

CHAPTER 12

UNIVERSITY OF MASSACHUSETTS AT LOWELL

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MATCHING CARD GAME: A GAME THAT INVOLVES EASILY MODIFIED MATCHING CARDS AND PROVIDES VISUAL ANSWERS

Designer: Christine Brunelle

Client Coordinator: Karen, Brookside Elementary School, Dracut MA

Supervising Professor: Alan Rux

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INTRODUCTION

The Matching Card Game was conceived as an upgrade to the current equipment that the kindergarten classroom of the Brookside Elementary School in Dracut, MA. The device has ten slots with pictures behind them. These slots accept cards with the same pictures. When a card is inserted into a slot, the box determines whether the right card is inserted based on holes or notches that are in the card and outputs a signal based on the answer. If the correct card is put into the correct slot, then a green light turns on and a musical tune will play, whereas if a wrong card is put into the wrong slot, a red light turns on and a buzzing sound is heard. The Matching Card Game is meant to be a learning tool for mentally and physically disabled children. The pictures on the cards are easily modified at the discretion of the teacher. The game idea came from the system already in place (See Figure 11.1), which requires the teacher's attention at all times to provide the necessary correction to the child's action. The Matching Card Game is an independent learning tool, so the teacher can set up what he/she wants the student to study, and leave the child alone to learn. The ultimate goal of this project is to create a universal independent learning device that can be modified according to the teacher's discretion.

SUMMARY OF IMPACT

This device allows a teacher to place in front of a student the desired learning lesson, such as matching colors, to work on the project independently. In this fashion, the teacher can focus their attention on other children in the classroom.

The game helps the student as well, by allowing them a sense of independent accomplishment. The game is easily modified to do something more complicated than matching colors, for example, it could be used in higher level classes to learn the multiplication tables.

TECHNICAL DESCRIPTION

The game has four main parts: optical switches, multiplexers, a microcontroller, and light emitting diodes (LEDS). Four optical switches are put in each slot to allow for a binary number up to ten. Each card has notches or holes in a particular order that is inherent to the correct slot for that card. When a card is inserted, the outputs from the optical switches go to the multiplexers to be fed into the microcontroller. The microcontroller then determines whether the input is correct for that slot and outputs accordingly, and then switches to the next slot and so on. In this scrolling manner, the microcontroller operates the multiplexers to read slots one through ten sequentially, and constantly check the status of the slot.

The components are placed in a box made of ABS plastic due to the nature of the classroom that it is used in. The optical switches (H21A1, 40 total) are chosen because they were slotted. The multiplexers (74150, 4 total) are 16-1 bit converters so that the microcontroller (Basic Stamp BS2p40, 1 total) scrolls between slots and have a parallel input. At the request of the teacher, large green LED's are used in comparison to the red LED's.

The cost of parts/material was about \$300.

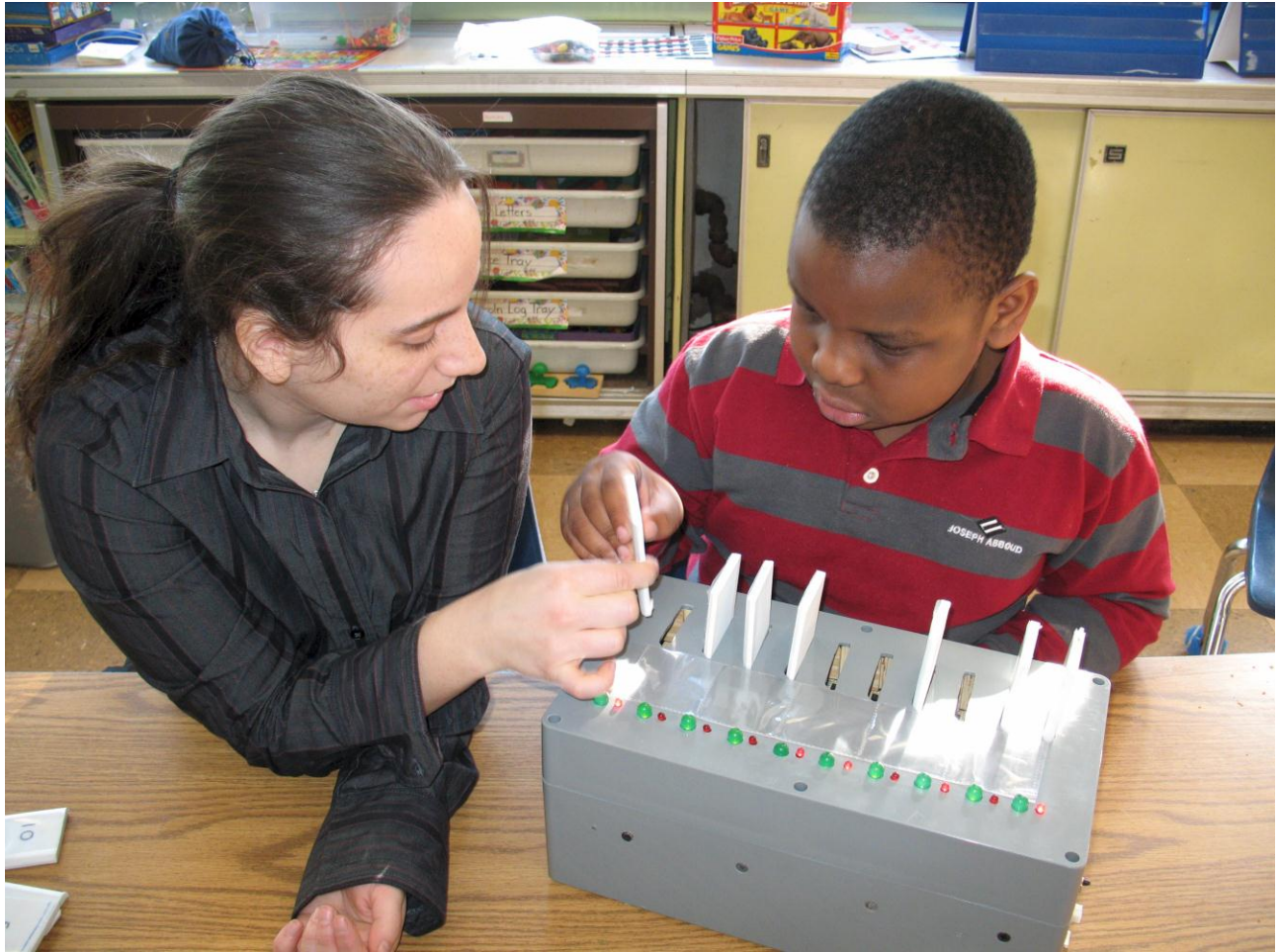


Fig. 12.1. A student showing the device to the client.

TOUCH SCREEN GAMES: SOFTWARE PROVIDING LEARNING ACTIVITIES, CURRICULUM REINFORCEMENT, AND CAUSE AND EFFECT STIMULATION

Designer: Dan Emerson

Client Coordinator: Marie Haggerty, Shore Educational Collaborative, Chelsea MA

Advisor: Jay Fu

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INTRODUCTION

Touch Screen Games is designed to provide learning activities and curriculum reinforcement, along with cause and effect stimulation, for students of the Shore Educational Collaborative in Chelsea MA. These students benefit from multiple types of learning activities, such as vocabulary, counting, tracing, ordering and simple puzzle games that using a touch screen monitor. All of the activities have some level of curriculum reinforcement and motor skill development. The Touch Screen Games presented here replaces an already existing

software/hardware device that uses a custom designed infrared sensor that senses a touch on either side of the screen. By using open source licensing, Touch Screen Games provides improved functionality and is available to any individual or group who can benefit from its use.

SUMMARY OF IMPACT

Touch Screen Games improves the available benefits of the previous device by using a fully active touch screen monitor. These new games are made available by using an actual touch screen monitor

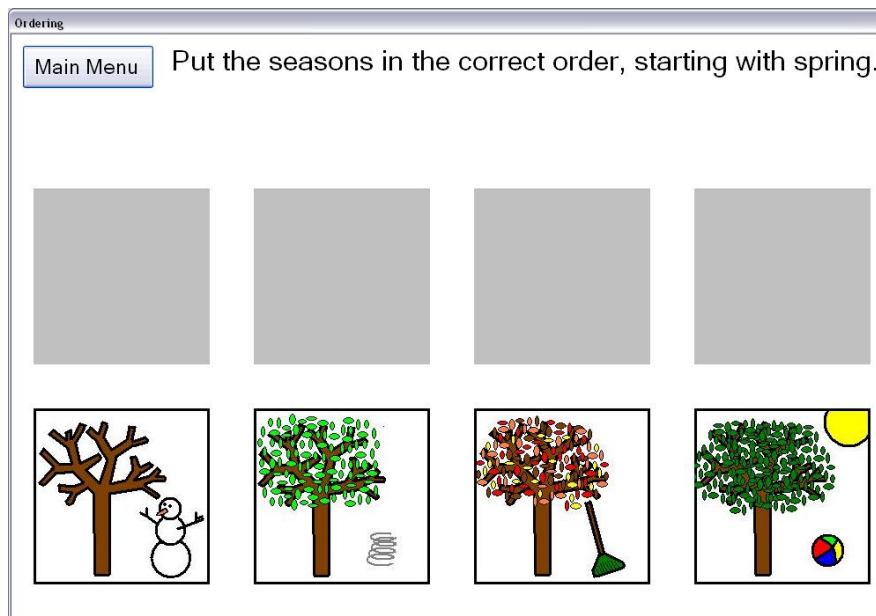


Fig. 12.2. Touch screen games in action – ordering seasons.

that adds more fine motor skill and cause and effect stimulation than those that were available with the custom designed hardware. Touch Screen Games provides educators with an extra and more powerful tool that combines classroom learning with motor skill development, and cause and effect experimentation.

TECHNICAL DESCRIPTION

Touch Screen Games is built in Microsoft Visual Basic Express Edition 2005. The Visual Studio family provides tools for efficient and effective user interface design linked to a wide range of programming languages. Visual Basic, as a programming language, is well suited to user driven programs and less intensive coding. Writing Touch Screen Games in Visual Basic allowed for more time for focusing on designing the content of the activities rather than on building user interface and dealing with more complex programming schemes that come with other programming languages.

The user inputs to Touch Screen Games are understood as mouse actions. By using Visual Basic's generic MouseDown, MouseUp, MouseMove, and Click functions, Touch Screen Games receives input from any device functioning as a computer mouse. Touch Screen Games can use "off the shelf" touch screen hardware rather than rely on custom designed interfacing hardware. A G-Vision L15AX-JA-452G 15" serial touch screen LCD monitor is to be used with Touch Screen Games.

In Touch Screen Games, counting and vocabulary activities function very similarly. Counting activities present a number of objects to the user and display two possible answers. Vocabulary activities either display an object to the user and present two possible answers, or display multiple objects and ask the user to find a specific one. To do this, the software generates a random number defining the correct answer. This number is checked against the previously used correct answer to ensure that the program doesn't repeatedly ask the same question. The program then generates another random number to define the wrong answer. If the wrong answer is the same as the correct answer, the value is regenerated. Based on the type of game, the

picture boxes are filled in with the correct images. When the user clicks or touches an answer, a check is done to decide whether or not it is the correct answer. If so, the form is reloaded, and then a counter is incremented. If the counter reaches a certain value, a congratulatory message is displayed to the user. If the counter has not been reached, the form is reloaded and the next question is asked. If the user clicks the wrong answer, they are told that it is wrong and the form is reloaded.

Ordering and Puzzle games use similar image dragging code to make available different activities to the user. In the ordering activities, a set of images is displayed to the user in a random predetermined order. The user is then asked to move the images into the correct order. For the puzzle game activities, certain images must be moved to certain locations while avoiding other locations. In each type of activity, when the dragging code senses a 'MouseDown' on an image, it records that mouse down coordinate and enables dragging. If the mouse moves over that image while dragging is enabled, the mouse down and mouse move coordinates are translated to the form coordinate system and the image is moved. For both activity types, timers are set to constantly check the location of the movable objects and act accordingly. If they are in the final location, the congratulatory message is displayed. If they are somewhere they are not allowed to be, the image is moved back to the original location.

Tracing activities allow the user to follow directions and trace a pattern. The different lines involved in tracing a shape are defined as different stages. An image is displayed with a starting and ending point for that stage of the drawing. If the user mouses down on the starting point, a graphic is drawn following their line. If they trace too far outside a determined bound, the image is reset and the stage is set back to the first. If the user mouses up inside the proper end point for that stage, the next stage is loaded. If all the stages of the drawing have been completed, the congratulatory message is displayed.

The only cost of Touch Screen Games is the touch screen monitor, costing approximately \$330.

INTERACTIVE TACTILE BALL: A DEVICE FOR ENFORCING CAUSE AND EFFECT RELATIONSHIPS

Designer: David Smith

Client: Susan - LifeLinks Inc.

Supervising Professor: Alan Rux

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INTRODUCTION

The interactive tactile ball was designed to reinforce cause and effect relationship. By rewarding interaction with the ball by lights blinking and children's music playing, a student is engaged and causal events are reinforced. The goal is to use a soft ball to focus on three areas of learning for the students with two modes of operation. The first was cause and effect—with a simple feedback mode, touching the brightly colored circles gave a positive feedback, reinforcing cause and effect. Colored circles on the surface the ball act as switches and are textured, providing tactile feedback to the students. The game mode provides the third learning mode, memory. The student must remember which light turned on and touch the appropriate light for a positive feedback. Touching the wrong switch cued a negative feedback.

SUMMARY OF IMPACT

LifeLinks needed a device to reinforce cause and effect. The interactive tactile ball described here is a tool to engage their clients. As such, LifeLinks required a device versatile enough for use by students of varying degree of disability, and plush enough to not worry about injury. The self-contained toy stimulated the student for long periods of time, as well as provided positive and negative feedback in their lives. Operation of the interactive ball does not require actions to be performed by the teacher except to change it from simple feedback to the game mode.

TECHNICAL DESCRIPTION

The main structure of the interactive tactile ball is a foam soccer ball eight inches in diameter. It is cut in half, hollow in the center for batteries and electronics and has holes drilled out to fit the input



Fig. 12.3. The interactive tactile ball.

switches, output lights and speaker. The ball is held together by Velcro and an outdoor-grade rip-stop nylon shell that covers the ball to ensure a waterproof and rugged exterior. The lights on the outside are high-efficiency light emitting diodes (LEDs) to provide the maximum brightness at the lowest power consumption. The switches are momentary pushbutton switches that are normally off and turn on when pressure is applied.

The electronics that control the output of the device are divided into three groups. The first is I/O formatting. This takes inputs from six switches and encodes it into a binary coded decimal input to the microprocessor. It also takes three coded outputs from the microprocessor and selects one output to

turn on one set of LEDs. The second section of electronics is the sound playback chip. This chip was recorded previously, and when used it receives an address from the microprocessor and plays a sound message. The music is played through a speaker that is mounted near the surface of the ball but is under a small amount of protective foam. The last section of electronics is the microprocessor, which controls the operation of the device. The inputs to the system are a switch governing simple feedback or game mode, and six switches that tell the microprocessor which button has been activated. The outputs of the microprocessor are the LED, a signal to tell the chip when to play, and a signal to turn the system off when it has been inactive for a period of time.

When the device is activated, it determines if it is in game mode or simple feedback mode. If in simple

mode, it outputs addresses for the correct sound message and plays the sound and then blinks the corresponding LEDs. If the game switch is activated, a random switch is selected and blinks. The user must activate the corresponding switch for music to play. If the wrong switch is activated, a negative feedback message is played, telling the user to "try again." Once the correct switch is activated and music is played, a new random switch is selected and lights up. If no switch is activated, the system powers itself off.

The whole system is battery powered, and parts are selected based on their power consumption to maximize battery life. This, coupled with the self-power off and on configuration switch allows minimal set-up and carefree operation.

The cost of this device is about \$120.



Fig. 12.4. Student with interactive tactile ball and clients.

THE REMOTE CONTROLLED TRICYCLE: A WIRELESSLY CONTROLLED TRICYCLE THAT HANDICAPPED AND MENTALLY CHALLENGED PATIENTS CAN USE

Designer: Emile Dagher

Client/Organization: Bob Zalis & Brooke, Hogan Center, Danvers MA

Supervising Professor: John Fairchild

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INTRODUCTION

The purpose of this project is to provide caregivers a way to control a motorized tricycle. Control is accomplished wirelessly, which eliminates any physical contact between the caregiver and the person riding the tricycle. The device is helpful especially for those who do not have the power to ride the tricycle themselves.

Using the remote control, the caregiver controls the forward and backward movement of the tricycle. Because there is no physical contact between the patient and the person controlling the tricycle, safety measures and controls are implemented in the design to keep the tricycle and its rider as safe as possible. The tricycle can be stopped by a click of a button from the remote control.

Compatibility, simplicity and ease of use have made this project a great success.

SUMMARY OF IMPACT

The idea for this project came from a nurse working at the Hogan Center in Danvers, MA. The patient using this device has physical and mental disabilities. She loves riding her tricycle around the Hogan Center. Because she does not have the power to pedal a tricycle herself, the nurse pushes her around on the tricycle.

The nurse suffers back pain after pushing the tricycle for long period of times. She has suggested having the tricycle motorized and controlled using a remote control. When the tricycle moves, the patient pedals along. By pedaling, the patient trains her muscles and develops more power in her legs. The



Fig. 12.5. The remote controlled tricycle.

goal for the patient is to ride the tricycle herself in the near future.

TECHNICAL DESCRIPTION

Both parts of the project, the transmitting side (remote control) and the receiving side are designed using very simple and basic techniques. Easy to use ICs along with the use of Parallax Inc.'s Basic Stamp microcontroller and Crydom Co's power relays helped make this design simple and easy to operate.

The remote control uses switches and push buttons to send data. Data is encoded and converted into a serial data, which then gets amplified and modulated at 434MHz. The data signal is then transmitted to the receiver.

At the receiver, the RF signal is demodulated and decoded into 4 parallel data lines. Data is then processed by the basic stamp microcontroller, which

controls relays, brakes and the movement of the tricycle. This flow of data is illustrated in Figure 12.7.



Fig. 12.6. Remote Control.

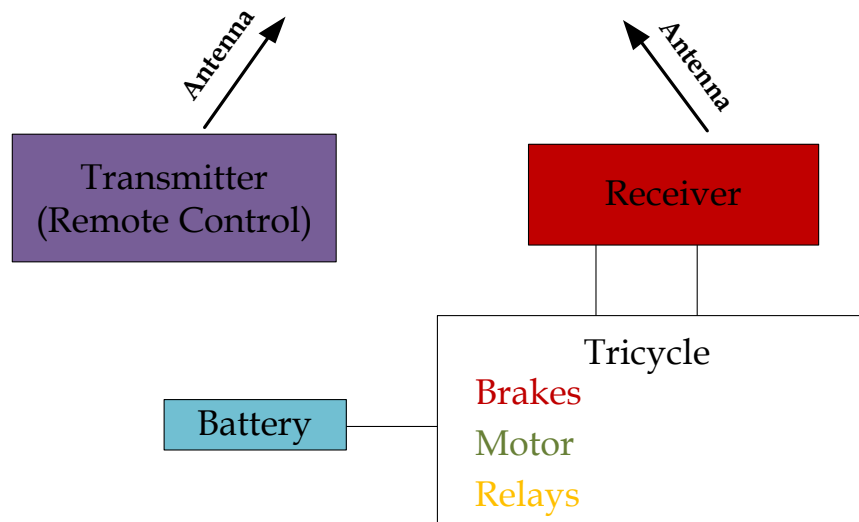


Fig. 12.7. Flow of data between components.

PROVIDING A TOUCH OF INDEPENDENCE: A SWITCH ACTIVATED ENVIRONMENTAL CONTROL SYSTEM

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Supervising Professor: Jay Fu
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INTRODUCTION

The Touch of Independence (TI) is designed to enable a client with limited motor control to control electrical devices within his immediate surroundings. This device consists of a transmitter

and several receivers that provide remote ON / OFF functionality for any AC-powered devices within the client's room. The TI is activated by depressing a pair of large buttons mounted to the client's bed. The ability to simply turn on and off devices in his immediate surroundings provides the client with a



Fig. 12.8. The touch of independence.

level of independence he has never previously experienced. Prior to receiving the TI, the client was completely at the mercy of the aides he relies upon. Simple desires, such as turning on a light or the television, required the client to get the attention of an aide to provide assistance.

SUMMARY OF IMPACT

The design criteria for the TI are defined by the extremely limited capabilities of the client. With concentration, he has partial control over his left hand and head, with a large amount of concentration. But the left hand lacks any fine motor skills. Aside from his left hand and head, he has no muscle control and cannot leave his bed without assistance from an aide. The client is also essentially non-verbal. Thus the TI had to be simple to use, touch activated, and provide control over essential devices in the client's environment. Control of both a bedside lamp and a television were deemed essential to meet the goal of providing the client with some level of independence. The TI provides an essential need (turning on a lamp without assistance) in addition to an enjoyable desire (the ability to turn on a television without assistance). The TI thus gives the client some control over decisions regarding his environment, in addition to reducing the level of dependence the client has on his aides while relaxing in his room.

TECHNICAL DESCRIPTION

The TI consists of two major functional units. A single transmitter module controls two wireless receiver modules. The ability to control a third device is built into the transmitter, allowing expandability should the client desire it.

The transmitter module is based on a PIC 12F509 microcontroller running on a 4 MHz clock provided by an Epson SG31P oscillator. This microcontroller sleeps, to conserve battery power, until the client presses a button. By pressing a button, the corresponding input to the microcontroller is pulled low. Upon this change of state to the input, the microcontroller encodes the current state of the inputs using the Manchester Encoding Scheme. This

encoded data is then sent serially from the PIC 12F509 microcontroller to a Rentron TWS-434 RF transmitter. The transmitter then transmits this serial data stream as a 434 MHz wireless RF signal. The transmitter module consists of a small box that is easily slipped under the client's bed. Two 1/8" jacks are provided as inputs to the device. A pair of Able net Jellybean switches are mounted to the client's bed and plugged into the transmitter module to provide the client-to-device interface. A benefit of this design is the ability to easily change the actual client-to-device interface should the client's abilities change. The PIC 12F509, RF transmitter, and oscillator are powered by a single 9V battery, which is then down-converted to 5VDC internal to the device.

The receiver module is also based on a PIC 12F509 microcontroller running on a 4MHz clock provided by an SG31P oscillator. When the RWS-434 RF receiver receives a wireless signal from the transmitter module, it outputs the serial data received to the PIC 12F509. The microcontroller then decodes this serial data and compares it to the current output states of the two outputs. If the input data does not match the current state for one of the outputs, that output is toggled. Each receiver unit has a single output circuit connected to a different output of the microcontroller. This allows each of the two buttons on the transmitter module to control a different receiver module. This output circuit consists of a transistor and a pair of resistors intended to increase the output current of the microcontroller. This output is then applied to a Crydom CDS-2410 solid state relay to switch AC power to the target device on or off using a DC input. The 120 VAC provided to the relay comes into the receiver unit from a standard AC wall plug. The relay output is then applied to an AC jack, similar to those on the walls of most homes, on the receiver unit. This jack provides power to the device under control.

The cost of parts/material is approximately \$250.

REMOTE CONTROL OPERATED FOOD DISPENSER

Designer: Hitesh Amin

Client Coordinator: Jill Siebeking, Helping Hands Monkey Helper.

Supervising Professor: Jay Fu

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INTRODUCTION

The objective of this project is to design a wireless remote control to operate a food dispenser. The project was delivered to Helping Hands Monkey Helper, located in Cambridge MA. They train monkeys to help people with a spinal cord injury. These monkeys act as a care taker by doing routine work such as pick up a remote control, pills, phone from the floor, to turn on the lights and more. One of the monkeys that they have trained does not go inside a cage after helping the client, so they decided to put a food dispenser with wired switch inside the cage, which provides food as an incentive to go inside a cage. However, few times a monkey broke the wire by mistake, so based on the need a prototype of the Remote Control Operated Food Dispenser was designed.

SUMMARY OF IMPACT

With this new design, the client does not have to be concerned about wires anymore. Finally, the client does not need any assistance to turn on the device, as she does presently. She can turn on the device by herself just by pushing a button. Moreover, very small amount of food will be provided to a monkey every time. The Helping Hands can also use this device while they train other monkeys.

TECHNICAL DESCRIPTION

The device consists of two units: a transmitter and a receiver. A TWS-434A, Holtek HT-12E, encodes the IC and jelly bean switches used by the transmitter. The oscillator resistor (Rosc) for HT-12E is determined by using the oscillator frequency vs. supply voltage graph provided in the data sheet of HT-12E. The receiver is designed using RWS-434 and Holtek HT-12D decoder IC. The oscillator resistor (Rosc) for HT-12D is determined by using an equation " $f_{osc}(\text{decoder})=50f_{osc}(\text{encoder})$ " and the graph provided in HT-12D data sheet. To regulate

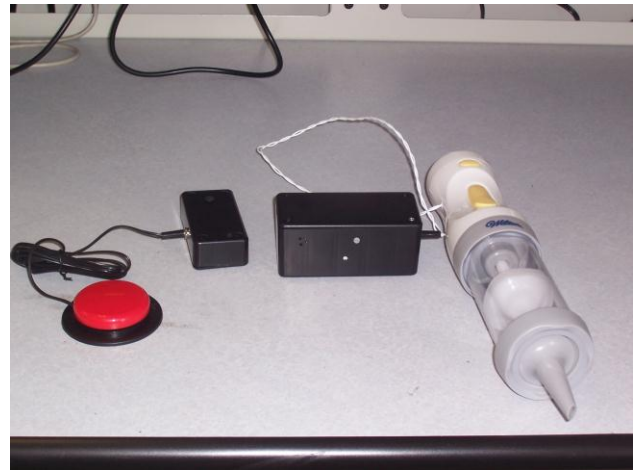


Fig. 12.9. Final project.



Fig. 12.10. Coordinator of helping hands.

the amount of peanut butter or cream cheese dispensed, the food dispenser needs to be ON for one second or less. So, using LM555 timer IC, the monostable timer circuit is designed, and instead of

connecting data output of HT-12D directly to the solid state relay, it is connected to the timer circuit. It also solves another problem such as when the switch is pressed for longer time by mistake, the relay will not operate for more than a second. The output pin of LM555 is connected to the base of 2N3904 transistor through 10KΩ resistor. The 10 kΩ resistor is connected to the base of a transistor to convert the changing current to a changing voltage, and to amplify the voltage. The collector of a transistor is connected to the solid state relay. The 1N4001 diode is connected across the relay to protect the transistor from damage when the load is switched off. The relay is used as a switch to turn on the food dispenser. A cordless cookie press is used as a food dispenser, which is operated with 4 AA batteries.

When the jelly bean switch is pressed, it sends the data in a binary code to an encoder. The binary signals are encoded based on HT - 12E's preprogrammed address setting A0- A9. Data from encoder IC is sent to the data input of TWS -434A by a square wave. Then, the input data is transmitted

through the TWS - 434A and is received by a receiver. The RWS - 434 converts a radio wave into a square wave and sends the digital data output waveforms to the HT - 12D decoder, the decoder converts the data into binary impulses. The voltage change at the Data output of HT-12D triggers the flip-flop in LM555 timer, and releases the short circuit across the capacitor and drives the output high. The voltage across the capacitor then increases exponentially for a period of $t = 1.1 RC$. For this time t , relay connected to the timer through a transistor receives high voltage and stays ON. That completes the circuit between pin 4 and 3 of the relay and turns ON the food dispenser.

The transmitter is powered using two AAA batteries, since The TWS - 434 operates from 1.5V to 12V DC. HT - 12E operates between 2.4V - 5V DC. The lifetime for these batteries is 36 days. The RWS-434 operates between 4.5V to 5.5V DC, HT-12D, LM555 and solid-state relay operates at 3.2V DC. The receiver is powered using 4.8V, AC to DC power adapter.

The total cost for this project is \$97.00.

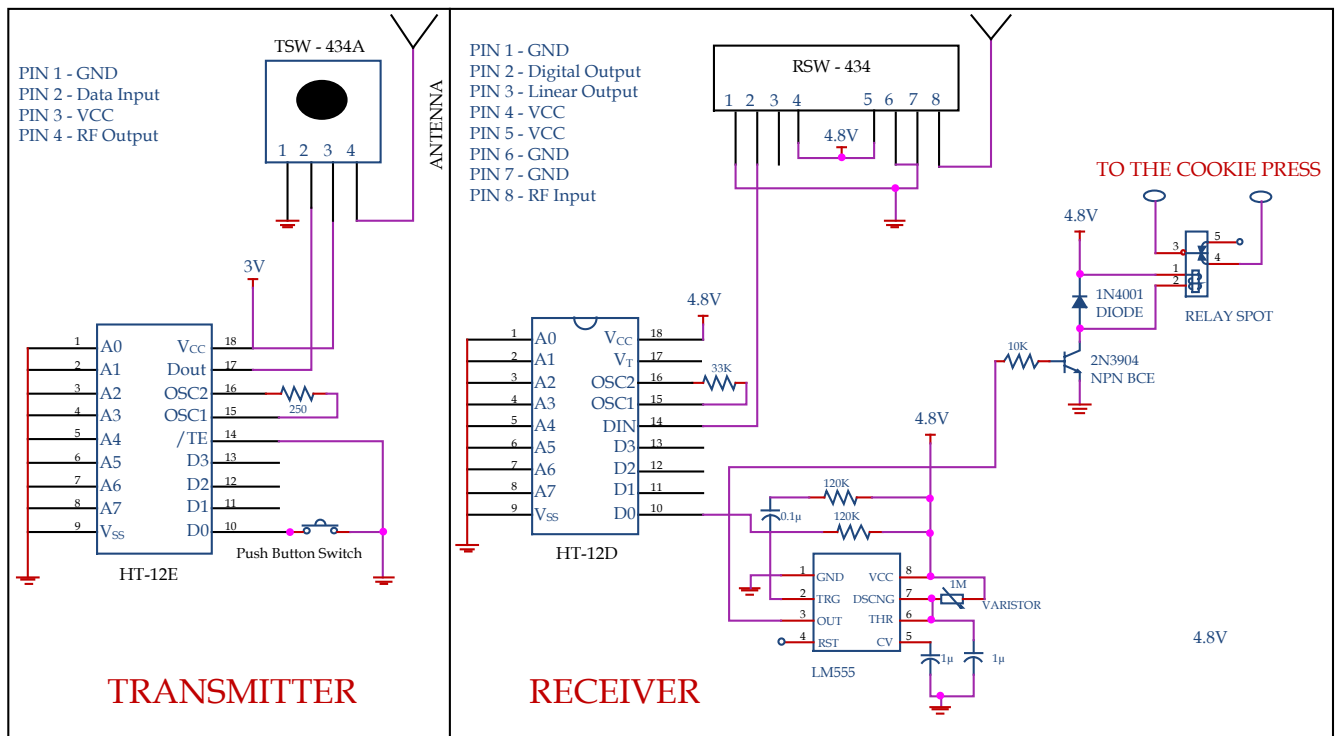


Fig. 12.11. Schematic of transmitter and receiver.

SPEECH TRAINER

*Designer: Iliana Voynichka
Client Coordinators: Marie Haggerty, Jeff Baehrend
Supervising Professor: Alan Rux
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INTRODUCTION

The Speech Trainer is designed to help people with speech disabilities improve their communication skills. The device was not tailored for a specific client, but for classroom use by all students. With this in consideration, it had to be 1) safe, 2) portable, 3) easy to use, and 4) adaptable to different users. The device has four buttons, a record/playback switch, a difficulty selection switch, light emitting

diodes (LEDs), a microphone and a speaker; it is powered by four AA batteries. The Speech Trainer operates by having four words recorded to it by a speech therapist, and then listening to a student pronounce those words and determining if they were said correctly.

There are not many tools on the market to help people with speech disorders improve their verbal skills. Most available devices act as a talking box



Fig. 12.12. A Client using the speech trainer.

and generate phrases and words instead of the person using them. The speech trainer could be used as a speech-generating device, but its main goal is to help the user improve his or her communication skills.

SUMMARY OF IMPACT

The Speech Trainer lets people with speech disabilities practice their verbal skills in a fun and easy manner. The client can use this device even when their speech therapist is not there to help them. The device listens to the way the word is pronounced and determines if it is correct. It lets the user try three times before concluding that the word is wrong.

TECHNICAL DESCRIPTION

The main components of the Speech Trainer are record and playback chip (ISD2560), microcontroller (Basic Stamp) and voice recognition chip (VR Stamp).

The ISD chip is used to record and play the words or phrases to be practiced. The VR stamp saves a template of the acoustic characteristics of the recorded word, and later compares it to the spoken word to determine if it is correct or not. The programming capabilities of the VR Stamp allows the user to be able to select between three levels of difficulty: 1 – less strict, 2 – medium, 3 – very strict.

This provides people with severe speech impairment with more flexibility. The Basic Stamp controls the operation of the ISD chip, the VR Stamp and the push buttons and switches.

To record a word, the switch is put in record position, one of the four buttons is pressed and the desired word is spoken into the microphone. The user has to say the word twice in order to train the voice recognition chip. To indicate that recording is in progress, a red light emitting diode (LED) lights up when the user is prompted to say the word again. The voice recognition stores the characteristics of the spoken word in memory during the record cycle. To practice a word, the switch is put in playback position, a level of difficulty is selected for the voice recognition, and the button associated with that word is pressed. The recorded word is played back and the user is prompted to repeat it. The VR Stamp then compares the spoken word to the original one. If they are the same, a message is played and the LED associated with the word lights up. If they aren't the same, the user is given two more tries to say the word, if he or she doesn't succeed, the device beeps and the practice cycle is over. The Block Diagram in Figure 12.13 depicts the connections between the different components.

The approximate cost of the project is \$250.

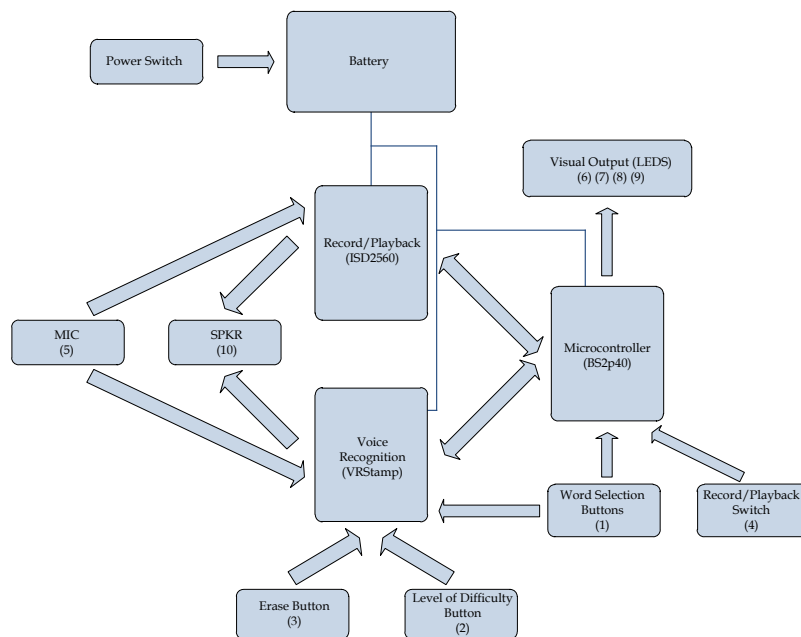


Fig. 12.13. Speech trainer block diagram.

AUTOMATED LASER POINTING DEVICE FOR CAPUCHIN MONKEY HELPERS

Designer: John C. Newton

Client Coordinator: Jill, Helping Hands Monkey Helpers, Boston, MA

Supervising Professor: Alan Rux

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INTRODUCTION

The automated laser pointing device enables people with limited mobility to point to object(s) in their environment. Capuchin monkey helpers are trained to respond to the laser by retrieving the selected object(s) or by performing a task on the selected object(s). The device consists of a hand-held joystick that communicates the desired coordinates wirelessly to a receiver. The receiver controls the position of the laser via two servos. Upon completion, the automated laser pointer was presented to Helping Hands Monkey Helpers in Boston, MA. Their clients have very limited mobility and have trouble manipulating a laser pointer to identify objects in their environment. This device allows them to have more control over their environment and decreases their dependence on their caretakers.

SUMMARY OF IMPACT

Helping Hands of Boston is a nonprofit organization that breeds, raises and trains capuchin monkeys to assist people with limited mobility. Many of their clients have spinal cord injuries. One method of training involves the use of the laser pointer to point to an object(s) in the room. The monkeys are trained to retrieve the selected object(s) for the client. They can also be trained to perform a task in response to the laser. The client may experience trouble physically manipulating a laser pointer to point out an object. To alleviate this problem, they will instead maneuver a small joystick to position the laser on the desired object. This device allows their clients to take control of the laser pointing device and become more independent.

TECHNICAL DESCRIPTION

The automated laser pointer was realized with two separate modules; a transmitter and a receiver (see Figure 12.15). The transmitter module is a wireless



Fig. 12.14. Student with a trained capuchin monkey.

handheld unit. It has an on/off switch, a button and a small analog 2-axis joystick. A microcontroller runs a small program that controls the operation of the device. An RF transmitter sends data wirelessly to an RF receiver in the receiver module. The receiver module also contains a microcontroller running another small program to control its operation. The laser is mounted on two servos, and all of them are directly connected to the receiver via

a cable. It has an on/off switch and a power indicator LED.

The client operates the joystick to select an object in the room. The joystick has an X axis (left and right) and a Y axis (up and down). For fine adjustments, small deviation from the central axis results in a slow movement of the laser. For coarse adjustments, large deviation from the central axis results in a fast movement of the laser. Once the laser is positioned correctly, the client activates the button to excite the laser. Exciting the laser simply shakes it in close proximity to the object to get the monkey's attention. The transmitter module wirelessly transmits the desired state of the laser to the receiver module at 9600 baud. The receiver module interprets this state and positions the laser accordingly by sending pulse-width-modulated (PWM) signals to the servos.

The device is intended to operate indoors, specifically in a room in close proximity to the client and the monkey. The laser must remain in the field of view of both the client and the monkey. The receiver module can be mounted to a wheelchair, table or bed-frame. The servo/laser mechanism is affixed to an adjustable arm to ease the initial set up. The transmitter module is a handheld device that remains with the client.

The receiver module is powered by an AC/DC adapter providing 5 V and 10 W. The transmitter module consumes less than 8 mA during normal operation and is powered by four AA batteries, providing 4.8 volts and 2500mAh.

The cost of parts/material for one unit is less than \$300.



Fig. 12.15. Automated laser pointing device.

THE SOAP DISPENSER: A CUSTOMIZED AUTOMATED SOAP DISPENSER FOR A CHILD WITH CEREBRAL PALSY

Designer: Mark Houseman

Client Coordinator: Bethany Campbell, Forestdale Memorial School, Malden, MA

Supervising Professor: Chuck Maffeo

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INTRODUCTION

The Soap Dispenser (SD) is an automated soap distributor that provides an independently operable method of hand hygiene for persons with disabilities. Commercially available dispensers dispense soap downward, but not every disabled person wants soap dispensed downward. Additionally, most high end automated soap dispensers are mountable rather than mobile countertop devices. The SD is an alternative to commercially available dispensers that meets the needs of persons with disabilities by dispensing soap sideways into a shallow dish, while retaining the ability to be easily relocated.

SUMMARY OF IMPACT

The SD is designed to dispense soap frequently, efficiently, and without adult assistance to a child with Cerebral Palsy. Most soap dispensers require some form of muscle contraction on the part of the operator for soap to be dispensed. My client lacks the ability to grip tightly with his hands, and the ability to rotate his palm to face upwards. As a result, he requires assistance any time he wants to wash his hands. The SD uses an infrared sensor to detect motion, which triggers soap dispensation into a shallow dish. Additionally, the SD is easily used without rotating the hand palm upward. The SD is shown in Figure 12.16.

The design of the SD is defined to meet the needs of a student with Cerebral Palsy who is currently attending the Forestdale Memorial School. The class of children with disabilities at Forestdale Memorial School ranges from ten to fifteen students. The ratio of teacher to students varies depending on the number of helpers a teacher has on a given day, but can be averaged as one to five. Any time spent

washing hands with one student is time taken away from the rest of the students. With the SD, my client is able to wash his hands without taking up large amounts of the teachers' time.

TECHNICAL DESCRIPTION

The housing for the SD is made from 3/4 inch wide aluminum tubing, 26 gauge steel plating, 16 gauge steel plating and fiberglass. The aluminum and steel plating were bolted together to form a sturdy housing, and the fiberglass was used to coat the housing. The steel and aluminum provide the strength need for the SD to survive an impact and the painted fiberglass provides water resistance, as well as giving the dispenser a more finished look.

The dispenser has a 3300mAh battery which allows for operation in locations without a nearby AC outlet, but the battery must be recharged once a week by plugging an AC wall adapter into a power jack on the SD. The battery offers the advantage of operating the SD near a sink without also having an AC wall adapter near the sink. Furthermore, the battery is a NiMH, which has the advantage over NiCd batteries of being unchanged by the "memory effect". The "memory effect" is where a battery is recharged before it is completely drained, and loses overall potential capacity. The charging circuit is monitored by a BQ2002T IC. The BQ2002T monitors the battery voltage using a voltage divider, and monitors the battery temperature using a thermistor (a heat sensitive resistor). When the battery is fully charged, the LED lights up and the BQ2002T trickle charges the battery to keep it at maximum charge.

Soap is dispensed when infrared light emitted from an LED reflects off the hand of the operator, and becomes incident on a photosensitive transistor. A microcontroller senses a change in the voltage across

the photosensitive transistor. The microcontroller provides power to an ISD1400 sound chip, a solenoid valve, and a linear solenoid. The ISD1400 sound chip plays a sound, and then the solenoid valve opens enabling soap to flow through the nozzle of the dispenser. After that, the linear solenoid pushes a spring pump for five repetitions. The spring pump moves the soap from a reservoir through a tube and out the nozzle.

When dispensing soap, the SD plays back a variety of Taz noises using the ISD1420 IC. The ISD chip is

activated by the microcontroller, and is activated prior to the linear solenoid. The ISD chip plays back seven consecutive noises before playing a noise that was already played. The audio playback can be toggled on or off using a switch located on the back of the dispenser. The switch is easily used by an adult, but cannot be used by a child with Cerebral Palsy.

The cost of parts and materials was about \$600.



Fig. 12.16. The soap dispenser.

THE VOICE CONTROL SYSTEM (VCS): A LANGUAGE INDEPENDENT VOICE CONTROL SYSTEM FOR A PC MOUSE, TELEPHONE, AND TOYS

*Designer: Michael Darish
Client Coordinator: John Fairchild
Supervising Professor: Alan Rux,
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Lowell, MA 01854*

INTRODUCTION

The Voice Control System (VCS) is designed and developed for a five year old girl (client) from Italy to provide her with the ability to control the PC mouse functions using only her voice - specifically the click, drag, drop, and double click functions.

The girl has quadriplegia due to a car accident and is limited in what she could do for herself. She needed the ability to accurately control the PC mouse so she can do homework when she entered school. Although the client's father searched all over Italy, Europe, and the much of the USA, he could not find an acceptable PC mouse (mouse) click, drag, and drop control solution and asked if it was possible to design a system that would use his daughter's voice. The father mentioned that he had a solution for moving the mouse cursor around the screen with a device named Tracker Pro, but it did not meet his daughter's "click" control requirements for school assignments. Since the client is on a ventilator and does not read due to her age, commercially available voice recognition products are too difficult for the client to learn due to the amount of talking time required to initially train these products. Also, these products are designed primarily for the English speaker, and the client speaks only Italian. Additionally, using only voice commands, she now has use of a telephone and has the ability to turn on three toys.

SUMMARY OF IMPACT

The design of the VCS is determined by my clients' limited control over her environment and the client's father's request for a device that would provide voice control of PC mouse functions - specifically

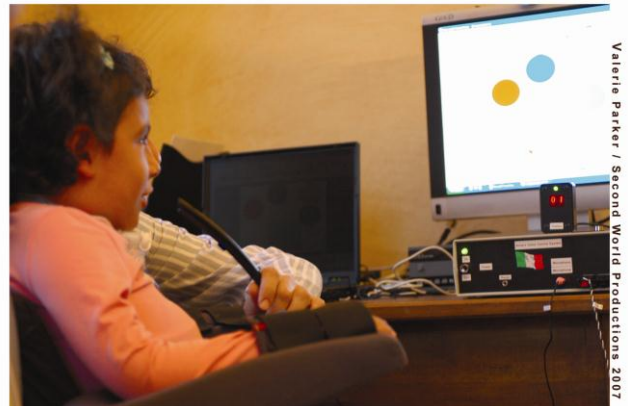


Fig. 12.17. Girl using voice control system.



Fig. 12.18. Voice control system.

the click, drag, and drop. Additional functions were added in order to expand the clients' ability to

control her world. This device provides her with the ability to self-educate, to entertain, and to explore the world through internet access, make telephone calls, and turn on three toys. The VCS provides her with a sense of freedom and control over her environment.

TECHNICAL DESCRIPTION

The VCS enclosure is an 11" x 8" x 4" plastic chassis as shown in Figure 12.18 and houses the core of the system, which is comprised of two boards. An overall block diagram of the system is shown in Figure 12.19.

The first board is the Voice Recognition Board (VRB) consisting of a filtered power supply and the voice recognition, memory, and display output circuitry. The VRB takes in the analog voice signal via a microphone and sends it for digital signal processing. The resulting digital output is sent to, and stored in, the memory (RAM) as a hexadecimal code.

The second board is the Control board (CIO). The CIO is where recognized output codes stored in the RAM are sent as inputs to the microcontroller. Software within the microcontroller uses the inputs to determine which output control relay(s) to activate.

A keyboard on the top of the enclosure provides the means to enter codes used to either clear a memory location or program a code to correspond to a specific function. A two digit hexadecimal display, also on the enclosure top, provides visual confirmation of trained and recognized function codes. The rear panel has the power input connection, fuse holder, a serial programming port, telephone and toy connectors, the mouse control jack, and a mouse direction switch which allows the left and right mouse click buttons to be reversed.

The ability for the user to reset the device was added through the use of a head activated "pillow switch," as shown in Figure 12.21.

The cost of parts/material is about \$400.

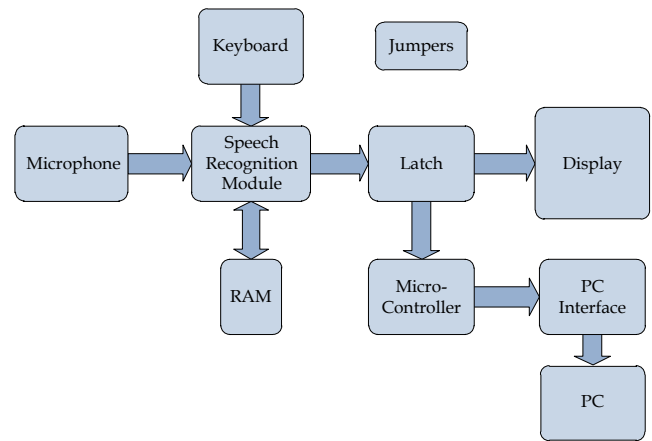


Fig. 12.19. System block diagram.



Fig. 12.20. Voice control system - rear view.

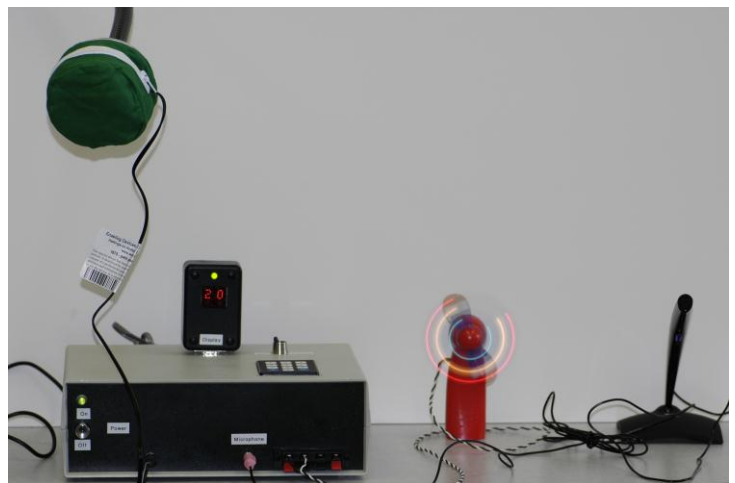


Fig. 12.21. Voice control system with pillow switch and fan.

MEDIA CONTROL CENTER

Designers: Michael L. Bray

Client Coordinator: Deborah, Coastal Educational Collaborative, Salisbury, MA

Supervising Professor: Jay Fu

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INTRODUCTION

At the Coastal Educational Collaborative (CEC), the clients get much joy from viewing the photographs presented to them on a slide projector; however, they cannot interact directly with the projector themselves. Additionally, it is difficult to manage a growing library of photographs on an old slide projector. Some possible solutions are Media Centers, designed for use with a television, and a simple remote for the PC, however these solutions immediately become limiting due to the small sized remote and cost. The Media Control Center (MCC) is designed to provide both solutions, give the CEC a computer-based solution to view photos, providing an easy way to handle a growing photo library, as well as give its clients an opportunity to run the slideshow themselves. The MCC accomplishes this by providing an interface box to a PC running the MCC application software. The application software monitors the interface box over the parallel port, responding to user button presses by opening photos and moving back and forth between photos in the library. These photos are ultimately displayed on the wall through the LCD projector, providing a modern replacement to the old style slide projector. For clients with varying degrees of motor skills, the MCC provides three 1/8" jacks, allowing any button with an 1/8" jack to be connected, such as AbleNet's popular "Big Red Switch" and "Jellybean" style buttons.

When presented with the MCC, the clients at the CEC were overjoyed at being able to view a gallery by themselves, currently consisting of over 100 photographs. The MCC not only solved the problem of CEC's growing library of photos, but gave their clients a way to interact with one of their most favorite pastimes.

SUMMARY OF IMPACT

The design criteria for the MCC are defined by the functional abilities of the clients and the needs of the



Fig. 12.22. Media control center interface box.

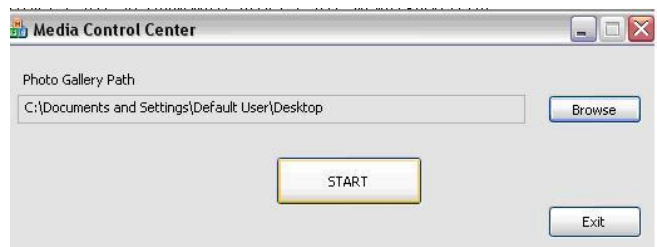


Fig. 12.23. Media control center application software.

facility. The CEC had a LCD projector that could replace their old slide projector, but no means to interact with it. A remote control could be used, but these typically are designed to run PowerPoint slide shows, severely limiting the ability to expand their photo library without time and work. Additionally, these remotes are tiny, allowing only a select number of clients to be able to use them depending on their level of motor control. Because the clients have varying degrees of motor control, it is necessary to design an interface that allows the facility to use the appropriate sized button to fit the needs of the client. To accommodate this, jacks were used rather than building buttons directly into the MCC. The result is a device that allows for individual button customization, allowing all clients

to interact with it, and a solution that can handle the CEC's ever-growing library of photographs. The MCC also offers the opportunity for clients of the CEC to view photos unassisted, giving the clients a feeling of independence, as well as freeing up the hands of staff members to assist others in the facility.

TECHNICAL DESCRIPTION

The MCC interface box contains three 1/8" stereo jacks which allow the user to connect a standard "Jellybean" style input device designed for use by persons with disabilities. Button presses are latched and read by the MCC application software via the parallel port. The application software, written in C++, is designed to run on the Windows 2000/XP platform and utilizes a third-party parallel port driver to access the MCC interface box. The software (See Figure 12.23) allows the user to select the source location of their photo library and stores this path in the Windows Registry to be used as the default. This path can be updated at any time, giving the user the flexibility to move and sort their library as they feel fit. The application looks for files

containing the JPG extension which is the photographic standard for digital media. When the user presses the "Start" button, the application initializes the parallel port and begins to monitor the button states.

The application checks for any new button presses every 250 ms when triggered by a Windows Timer event. The associated event handler parses the data read back and performs the appropriate action. These actions include starting the photo viewer, display the next photo, or display the previous photo. As the user traverses the directory, file paths are stored in a Standard Template Library (STL) vector of CString objects. These file paths are traversed by the use of a vector iteration. Unlike a standard array, an STL vector grows on its own, reallocating memory as needed. Images are opened on the screen utilizing the default windows image viewer and ultimately displayed on the wall via the LCD projector.

The cost of materials is approximately \$65.



Fig. 12.24. Student showing the device to the client.

THE TACTILE IMAGER: A DEVICE FOR THE VISUALLY IMPAIRED THAT CREATES A TACTILE REPRESENTATION OF A TWO DIMENSIONAL IMAGE

Designer: Nicholas H. Brunelle

Client: Anicia

Client Coordinator: Thomas David, Malden Elementary School, Malden, Ma

Supervising Professor: Alan Rux

Electrical and Computer Engineering Department

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Lowell, MA 01854

INTRODUCTION

The Tactile Imager was designed to provide a textured representation of a digital image. The interface of the device is an array of actuators that responds to an input from a computer and from a binary topographical map of the image. Figure 12.25 is an example of how a silhouette of a cat looks when displayed.

The blue squares represent a solenoid that is activated, and forms a raised bump. The white squares represent a solenoid that is off, and this forms a recess in the texture. The user can then feel the image with his or her hands and form a mental picture of the image being displayed. The device is a way of letting the visually impaired experience pictures in ways they previously could not.

SUMMARY OF IMPACT

The device is designed for one particular student in the Malden public school system, but remains the property of the school for use with all visually impaired students. To a person who cannot see, touch and sound are their interface with the world. I have created a way for something that once could only be seen to become something that can be felt.

TECHNICAL DESCRIPTION

The major parts of the device are: the solenoid array (Figure 12.26), the solenoid controller stack, the USB interface card and the power supply. Figure 12.27 shows a block diagram of the interconnection of each part.

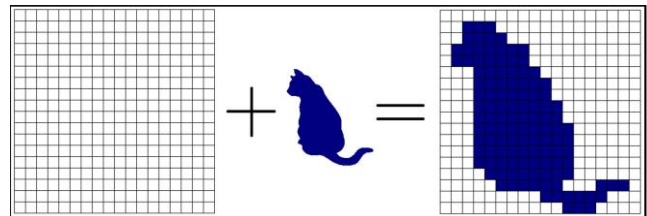


Fig. 12.25. Image output.



Fig. 12.26. Solenoid array.

The solenoid array is constructed of 2 sheets of 3/16" sheet aluminum bolted in parallel with a space in between containing the solenoids. The top plate has an 18 by 18 grid of 3/16" diameter holes that the solenoids mount to. The actuator from each solenoid has a small polymer block mounted to it. Together, they form the tactile surface. One lead from each solenoid is connected to the positive terminal of the power supply. The other lead from

each solenoid is connected to a switching transistor on the solenoid controller card (SCC). There are seven SCCs, each of which control up to 48 of the 324 solenoids. Each SCC has 6 latches with a common 8 bit data buss and up to 48 switching transistor circuits. The SCCs are controlled by loading 8 bits of data onto the data buss and enabling one of the latches. After the data is loaded into the latch, it is disabled and holds the data. The output from the latch is used to control the switching transistor circuitry. This is then repeated for each of the 41 latches across each of the SCCs.

Special considerations had to be made for the large power requirements of the system. Each solenoid draws about 240 mA of current. If every solenoid was to be turned on at the same time, the current draw is about 75 A at 12 VDC, and dissipate about 1 kW of power. Cooling fans are installed on the solenoid array to remove the heat generated by the solenoids.

The USB controller card contains a USB interface chip and latch-enable circuitry for the SCCs. The image is sent to it from a computer and loaded into its memory buffer. Data is sent to the USB controller as a string of 42 bytes of binary data. The circuitry on the USB controller card then reads off 1

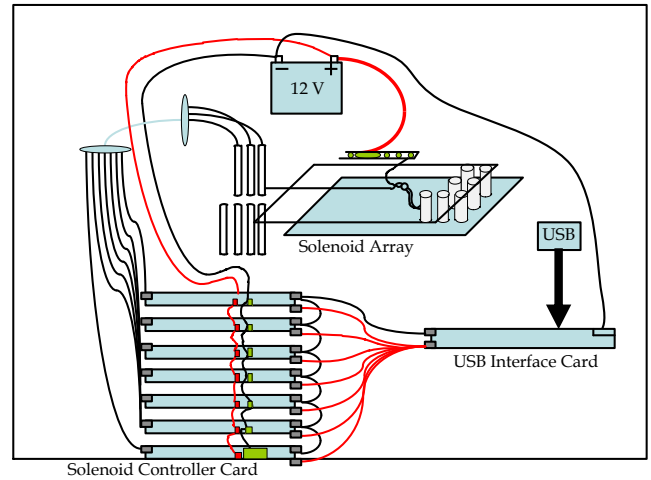


Fig. 12.27. System DIAGRAM.

byte of data at a time, puts the data onto the data buss and enables the corresponding latch which is to hold that data.

The device is operated via a computer program. An image is loaded into the program, converted to an 18 by 18 black and white image and outputted to the tactile imager via a USB connection.

The total cost of this device is about \$2,000.



Fig. 12.28. Student showing the device to the client.

AUDIO MIXER FOR THE VISUALLY IMPAIRED

Designer: Phong K. Dinh

Client: Bill R.

Client Coordinator: Tony Chavez and Keith Casavoy

Supervising Professor: Prof. Alan Rux

Electrical and Computer Engineering Department

University of Massachusetts, Lowell

Lowell, MA 01854

INTRODUCTION

The Audio Mixer for the Visually Impaired (AMVI) is a device designed for Bill, our client, to control an audio mixer. Bill preferred to control the volumes or faders of each individual channel using sliding potentiometers rather than rotary potentiometers. In addition, the application of large rocker switches and large knobs is used to maximize control and stability of the system. The physical layout for each controlling device is placed directly in front of the operator so that he can fully control every aspect of the audio mixer.

SUMMARY OF IMPACT

The main objective in designing the controls is to ensure Bill has total control of the audio mixer. The large rocker switches and large knobs enable him to locate the controlling devices much quicker than standard mixers. For Bill, controlling the sliding potentiometer was the best part of operating the audio mixer. With a built-in micro-switch inside every sliding potentiometer, Bill is able to simultaneously control mixer functions, something he cannot do easily on conventional mixers.

TECHNICAL DESCRIPTION

The AMVI is a modified version of the Arrakis 150SC Console. The audio mixer is powered by an AC to DC converter. The power converter converts 120 VAC to 12VDC. The console consists of five input channels; within each channel there exist two different sections A & B. The total number of inputs for the AMVI is ten. The inputs for each channel are located directly on top of the audio mixer that includes eight phono jacks and two microphone XLR female connectors. The controlling interfaces for the AMVI are the six sliding potentiometers and seven rocker switches.

The audio feedback circuit for the AMVI consists of a Basic Stamp 2E microcontroller from Parallax.



Fig. 12.29. Audio mixers for the visually impaired.



Fig. 12.30. Bill R. Using AMVI at WGAW radio station located in Gardner, MA.

This particular microcontroller is used because of its higher memory capacity, operational speed, and higher command capabilities than any other conventional microcontrollers. A voice recorder chip, ISD 2560 is also incorporated to process and store prerecords messages. The messages tell Bill the current status of the mixer. The ISD 2560 is used because of its ability to provide greater sampling

frequency (8 kHz/sec) than any other ISD chip, a feature critical in audio feedback systems. The ISD 2560 possesses 60 seconds of record and playback time that is sufficient enough to perform the job.

When in operation of the AMVI, the six rocker switches enables the individual reed relays be energized so that sound or music is output to the program buss. In addition to energizing the reed relays, the basic stamp 2 playbacks the stored messages through the ISD 2560. This message is

then heard through the phono jacks located directly in front of Bill. This audio feedback informs the current status of that particular channel. At any time Bill does not know or remember the status of whether what channel is on or off, he enables the status push button, which is isolated from the rest of the switches, to play the entire status of every channel on the audio mixer.

The cost of parts and materials is approximately \$1,500.

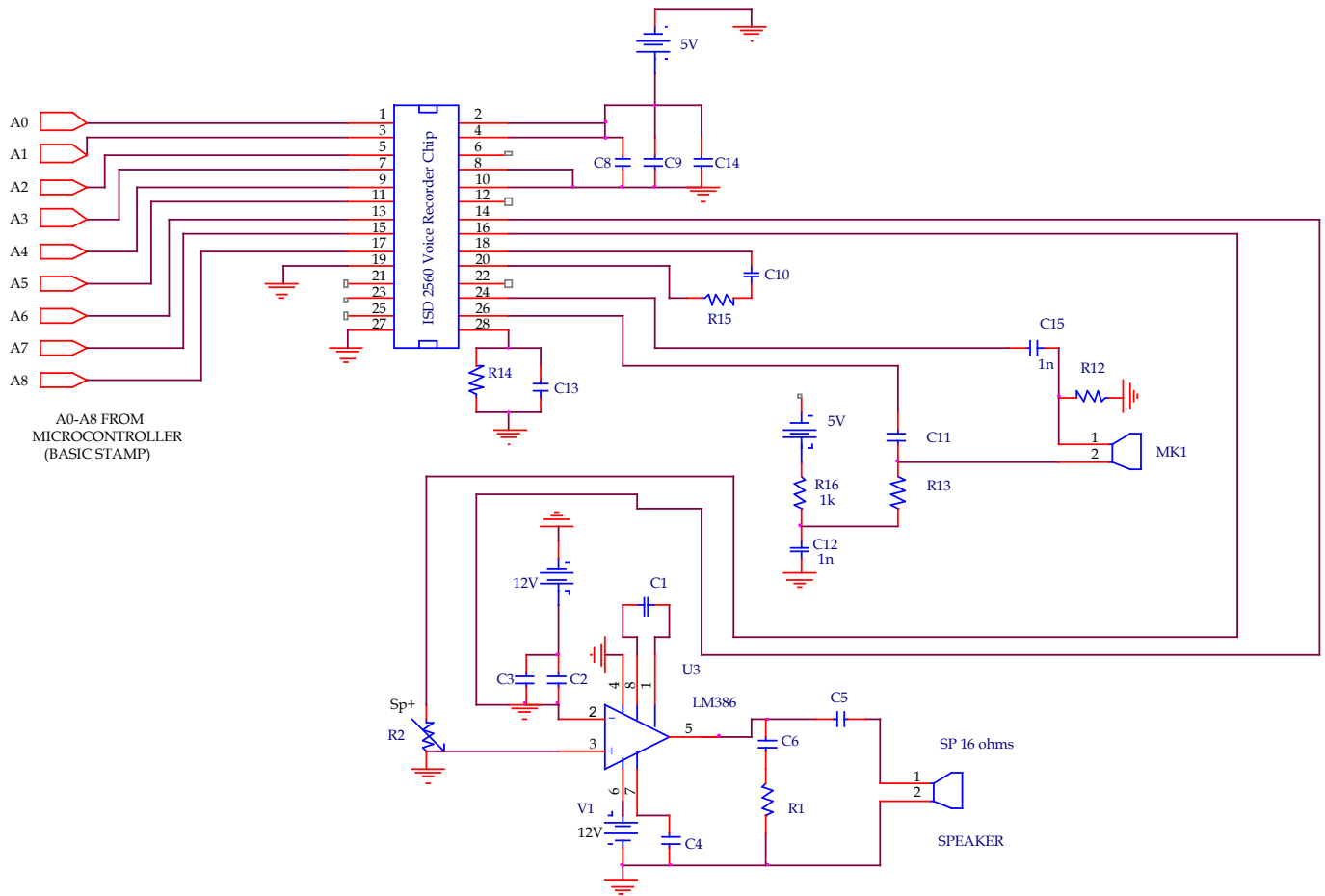


Fig. 12.31. Schematic for audio feedback.

WIRELESS REMOTE CONTROL WHEELCHAIR TRAINER

Designer: Run Ron

Client Coordinator: Bonnie Paulino, Franciscan Hospital for Children, Boston, MA

Supervising Professor: Prof. Alan Rux

Electrical and Computer Engineering Department

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INTRODUCTION

The Wireless Remote Control Wheelchair Trainer (WRCWT) is a miniature wheelchair frame mounted on the body of a remote control toy car (see Figure 12.32). Clients can practice motorizing the wheelchair control with the WRCWT for a period of time before controlling a full-size motorize wheelchair. This allows them to practice and become familiar with a joystick control that is found on a full-size power wheelchair. The WRCWT can also be a toy for all children to enjoy at the Franciscan Hospital.

SUMMARY OF IMPACT

The design requirement for WRCWT is described by Bonnie Paulino at the Franciscan Hospital for Children. She described the children's disabilities and expressed their needs. Most of their challenges are in the area of communication, mobility, motor control, vision and hearing. The children using the WRCWT have mobility and fine motor control difficulties. Clients rely on their wheelchair to get around. The product is designed to help increase motor control by allowing them to exercise their fingers using the joystick.

TECHNICAL DESCRIPTION

The structure of the WRCWT includes an 18 inch tall toy wheelchair from the American Girl Company. The frame underneath is a toy car frame 6 inches high from New Bright Company. The two frames are mounted together with two 3/8 inch screws. The wheelchair and remote control have an on/off power switch.

The remote control step design is similar to that of a controller on a real power wheelchair. The joystick can move in a 360-degree rotation. The transmitter and antenna are placed inside of the remote control joystick. The schematic used in the device is shown



Fig. 12.32. Wireless remote control wheelchair trainers.

in Figure 12.33. The design used a window comparator to connect the three circuits together. The window comparator has high and low references voltage. The high references voltage is 1.6 volt and low references voltage is 1.4 volt. The LM339 is the chip used for the comparator.

The transmitter is an electronic device that sends an electromagnetic signal through the antenna. Two 1.5 V batteries provide the power to turn on the transmitter and receiver. The transmitter is designed using an oscillator, modulator and amplifier. The transmitter module sends a radio frequency (RF) wave through the antenna to the receiver at 45 megahertz (MH). The receiver is mounted on the bottom of the toy wheelchair, where its antenna receives the signal and then decodes it to navigate the position desired by the user.

The WRCWT was powered by six 1.5 V AA Energizer batteries. The batteries are used to power the remote control and the motor connected to the wheelchair. The cost of parts/materials is about \$170.00.

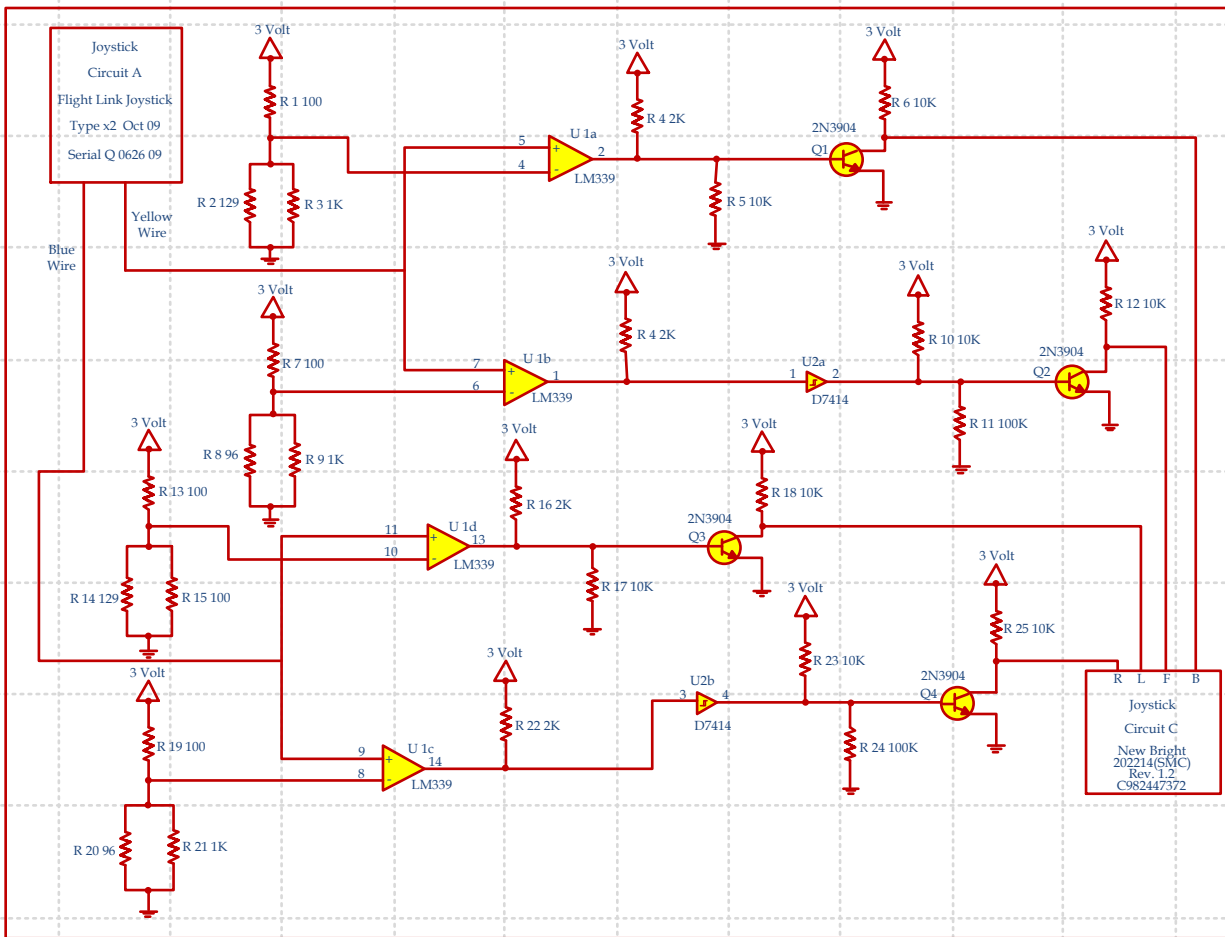


Fig. 12.33. WRCWT joystick schematic.

DUAL TOUCH LEARNING: A MONITOR SCREEN TOUCH LEARNING SYSTEM FOR THE SPECIAL NEEDS CLASSROOM, K THROUGH 12TH GRADE

Designers: Senait Haileselassie

Client Coordinator: Lisa, Shore Educational Collaborative School, Chelsea

Supervising Professor: Prof. Alan Rux

Electrical and Computer Engineering Department

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Lowell, MA 01854

INTRODUCTION

Students who have limited or poor hand, finger and arm dexterity find it difficult to interface with the many computer based software learning programs that are available which require student computer interaction. Most of these students are able to activate large switches and have sufficient hand-arm movement to touch the face of the computer monitor that they are using. A low cost touch screen device is described here that is attached to a computer monitor to replace the computer mouse input function. This touch screen allows an alternative input that is easy to use and provides interaction functionality. This device allows interaction with the learning software by touching the monitor screen to indicate their interaction with the learning software program. This input can also be used for other computer interactions that require mouse movement and left or right mouse switch click.

SUMMARY OF IMPACT

The Dual Touch Learning System is developed by a request, or more like a "Wish" from a Special Needs Teacher and the director of Assistive Technology at the Shore Educational Collaborative School, a special needs school with over 90 students with multiple profound disabilities. Students are in grades K to 12 and up to the age of 21 from the Boston area. The school is located in Chelsea, Mass.

The solution to the problem started out as a hardware mouse substitution problem and the ability to interface with available software of one engineering student with a Service Learning Senior Capstone project. But when working with the software, it was determined that the software programs did very little teaching of learning concepts, and in most cases was not age and skill

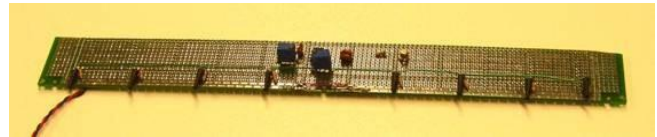


Fig. 12.34. Led array.

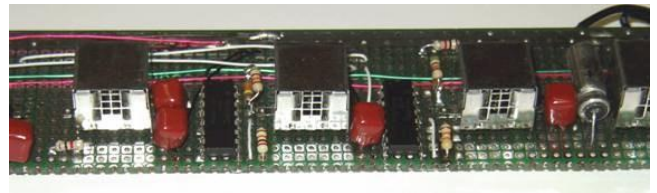


Fig. 12.35. Detector array.

level compatible with the students using the system. Another engineering student joined the team with programming skills and the understanding of the hardware interaction requirements to design new software that would meet the need and wishes of the teachers and students at Shore Educational Collaborative School. The goal is to have a flexible computer interface for students with disabilities and software that meets the needs of the school learning program and the student skill level. It had to be of low cost and allow for modification to the software as needed without professional programming skills.

TECHNICAL DESCRIPTION

In the literature review phase of our project and meeting with our Electrical Engineering advisor, he mentioned a machine safety product used to stop machinery like robots or mold injection equipment when a person enters a hazard zone and could be injured by the machinery; a safety light screen, made by Banner and called a "Machine-guard Safety Light

Screen". This is a device sends light from an emitting bar to a receiving detector bar, and provides an alarm signal when the light beam is broken by something that shields the light from the emitter to the detector, and also stops the equipment so personal do not get hurt.

This method of detection is used in this device. A row of light emitting diodes across the top of the Monitor face and a row of detectors across the bottom face form the interface. Circuitry is used to detect when the light beam is interrupted. The interruption data is sent to a modified computer mouse to interface with the computer through the serial mouse port.

Many types of emitters and detectors were tested, both in the visible and infrared ranges.

The best results are with inferred devices. The stray light interference is eliminated by modulating the emitter and filtering the detector output using a system similar to a remote TV control uses.

The final hardware design includes a modulated array of infrared light emitting diodes mounted across the bottom of the computer monitor screen (Figure 12.34).

Across the top of the monitor is a matching set of infrared detectors with band pass filters of 72 kHz, the same frequency used to modulate the emitters. Also on the detector board is the control logic that detects when the infrared light beam is interrupted and it supplies a right or left mouse switch click (Figure 12.35).

A standard two switch computer mouse is modified to receive commands from the control logic on the detector board, which allow the mouse keep its normal function for the teachers use. The two circuits are mounted on a plastic frame that attaches to the monitor face surrounded with Velcro (Figure 12.36).

The cost of parts/material is about \$150.



Fig. 12.36. Student demonstrating system.

HANDS DOWN, SIT UP STRAIGHT (HDSS): FEEDBACK/ CORRECTION DEVICE

Designer: Shawn P. Garvey

Client: Leon, Ferryway Middle School, Malden, MA

Supervising Professor: Alan Rux

Electrical and Computer Engineering Department

University of Massachusetts Lowell

Lowell, MA 01854

INTRODUCTION

Hands Down, Sit up Straight (HDSS) is designed as a learning tool for my client. My client has autism. His symptoms include playing with his hair and chewing on his shirt. He also has bad posture. As a result, his teacher has to constantly keep telling him to sit up straight and to keep his hands down. The HDSS detects arm motion and tilt angle and plays a prerecorded message from the teacher. For example, when my client raises his hand past his upper chest to chew on his shirt HDSS detects

motion and plays a message - "Please keep your hands down." A tilt sensor detects the angle of his body when he is sitting. If the client leans 'too far' forward it plays a message - "Please sit up straight." HDSS gives my client positive feedback without constant intervention by his teacher.

SUMMARY OF IMPACT

HDSS is designed to be used in a classroom setting. Special education teachers (SET) are very busy working with other students. As a result, the teachers are unable to pay constant attention to all

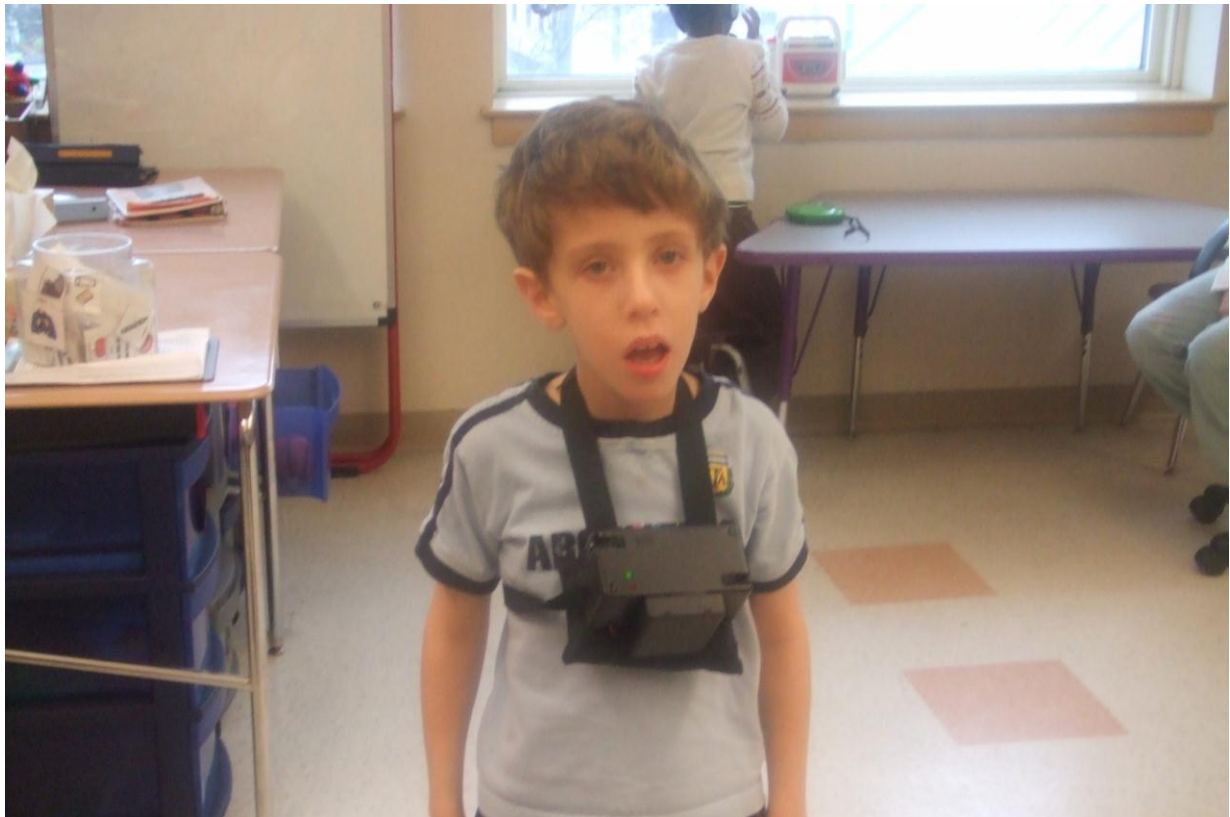


Fig. 12.37. Client using the device.

students at the same time. Hence, HDSS provides the feedback the client needs when the SET are busy working with other students.

TECHNICAL DESCRIPTION

The HDSS is comprised of a plastic case for the chassis with 4 buttons, 2 LEDs, and battery pack mounted outside the case. HDSS is attached to a strap that is put on the student and wears comfortably. The buttons are for the SET use only and they are: on/off, play/record, start/pause and stop/reset. On/Off turns the power on and powers up the circuit with 6 volts DC. Play/Record is a switch that is always in the play mode unless the SET want to record a new message. To record a new message the SET simply switches to record and pushes the start/pause button to start recording. To stop recording press start/pause again and switch back to play. Start/Pause resets the circuit if a problem arises. The LEDs are green and red. When the on/off switch is on the green LED will turn on to indicate that HDSS is powered up. If the SET want to record a new message then the red LED will turn on indicating recording mode.

HDSS internal circuitry uses two main sensors for tilt and arm motion. A playback/record IC chip is used for message storing and playback (see Figure 12.37). When the sensors detect motion or tilt they send a low voltage pulse to pin 23 of the ISD2540 and output a pre-recorded message through a speaker. For the ISD2540 IC the main pins implemented are the Chip Enable (CE) pin 23, Play/Record (P/R) pin 27, Speaker pins 14 and 15, and the addresses (A0-A8) pins 1-9. To record a message, the P/R pin must be low and the CE pin must be pulsed low to start recording, and then pulsed low again to stop recording. To play a message the CE pin needs to pulse to a low voltage and an 8-16 ohm speaker must be attached to pins 14 and 15. When motion and tilt are detected, the CE pin is pulsed to a low voltage, resulting in the message being played back.

For motion, a proximity sensor is used. This proximity sensor has a detection range of 24 cm.

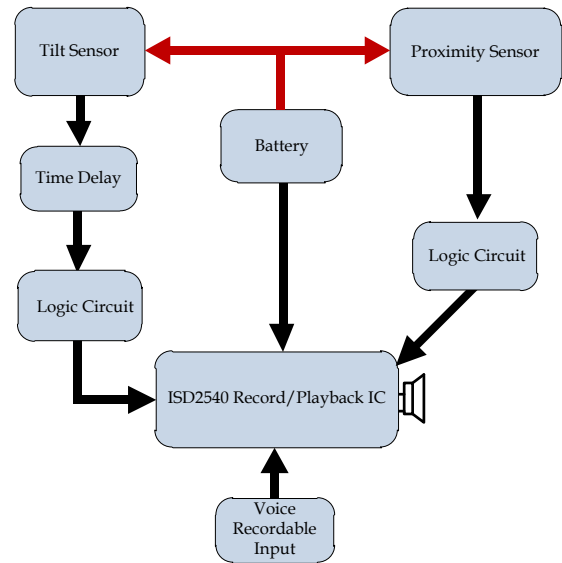


Fig. 12.38. Block diagram.

When this sensor detects movement it sends a high output voltage. That voltage then goes into a logic NAND gate, then to a logic AND gate that pulses CE to a low voltage, and plays the pre-recorded message. If there is no motion detected, the logic AND gate keeps the CE pin high and does not play a message. The tilt sensor produces a high voltage when tilt angle exceed 30 degrees. This high output voltage changes addresses A5 and A7 of the ISD2540 to high; such that when CE pulses low it plays the message at the corresponding address. However, this output voltage of the tilt sensor is only 1.7 V. This is not enough voltage to use the time delay IC and a logic NAND gate. As a result, a simple op-amp increases the voltage to 3.5 volts. From the op-amp, the high voltage goes to a time delay IC allowing enough time to change the address. From the time delay IC, the high voltage goes into a logic NAND gate then to a logic AND gate, which pulses CE to a low voltage and plays the pre-recorded message. If there is no tilt detected, the logic AND gate keeps the CE pin high and does not play a message.

The cost of parts/ material is about \$ 175.

THE SMART HAT: A DEVICE THAT TRACKS THE MOTION OF THE USER'S HEAD

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Client Coordinator: name, Malden MA
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INTRODUCTION

The Smart Hat (SH) is designed as a learning tool to help my client pay more attention in school. This device uses a low-g accelerometer (a microchip that measures gravity) as a two-axis tilt sensor mounted on a baseball cap. When The Smart Hat detects the user's head is no longer in an upright position, it sends a signal through a radio frequency (RF) link operating at 415MHz to an alarm system. The alarm system simultaneously turns off a music player and sounds a pulsating alarm. When the SH detects the users head is once again in an upright position, the alarm stops and the CD music is turned back on.

SUMMARY OF IMPACT

The purpose of the SH is to help a young girl from Malden named Erica. Erica has Spina Bifida that caused paralysis on her left side, as well as visual and speech impairments. Erica has also been diagnosed with a mild form of Down syndrome. Her disability has caused her to constantly leave her head down or flexed. When her head is flexed, Erica becomes unresponsive, which has made it difficult for her to attend school. Erica has the ability to keep her head up but needs constant reminders from teachers and parents to do so. Because of Erica's love of music, her physical therapist has suggested using a sensor that controls the music in the room to encourage Erica to keep her head in an upright position.

TECHNICAL DESCRIPTION

The SH is composed of two basic components; a tilt-monitoring circuit (Figure 12.40) and an alarm-triggering circuit (Figure 12.41). The tilt monitoring circuit is positioned on the brim of a baseball cap and monitors the orientation of the users head by measuring the net force of gravity along vertical and horizontal axis. This is done by using a low-g accelerometer from Analog Devices - the ADXL213.



Fig. 12.39. Complete project setup.

The outputs of the ADXL213 are digital signals whose duty cycles are proportional to acceleration. When the accelerometer is oriented so that both its X and Y axes are parallel to the earth's surface, it can be used as a two-axis tilt sensor. In this case, it is used to measure both the pitch and roll of the user's head. Two pulse width modulated signals are fed into a Parallax Basic Stamp microcontroller, BS2 SX, which measures the pulse width of the signals and then calculates the corresponding angle.

If an angle of orientation exceeds 60 degrees for more than three seconds, it means the user's head is no longer upright, and a signal is sent to the alarm triggering circuit. The circuit simultaneously turns off the music coming from a CD player and sounds an alarm. The communication between the tilt-monitoring circuit and the alarm-triggering circuit is generated by a small receiver and transmitter pair operating at 415MHz.

The alarm-triggering circuit is composed of a transmitter, a Basic Stamp Microcontroller, two MOSFETS used to switch music on and off, and a 9-

volt battery for power. The circuit itself is encased in a small project box with a power switch, a piezzo buzzer, and terminals used to connect a CD player and speakers. When a signal is picked up by the receiver, the microcontroller turns on the piezzo

alarm and cuts off the signal between the CD player and speakers by controlling the gate voltage on the MOSFET.

The cost of parts/material is about \$300.

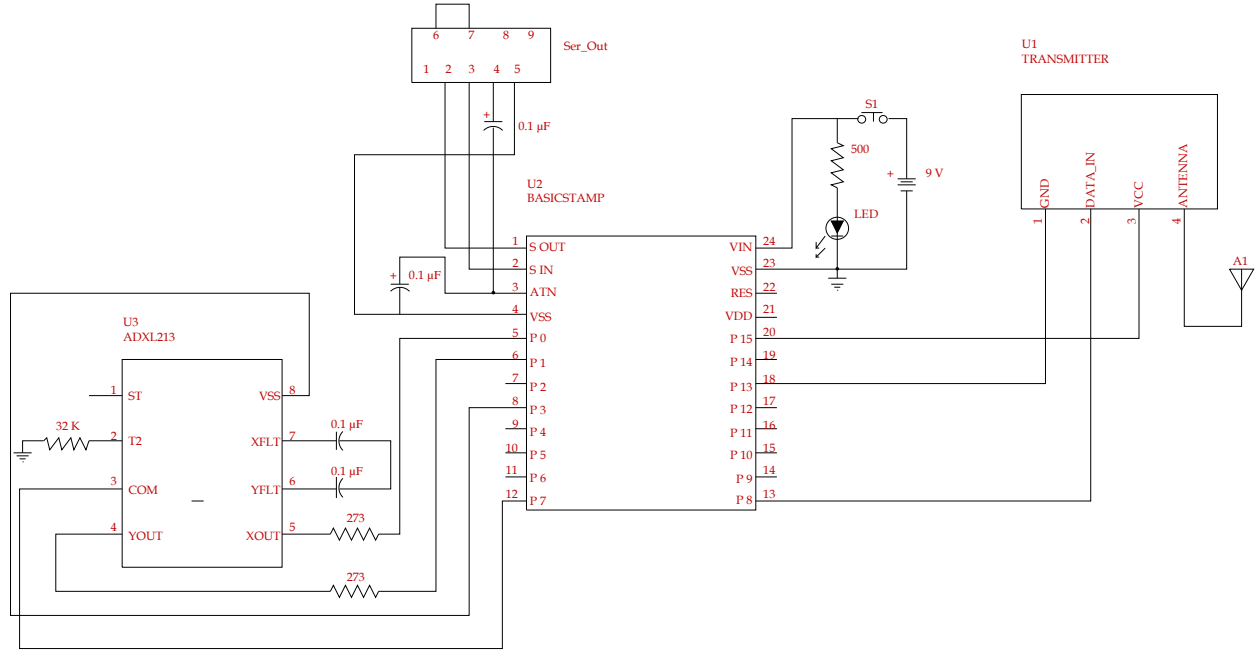


Fig. 12.40. Tilt sensor circuit.

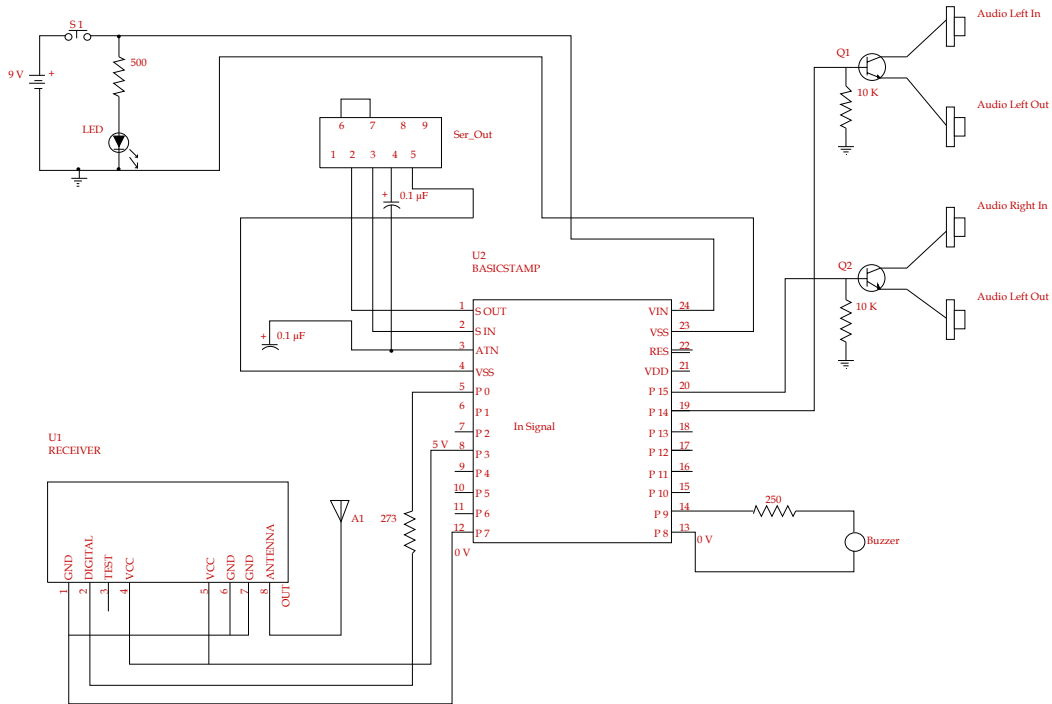


Fig. 12.41. Alarm triggering circuit.

ENHANCED ACCESSIBILITY OF THE COMPUTER INTERFACE: AN INNOVATION PROJECT MERGING A TOUCHSCREEN OVERLAY AND EZITEXT® PREDICTIVE TEXT SOFTWARE

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INTRODUCTION

For people with physical disabilities, devices designed for the able-bodied present barriers to complete social functioning. The computer and the Internet, for example, are indispensable tools of productivity, communication, and commerce. Yet the computer keyboard and mouse, portals to the “connected” world, are very challenging for persons without the requisite manual dexterity.

This project seeks to demonstrate that solutions need not be expensive or complex. Instead, barriers can be overcome by simply combining existing technologies in new ways.

Here, a resistive touch screen and a commercial predictive text-entry software package provide improved text entry and mouse functionality for a client whose writing and typing skills are limited because of the physical effects of Cerebral Palsy.

SUMMARY OF IMPACT

The client uses the computer to compose poetry. He has moderate dexterity in his left arm and types in the hunt-and-peck method with his index finger. As such, his text entry speed is limited by his ability to find and to press the correct sequence of keys on the standard keyboard. At present, his typing speed is 5 words per minute.

A solution was developed to compliment his physical abilities. By reducing the number of buttons and increasing their size by 400%, it is expected that the correct button will be easier to find and press. Secondly, a predictive text-entry program is included that reduces the number of keystrokes necessary to type full words.



Fig. 12.42. Student showing the device to the client.

The combined hardware and software package is expected to increase the client's typing speed, thereby allowing him to be more prolific as a poet.

TECHNICAL DESCRIPTION

Deliverables include a 12” resistive touch screen with housing, and a software suite including touch screen driver software and the eZiText® predictive text program.

The decision to redesign the keyboard was based upon two assumptions. First, the hunt-and-peck method has a trade-off between typing speed and typing accuracy. It is assumed that increased key size decreases the need for precision, thereby permitting more rapid keystrokes. It is noted, however, that increased key size results in a larger keyboard, which requires larger arm movements and diminish the gains in typing speed. The problem is overcome by reducing the number of

buttons on the interface in proportion to the increase in button size.

Noting the considerable success of the cell phone as a text entry device, the map for the touch screen buttons is modeled on the cell phone layout. Like a cell phone, a set of characters are multi-tap-accessible through a single touch screen button. As shown in Figure 12.43, the left and right mouse buttons and all 84 keys of the standard PC/AT keyboard, with the exception of the function keys and the Num Lock and Scroll Lock keys, are accessible through only 22 buttons.

The second assumption is that combining the mouse and keyboard into a single interface improves productivity by eliminating the need to move the arm between devices.

The touch screen hardware includes a microcontroller circuit that outputs serial data to the PC serial port. A LabVIEW® state-machine program polls the serial port for data, maps X,Y touch coordinates to characters according to the button layout, and then simulates the corresponding keystroke by calling the keyboard event function of the Windows® User Interface API.

Advanced features, such as pointer control, multi-tap text-entry, and keystroke repeat, are implemented as decision trees within the state-machine architecture. Figure 12.44 shows the logical flows implemented in the LabVIEW software.

The eZiText® predictive text-entry software package, produced by Zi Corporation of Alberta, Canada, is selected to reduce the number of keystrokes needed to generate a word. Zi Corporation claims that their product provides a 450% increase in typing speed for multi-tap interfaces by predicting word output based upon a minimal number of input characters.

Zi Corporation donated a development copy of their eZiText predictive text software for the project. A routine written in the C programming language handles calls to the eZiText DLL functions. LabVIEW Code Interface Nodes were used to transfer data between LabVIEW and the C routine.

" ~ ' ^	! 1 a b c	ABC @ 2	DEF # d e f 3	Pg Up Up ^ 	Pointer Control & Left Click Pad
GHI g h i	\$ 4 4	JKL % j k l 5	MNO ^ m n o 6	Pg Dn Down v	
PQRS p q r s	& 7 7	TUV * t u v 8	WXYZ _ w x y z 9	End Left	Right Click Pad
Backspace	:: \ .. ? /	-)]] > 0 ([[< =	+ =	Home Right	
SHIFT	TAB Space	ESC Enter	Insert Delete		

Fig. 12.43. Map of touch screen button layout.

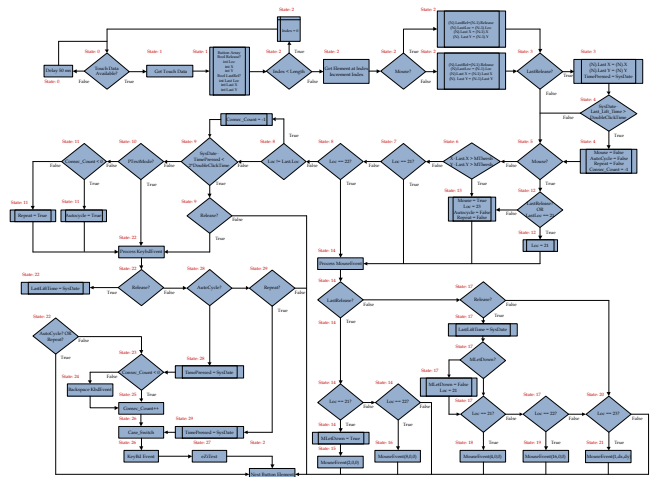


Fig. 12.44. Flow Diagram of state-machine logic.

Once the project is complete and delivered, the client's text-entry rate using a standard keyboard will be compared to the rate achieved using the new interface and predictive text software. Ultimately, however, the success depends on whether the client accepts the delivered project as a suitable replacement for the keyboard and mouse.

The cost of parts/materials is about \$200.00.

THE COMMUNICATION DEVICE: A DEVICE THAT PROVIDES SPEECH IMPAIRED PATIENTS A MEAN TO COMMUNICATE

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INTRODUCTION

The Communication Device (CD) is designed to record and playback voice commands for non-verbal patients at Coastal Educational Collaborative. The therapist stores messages in the CD so the patients can play them back when they need assistance with eating, for example, or any other services. The CD plays a total of six 20-second messages. The device also has six LEDs that scan in a loop, one LED underneath each display picture (See Figure 12.45). The LEDs aid the client in the selection process. When an LED is lit under a desired image, a Jellybean switch is pressed to play the message associated with that image. A similar process is performed to record a message for an associated image.

SUMMARY OF IMPACT

Besides allowing the patient to play a previously recorded message, the CD also helps patients improve their eye-hand coordination. It can be used by an individual or by a group of patients at the Coastal Educational Collaborative.

TECHNICAL DESCRIPTION

The two major components in the design are the ISD25120 (ISD) playback and record chip that provides a high quality of voice reproduction, and the Basic Stamp II microcontroller (See Figure 12.46). The ISD chip is used for direct addressing. The Chip has ten address pins corresponding to ten binary digits. They can be either HIGH (Binary 1) or LOW (binary 0). Each combination of those ten binary numbers refers to the beginning of a memory space, where six 20 second sound recordings are possible. Three I/O pins on the Basic Stamp microcontroller are used as inputs: one for the Jellybean switch, one for the Record switch and one for Play switch. Six



Fig. 12.45. The Communication device.

I/O pins are used as outputs for the six LEDs. Ten I/O pins are used as outputs that are connected directly to the Address pins of the ISD to set the message address, and three I/O pins are used as outputs that are connected to P/R, PD and /CE pins of the ISD. The Basic Stamp is programmed to turn the LEDs ON and OFF in a loop, and map each LED to specific address segmentation.

The CD has two modes: Play and Record.

For the Record Mode, the user turns the Record switch ON, waits until the LED that corresponds to the desirable message is on, and then presses the Jellybean switch and holds it for the duration of the recording. The Basic Stamp then sets the message address on the ISD and sets the Power Down (PD) pin LOW and Chip Enable (/CE) pin LOW for recording. A Microphone is used for this process). To end the recording, the user must take his or her hand off the Jellybean switch, which gives the Stamp the instruction to make PD or /CE go HIGH.

For the Play Mode, the user turns the Record switch OFF, and turns the Play Switch ON, waits until the LED that corresponds to the desirable message is on, then presses the Jellybean Switch. The Basic Stamp then sets the message address on the ISD and Sets PD HIGH and /CE Pulsed LOW for playing. A

Speakerphone is used for this process. The end of playback is automatic.

The cost of parts is about \$171.64.

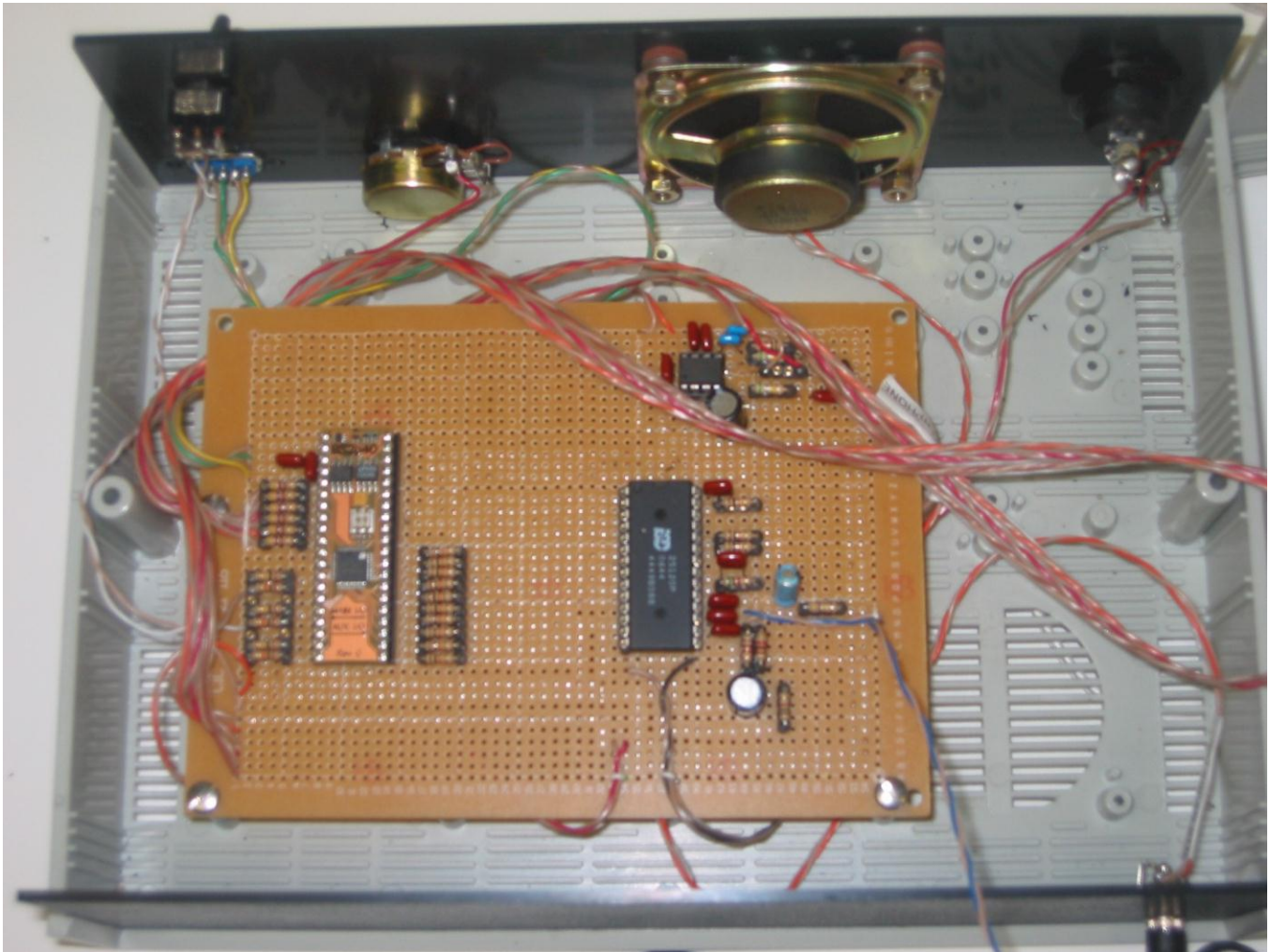


Fig. 12.46. The internal components of the CD.

