Telephone Access:

Proposed Designs for Handicapped Telephone Operation

BME 201
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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 providing an individual who has multiple physical and communicative disabilities with sufficient means to both receive and place telephone calls from an extensive telephone list. This project focused on modifying and combining existing products, as well as creating new ones in an effort to solve this problem. In the long run, however, it could be adapted to help others suffering from similar ailments.

I. Background

Introduction

The targeted patient suffers from hearing, visual, and physical impairments: however, the patient is very mentally aware. The patient wears hearing aids and suffers from tunnel vision. The visual impairments allow the patient to read the text of a newspaper at a distance of approximately two feet, but prevent the patient from being able to read the headlines. While this type of visual impairment uncommon, it is typical for individuals with tunnel vision. The patient‘s physical ailments resemble that of a patient with multiple sclerosis and confine the patient to a mechanized wheelchair. The patient also suffers from the loss of fine motor control of the extremities. These ailments prevent the patient from being able to initiate a telephone call independently. Currently, in order to place a telephone call, the patient must summon a nurse on duty to place the

call. However, the patient is able to answer telephone by pressing a button that hangs from her neck. A speakerphone is used instead of a hand held phone to communicate.

Motivation

If successful, our design would allow our patient to initiate telephone calls without relying on others, which would provide our patient with a sense of freedom and independence. This ability would help relieve the frustration of relying on others because the patient is very mentally aware but physically dependent. The telephone is the patient's main source of contact with family and friends. Our design would also increase the productivity of the nurses who help our patient place calls because our client would be able to make calls at her 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 patient. 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.

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 patient's inability to speak in a commanding tone and the noisy ventilation system present in the patient's room that interfered with the device's 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 difficult for the client. A wireless headset was also tried. This interfered with the client's hearing aids because in order to use the headset, the hearing aids could not be worn.

Currently the pateinet uses a RC200 speakerphone made by Clarity. While the phone has exceptional noise-canceling capabilities and a 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 aids to update readily. Another drawback is that the patient must remember the people that correspond to the ten preset buttons.

Our group made an on site visit in order to gain first hand knowledge of the extent or the patient's disabilities and gain valuable insight for our design. Our research included digitally sampling our patient's voice and evaluating the patient'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 patient'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.

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.

II. Design Considerations

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 for the patient 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.

Program

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 a 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 store the eighty plus phone numbers, a drastic increase from the currently available products that can only hold approximately ten 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 with which she is familiar.

Input Methods:

We considered three input methods:

Button Input

The first input being considered is a remote similar to 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.

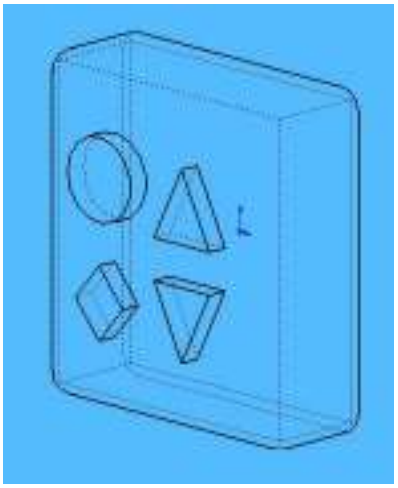

Figure 2: Proposed design of button input

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 patient, 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, 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.

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 previous 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.

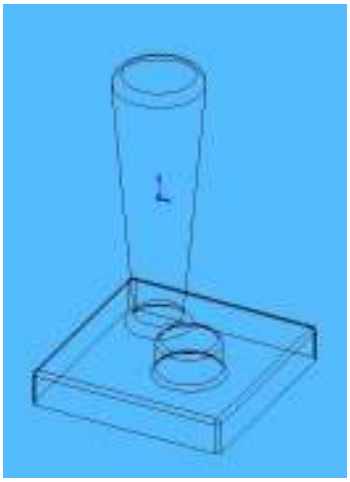

Figure 3: Proposed design of joystick control

If the control were to be built from scratch, it would likely be made of a 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.

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. First, the display on a PDA is limited in size and may not be capable of displaying a font clear or large enough for our patient. 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.

Display Methods:

We considered three display methods:

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.

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.

Touch Screen

The final idea ties directly into the final input idea. As was stated earlier, the use of a touch screen input would eliminate the need for a separate display and input interface. Once again, the downsides to this idea are the limited size capabilities and the high price.

III. 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. We ranked the individual display and input methods in accordance with those categories. 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 patient's ability to 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 similarly for the button pad and joystick, whereas 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 compatibility of the button input with the display.

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	5	7	8	28

Figure 6: Display methods design matrix

The next step after determining the most effective input method was determining the display method. 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: laptop and television. The main drawback of the television is that it

requires a laptop with a video output, however, the screen angle and lighting in the room can greatly affect the clarity of a laptop screen. Also, the patient is able to read the captions of a television clearly. These factors make the television, with proper adjustment of the font, superior to the other two options. The button control and television display had the highest point totals for the input and display respectively.

IV. Final Design

Program

In order to organize telephone numbers that our patient desired to call and to simplify initiation of dialing numbers, we created a telephone dialing program with an internal phonebook. This program was created using four main applications. All of the code for the program was created using Microsoft Visual C# 2005 Express Edition. We choose to use this program because it has a simple format, which makes it easy to alter the color, font, font size, and the window design. Other essential features of the program include the "dialer.exe" program available on all newer computers. A basic XML file was created to both store and organize the phone list information. Similarly, a folder was created to store WAVE files containing name clips. These four basic components work collectively to add and edit entries to the phonebook list, choose an individual to call, confirm and place a call.

Intro Screen

The first screen that is displayed when our program is started serves as a main menu. It provides the two options to either enter the phone book to place a call or to a link that opens a menu in which phone numbers can be edited and added. Most portions of this program the ">" arrow indicates which page the user will be selecting upon pressing "enter".

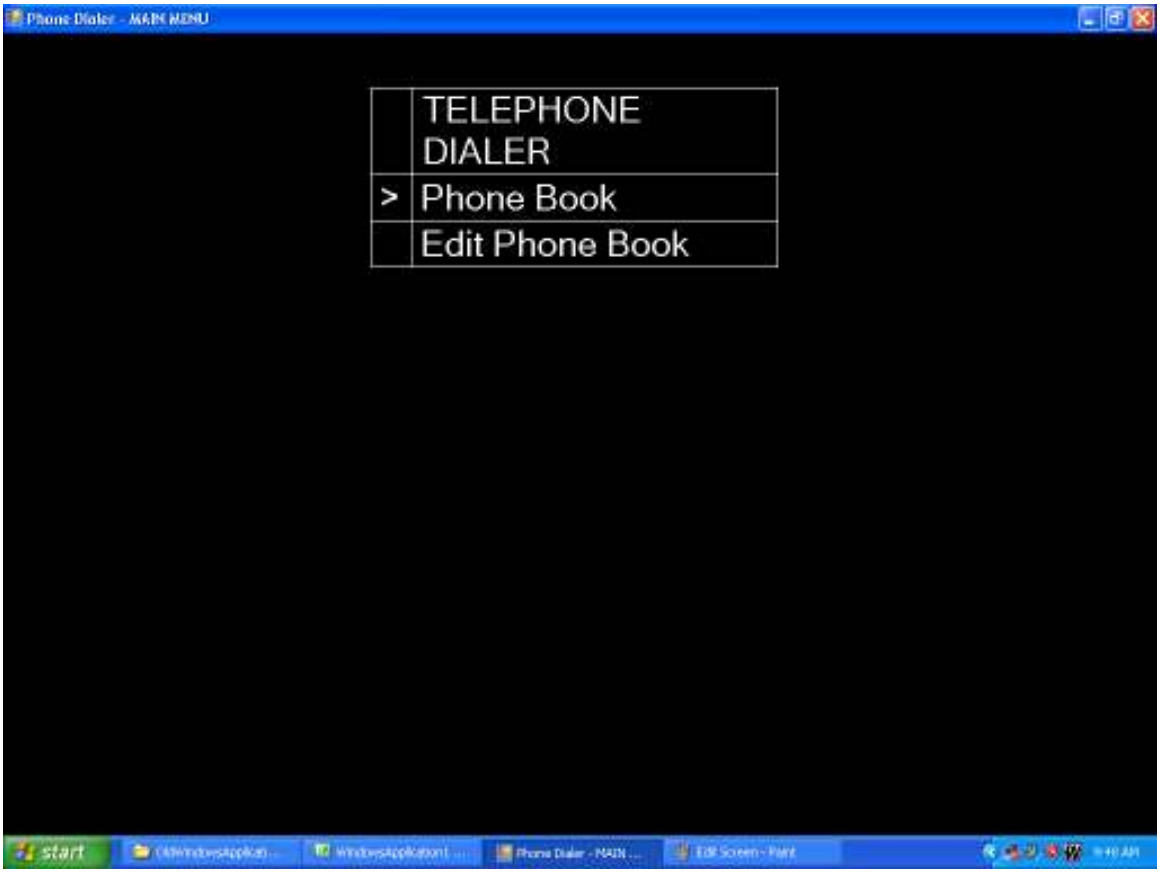

Figure 7: Main Menu

Edit Screen

Unlike the phonebook category, those wishing to use editing capabilities must use the entire keyboard. The editing page works mostly with the XML file which stores all of the data for individual's names and their corresponding phone number. We chose to

use an XML file because there is a relatively small amount of data and no additional program is needed. In addition, the XML file can be easily moved to another computer.

For sorting purposes it is essential that names are added in the following format: "Last Name, First Name". A note of this is located at the bottom of the screen to remind users. Phone numbers can be formatted using any number and combination of dashes and parentheses. Our patient's phone system is more restrictive than regular phone lines, therefore, one must remember the following rules:

1. To place a call within the building only the number is needed, i.e. 555-5555
2. To place a call out of the building a 9 must be dialed prior to the phone number. i.e. 9-555-5555
3. For long distance phone calls the number should be formatted 9-1-(555)-555-5555.
4. Local calls do not require the 1 and area code before the number.

Typing a name and phone number in their subsequent boxes and pressing "Save" will allow the user to add new names to the phone list. This information is sent to the XML file and upon pressing the "Save" button on the edit screen, the XML file is programmed to automatically save the new information. Likewise checking the "Delete" box and then pressing the "Save" button will first find the corresponding data in the XML file, then delete it, and finally save the changes. The last option on this page is to edit an existing name from the list. For this change, the user must check the "Edit" box , type the correct name and phone number in boxes, and then press the "Save" button. The corresponding name will then be retrieved in the XML file and deleted. Then the changed name will be added and the XML file will be saved. In order to exit this screen

and go back to the main page, the “back” button must be pressed.

Figure 8: Edit Screen

Phonebook

The phonebook category of the program can be solely controlled by the control pad by using the “up”, “down”, “back”, and “enter” buttons. The “up” and “down” buttons can be used to scroll through lists. “Enter” can be used to select the appropriate name/category and to place a call. If at anytime the user makes the wrong selection, simply pressing “back” will return them to the previous page. This program compiles information in the form of tables for easy use. On the left side of each table is an indicator column. The indicator “>” moves up and down with scrolling and indicates which name/category will be selected upon pressing “enter.”

Category Selection

The first screen that appears in the phonebook is a list of categories that divide the alphabet into 4 sections. This page was implemented to reduce the number of names that appear on the screen at a single time. As a result, the user will spend less time scrolling through the list. The indicator icon follows the scrolling and points to the name that will be selected upon pressing enter. Pressing the "enter" button will then prompt the Person Selection screen.

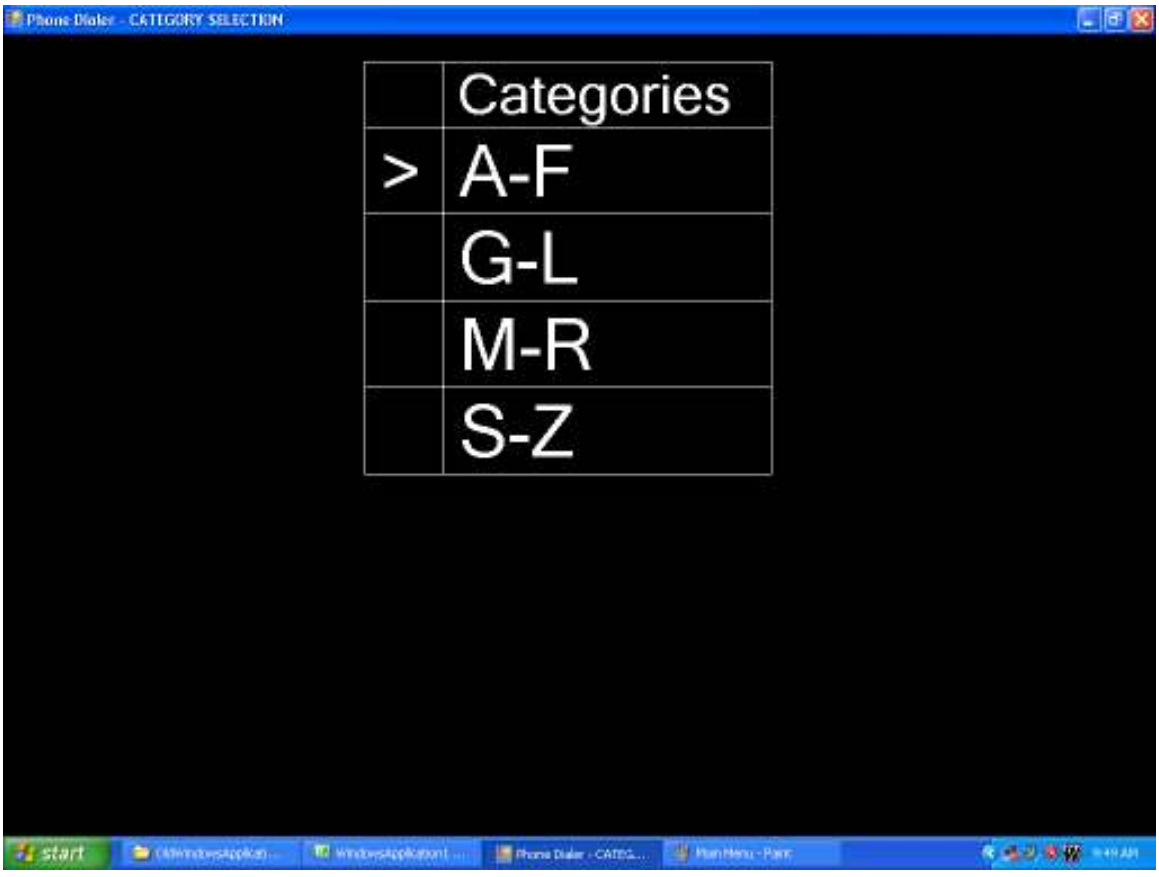

Figure 9: Categories Screen

Person Selection

Pressing "enter" on the previous page not only triggered the prompting of this page, it also retrieved a list of names from the XML file. Since the XML file contains

names in the format Last Name, First Name, upon pressing "enter" the program also sorts through the file searching for entries containing Last Names that fit the criteria selected; A-F, G-L, M-R, or S-Z. Scrolling up and down will allow the user to focus in on a specific individual and pressing "enter" will prompt a Confirmation Screen.

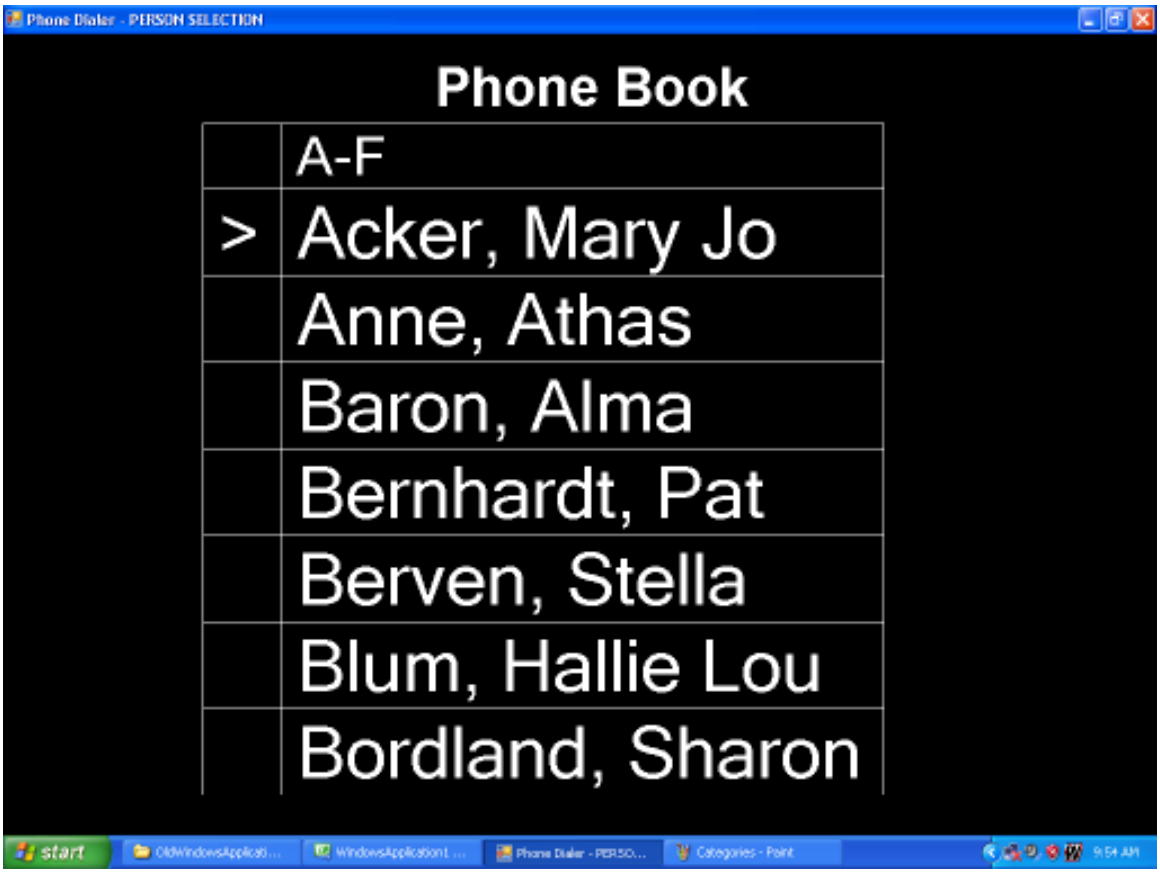

Figure 10: Phonebook Screen

Conformation Screen

We have implemented a confirmation screen for a few reasons. Displaying only one name largely across the screen gives the user a clear view of the individual that they have selected confirming that it is the correct individual. The audio clip announcing the name of the individual selected serves as a secondary source of confirmation. This feature was added to lengthen the time the patient is able to use the system because of her

deteriorating eye-sight. In addition, if an incorrect name is chosen, this screen gives the user an opportunity to press "back" and choose the correct person.

The way that the data gets displayed on the screen is similar to that of the Person Selection screen. When a name is chosen by pressing "enter" on the Person Selection screen, the program is prompted to search the XML file to retrieve the name and phone number of the person selected. The corresponding data is then displayed on the Confirmation Screen. Simultaneously, the program searches through a folder that contains a series of WAVE files containing the recordings of each individual's name. These files are saved in the same format as the phone list information "Last Name, First Name."

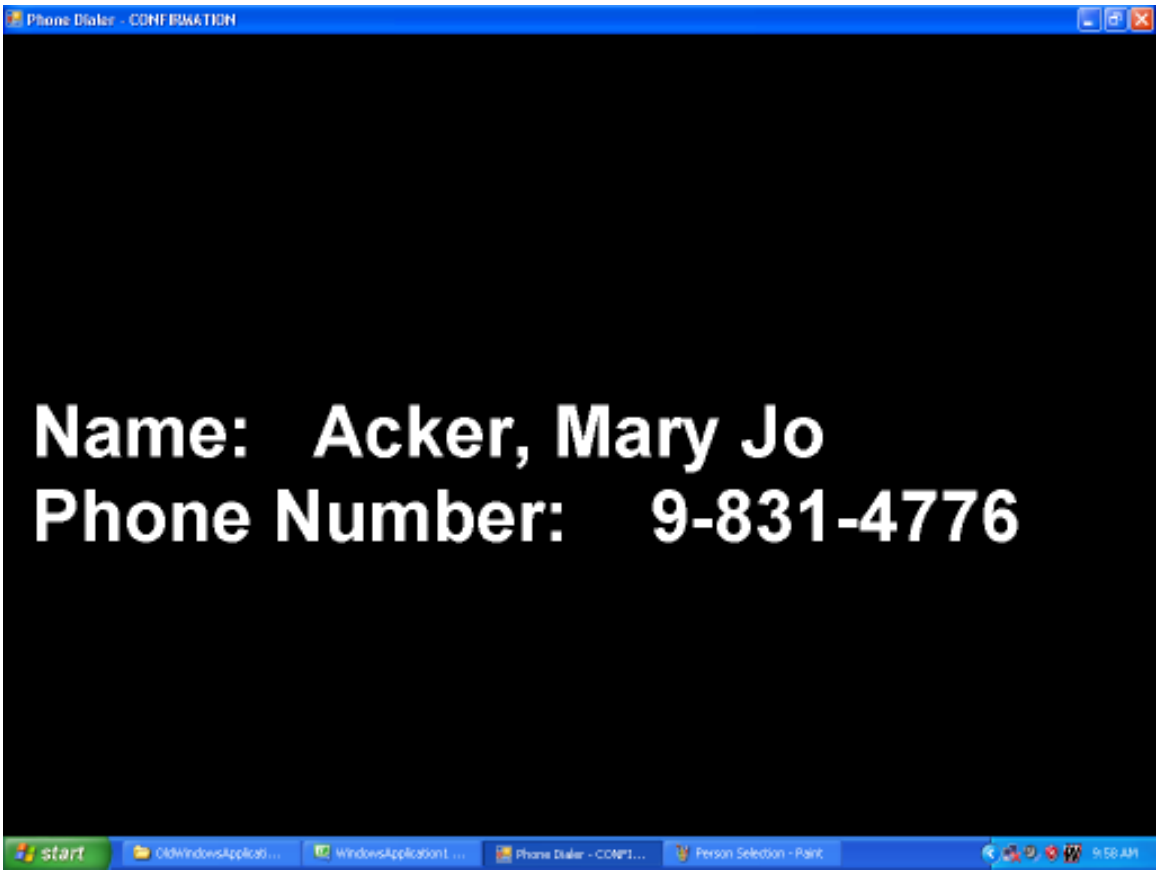

Figure 11: Individual Name Screen

Placing Call

Pressing “enter” while on the confirmation screen will place the call through the phone line using the dialer.exe. The phone number that is displayed on the screen is inserted in to the dialer.exe program. After insertion, our program is designed to trigger calling by automatically pressing the “call” button on the dialer.exe program. After the call has been placed, the screen turns white indicating that the user should pick up the phone. Another good indication that the user should pick up the phone is the dial tone and the ringing emitted by the computer. The user is then allotted 20 seconds to pick up the phone, as we have programmed the dialer.exe program to be on a 20 second timer. Twenty seconds should give the user enough time to pick up their phone successfully. After this time the dialer program will be closed and the phonebook program will return to the categories page. This page was selected because it will allow the user to go one fewer steps to place another phone call.

Display

In order for our patient to be able to consistently navigate the program, we decided to use her television as the means for display. This is because viewing a laptop screen from several feet away can be difficult depending on the angle of the screen and changing light conditions in the room. Also the television is in a fixed that is very functional to the patient and will not likely be moved.

Controller

Rather than manufacture a fully functional wireless controller from the ground up, it was decided that an existing product would be modified to meet our needs. An

already-on-the-market wireless gaming controller was used. The circuit of the controller would be re-housed and modified; the following is a walkthrough of the process that was used.

Figure 12: The wireless controller

The Circuit

The specific controller that was used was the Logitech® Cordless Rumblepad™ 2 (Fig 12). As the name suggests, the controller originally contained a feature that allowed the controller to vibrate. Due to size and weight issues, the mechanisms used to create these vibrations were removed. This was done through removing the wires that attach the vibrating mechanisms to the main circuit board.

Another issue facing the re-housing process was the restriction imposed by the length of the wires that connect the usable buttons to the circuit board. To cope with this, the original wires were trimmed off and replaced and re-soldered with longer ones that are less restraining on the design. This also allows the circuit to rest on the bottom of the casing.

The final modification made to the circuit was the addition of a freestanding battery component. Due to the original design of the controller, the existing battery component could not be used. This issue was easily solved by ordering a second 2AA battery holder and soldering it into the place of the old one. This was the final modification made to the circuit.

The Casing

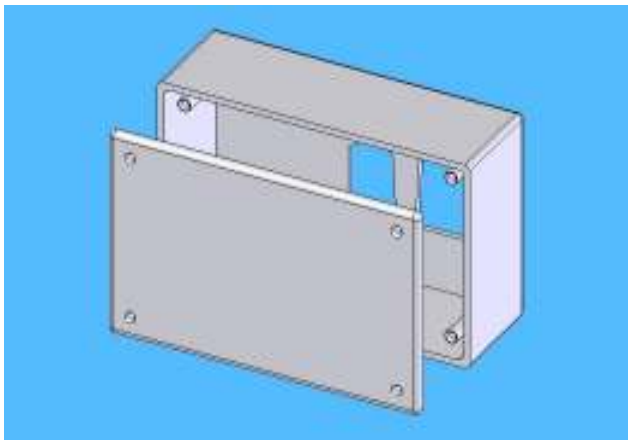

Fig (13): The complete plastic box.

The circuit was removed from its original plastic casing because it was an awkward shape and unnecessary buttons were visible. After the said modifications were made, it needed to be placed in a new box that could provide a simple interface for the patient to use. Plastic was necessary as to use because it does not shield the wireless RF signal. We did not possess the means to create a custom mold for our project so we decided to purchase a pre-constructed box (Fig 13). Two holes were cut into this box so that only four buttons from the original controller would be accessible. These buttons were glued into these slots using epoxy to ensure a tight and lasting fit. These buttons would correspond to "up, "down", "forward" and "enter." After insertion into the box, the old circuit functions just as it had before, and the device is ready for use.

Testing

Additional testing was done during the final stages of the design process. Again we tested the font, font size, color, and placement of the display to insure choices made were appropriate for our patient. However, this time we also looked into software and telephone line compatibility and also tested our patient's ability to navigate easily through the program. Testing confirmed that our program's setup was sufficient for our

patient. On the other hand, test involving compatibility demonstrated that changes were needed in the programs format, due to the nursing home's restrictive telephone system. All necessary modifications have been made.

V. Future Work

The final step for this project will be to integrating our final design it into our patient's room and everyday life. We have already taken into account many of the obstacles associated with implementation, as it planning for installment was done during our testing visit. We have considered placement of the laptop and button pad, as well as hooking up and concealing all wiring associated with the design. In addition to installation of the product during our final visitation, we will also be demonstrating how to use the product and answering any questions she may have regarding the product.

Based on how well our design is implemented into our patient life, future modifications to our design may be needed to better suit our patient. However, we project these modifications to be minimal. One possible addition to the program would be to include a section on the editing page that would allow for simple addition of the WAV files, since currently these files must be manually placed in a folder. One change we would like to further explore options to downscale the size of our controller, since it is currently bulkier than desired. An additional change that we could foresee, would be changes made in the telephone service our client receives. These changes would involve the formatting of the telephone numbers in the list, which could easily be done by using the edit function. Furthermore, if patient's condition changes additional modifications in our design may be require to accommodate our patient's needs.

VI. 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.

VII. Conclusion

Our finished product operates and meets all design constraints that have been set forth by our client and patient. Additional features have been added to the program that will hopefully increase the longevity of the product by evolving as our patient's condition changes. Although the product we have created caters to the needs of a specific individual with multiple impairments, our design is flexible. We are be able to add additional features or make modifications for those individuals who suffer from disabilities that are different than our client. Through minor improvements, our design could be applied to a much larger population.

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 use the telephone only one 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 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:

1. Physical and Operational Characteristics

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 must dial accurately 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 _____ years. However, if battery operated once power was gone it would need to be replaced or charged.
e. *Materials:* There are no restrictions or requirements on the types of materials to be used to construct this product.
f. *Aesthetics, Appearance, and Finish:* Shapes, colors, textures, and form have not been specified for this product. Ideally, the shape and form should enhance the products accessibility and simplicity for the client.

g. *Shelf Life:* Product should last as long as possible, at least as long as the telephone it is connected to.
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.
i. *Size and Weight:* The device needs to be large enough for a user with poor eyesight to read. The buttons must also be of ample size, since the individual has lack of fine motor control. The device should be as lightweight as possible.
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:* Model will be designed for a specific individual, therefore at this time only one model will be needed.
l. *Target Product Cost:* Since some potentially useful materials are available, the target cost of our product will be under $300. However, cost may vary depending on the technology utilized.

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: Table of Materials

Part	From	Part Number	Quantity	Cost Each	Shipping	Total Cost
Logitech Cordless Rumblepad 2 with Vibration Feedback	Amazon	963326-0403	1	30.99	5.58	36.57
Project Enclosure 6x4x2	Radioshack	2701806	1	4.99	5.5	10.49
Battery Holder Polypropylene, Side By Side Style for 2 AA Cells	McMaster-Carr	7712K12	1	0.86	3.75	4.61
						51.67

Appendix C: References

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