plan on introducing the device to her prior to installation. We will then confirm that the input is suitable to her needs and the program works as planned. Any modifications necessary will be made, and ultimately the final design will be installed into her room.

IX. Ethics

The health and safety of our client is of major concern to us while constructing our final product. Thankfully, the health risks associated with our current design ideas

are pretty much non-existent. We are concerned about the ability of our client to receive and place telephones calls, the issues pertaining to ethics with our design are very minimal.

Appendix A:

Product Design Specifications

Title

Telephone for Mobility, Vision, and Hearing Impaired Person, February 2, 2006

Team Members/Roles

- Jon Sass/Team Leader
- David Schurter/Team Communicator
- Ashley Huth/BWIG
- Bryan Fondrie/BSAC

Abstract:

Current devices that are available to help individuals with disabilities to use the telephone only address one ailment. Individuals with multiple disabilities who need the aid of two of these devices often find them to be incompatible with one another. Another great disadvantage is that these devices have a limited capacity for storing telephone numbers. Our client is looking for a way to provide an individual, who has multiple physical and communicative disabilities, with sufficient means to both receive and place telephone calls to an extensive phone list. This project will focus on modifying a telephone for a specific individual; however, in the long term it could be adapted to help others suffering from similar ailments.

Problem Statement:

Create a system that allows a physically, visually, and aurally handicapped person to initiate and receive phone calls in a simple and efficient way.

Client Requirements:

a. *Performance Requirements:* Telephone should provide efficient means for user to place and receive calls. It should have to capacity to store at least 100 phone numbers and the phone number list should be easy to update.
b. *Safety:* Product must not interfere with the user's ability to move around in a power wheelchair.
c. *Accuracy and Reliability:* The product should alert the user every time when there is an incoming call and provide the user with simple and reliable means for answering the phone. Placing calls should be easy for the user and the product must accurately dial the number that the user desires.

d. *Life in Service:* An optimal design would have an input and output that could operate for at least 10 years. However, if battery operated once power was gone it would need to be replaced or charged.
e. *Materials:* Ideally the input will be made of lightweight materials that are easy to grip.
f. *Aesthetics, Appearance, and Finish:* Shapes, colors, textures, and form have not been specified for this product. In ideal input would have a shape and form that enhances the products accessibility and simplicity for the client. Writing should have a black background with white font, at a medium size.
g. *Shelf Life:* Product should last at least 10 years.
h. *Operating Environment:* The room in which the telephone will be operated has lots of background noise due to a noisy air vent. Components of the telephone should be wireless to allow mobility. Space is also limited for the display.
i. *Size and Weight:* Buttons must be of ample size, since the individual has lack of fine motor control. The device should be as lightweight as possible. Display should be small enough to fit in the limited chubby space available, but large enough for the user to read from 5ft away.
j. *Ergonomics:* The size and placement of the device should be situated to be easily assessable and be comfortable for the user.

2. Production Characteristics

k. *Quantity:* Design focuses on a specific individual, therefore only one model of the product is needed.
l. *Target Product Cost:* Total cost of fabrication should be under $300, since some materials will be provided by our client.

3. Miscellaneous

m. *Standards and Specifications:* Because the device is not for medical purposes, FDA approval is not required. The device must meet any sort of telephone safety requirements.
n. *Customer:* Currently, the device is being designed for one person. This person becomes tired easily, and is physically handicapped, including visually and aurally.
o. *Patient Related Concerns:* The device should not need to be sterilized between uses; however, regular cleaning, as with any telephone is recommended.
p. *Competition:* There are many items on the market that address each issue individually. A comprehensive solution has not yet been produced.

Appendix B: References

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