CHAPTER 16
UNIVERSITY OF MASSACHUSETTS AT LOWELL

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TOUCH-2-SPEAK: A SOFTWARE APPLICATION THAT AIDS THOSE WHO ARE CHALLENGED WITH COMMUNICATION

Designer: Anthony Maglio
Client Organization: Shore Collaborative, Chelsea, MA
Client Coordinators: Bob Wierzbicki, Shore Collaborative, Chelsea, MA
Supervising Professors: John Fairchild
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INTRODUCTION

The Touch-2-Speak (T-2-S) application is designed to help students are unable to communicate verbally with their teacher. A software solution utilizing touch-screen technology is chosen to address the communication barrier because teachers and students find touch-screen software applications intuitive and fun to use. Also, software is generally versatile and applications can be created to meet specific and unique needs.

The T-2-S aids communication through two main functions. The first and primary function is called the Communication Tool and it allows those with communication disabilities to communicate with others by touching a grid of pictures displayed on a computer's touch-screen. Each picture has a unique pre-recorded audio clip that is related to what the picture displays. When a picture is pressed its audio clip is played. The idea is that the person with the disability can identify what they want to communicate by finding and touching one of the pictures.

The second function is called the Schedule/Calendar/Time Tool; this function provides answers to some of the most common questions asked by the students. This part of the application will display a clock, a calendar, a picture portraying the current classroom activity, and a picture portraying the next scheduled classroom activity on the touch-screen. At any time, a student can and press the clock on the computer to hear what time it is, the calendar to hear the date, the current activity to hear what the current activity is, or the next activity to hear what the next activity will be.

Fig. 16.1. Communication Tool.

There are devices on the market that are similar to the primary function of the T-2-S, however they are limited in the number of pictures they can hold at a given time and are not as versatile in other ways. The Schedule/Calendar/Time Tool makes this application unique; the devices that are similar to the Communication Tool do not have the added features provided in the Schedule/Calendar/Time Tool. There are no such devices in the marketplace that combine all of the functionality that is built into the Touch-2-Speak.

SUMMARY OF IMPACT

The design of the T-2-S is based upon the unique communication needs of the students at Shore Collaborative. It improves the quality of life of students by giving them the ability to communicate their needs. Also, this application gives the users a

sense of independence in the classroom because they can access the computer to determine the time, date, current activity, or next activity. The T-2-S application has also been a benefit to the classroom teachers because they are no longer interrupted by students wanting to know the date, time, current activity, or next activity. Consequently, the teacher has more time to focus on other, and possibly more important, matters. Overall, this application is very useful in the classroom setting.

TECHNICAL DESCRIPTION

The Touch-2-Speak application is written in LabVIEW version 8.5. When using picture and audio files in an application, one of the biggest concerns when writing code is available memory. Therefore, the operations must be as efficient as possible or memory issues could arise. The efficient use of common routines located in different parts of the application are used to avoid re-writing code. Each part of the application is designed using a state machine. A communication system is in place to allow the different parts of the application to communicate with each other. Expandability of the picture library is an important aspect and is
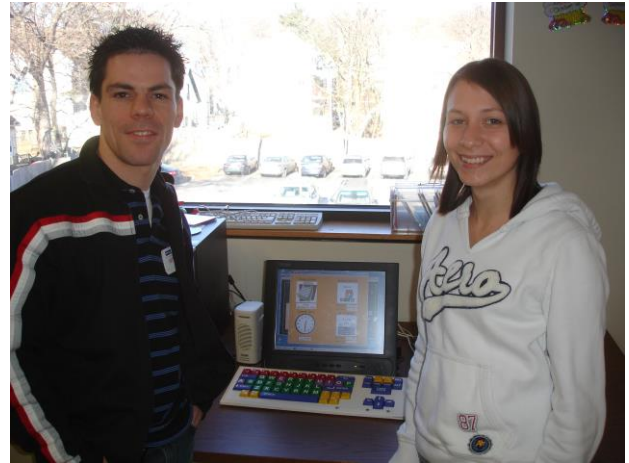

Fig. 16.2. Picture of Client, Myself, and the Project.

included as one of the features in the application. This allows the teachers to add new pictures. The design for this application is well suited for its purpose. This application has much to offer and all critical specifications are met. There are no associated costs with this application as no parts or materials were required. The touch-screen computer was provided by the client.

SPEAK AND REACT: A CAUSE AND EFFECT DEVICE PROVIDING POSITIVE REINFORCEMENT THROUGH MULTIPLE SENSORY STIMULI BY WAY OF USING SPEECH.

Designer: Bryan Cripps
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INTRODUCTION

The Speak and React Device (SRD) is designed to provide positive reinforcement through multiple stimuli by way of speech. This can be beneficial to individuals with limited vocabulary of speech abilities. This device is simply a noise activated wireless switch that enables use of an outlet receptacle. The device consists of two plastic enclosures, the first enclosure is the transmit portion of the device and it is powered by battery. The other portion of the device is the receiver and it is powered by an outlet receptacle. Upon completion, the SRD was presented to the Nashua Center for mentally changed persons in the Nashua, New Hampshire area.

The SRD is intended to be used as a learning device requiring users to use their voice more to communicate. The SRD can be used to help create a natural instinct of expressing desires verbally. The SRD can be used to administer a variety of exercises to encourage speech as a means of communication.

SUMMARY OF IMPACT

The design criteria for the SRD are defined by the varying capabilities of each client at the Nashua Center. The coordinators at the center often struggle trying to communicate with the clients. Most of the clients are able to understand what the coordinators are saying, but lack the ability to verbally respond. Over time, general behavioral patterns can be observed and associated with certain desires, but this communication method can be ambiguous to the instructors and requires extensive personal experience with each client. Current communication exercises with the clients can be monotonous and

Fig. 16.3. Client and device.

Fig. 16.4. SRD Transmitter.

the instructors often have trouble keeping their clients' attention. The SRD assists coordinators by making the speech exercises blend with the individual's favorite activities, which in turn

stimulate their senses. Supplemental devices can include a radio, video player, lamp, fan, and vibrating seat, and many other devices that can be plugged into a standard electrical outlet

TECHNICAL DESCRIPTION

The SRD is housed in two black plastic enclosures, a large enclosure (5" x 8" x 3") and a small handheld enclosure (2" x 4" x 0.5") made by Serpac. The benefit of using plastic enclosures includes an overall lighter weight and it also provides nonconductive material which will protect the user from electric shock.

Triggering of the AC receptacle is done using an Electret Condensing Microphone (ECM) which is then amplified from 1 to 43 times the intensity than the original signal. That signal is then rectified producing a DC voltage as a signal. The DC voltage will vary depending on the intensity and loudness of the tone going into the ECM. The varying DC voltage is fed into the positive input of a comparator, where a fixed DC voltage is set on the inverting input. The fixed voltage on the negative input sets the minimum voltage needed. When the DC voltage is larger than the minimum voltage, the comparator will output a "high" voltage, in this case 5. The output of the comparator goes into an input pin of Parallax's Basic Stamp 2 (BS2). The logic of the BS2 is as follows; two inputs are needed to be a high (5V), when the requirement is met, the BS2 will then output 5V. The second input voltage needed by the BS2 comes from a three position slide switch. The switch is tied to a 5V source that will supply a set of three input pins, individually set "high". Depending on the position of the switch depicts what input pin on the BS2 will be "high", in turn determining how to delay the Solid State Relay (SSR). The output of the BS2 is connected to the SSR, which is the driving mechanism switching the AC receptacle on and off.

Fig. 16.5. SRD Receiver.

Aside from the signal chain processing, additional circuits were needed including the DC power circuit that supplied power to the entire receiver chain. This was accomplished by tapping off from the AC receptacle on the receiving device and directing the 110 VAC into a step-down transformer (SDT). This SDT reduced the AC power to 12.6 VAC. The AC power was then converted to DC by using a similar bridge rectifier as used in the signal chain conversion. The rectified DC power is then used to supply two voltage regulators, the first regulator outputs five volts and the other regulator outputs nine volts.

With safety in mind, separating the AC receptacle from the user was paramount. The microphone was isolated from the power source supplied by the 110 VAC. This required wireless transmission from the user's microphone to the switching unit, which was achieved by using an analog audio transmitter and receiver. Both are paired to work with each other at the same frequency. The transmit chain consists of an ECM and the analog audio transmitter, that run on two AA batteries.

The cost of parts and materials was about $150

SMART HAT: A DEVICE THAT ENABLES CHALLENGED CHILDREN TO CONTROL AN MP3 PLAYER WITH HEAD MOTION.

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INTRODUCTION

The Smart Hat is designed to help children with limited mobility control an MP3 player using the motion from their head. The Smart Hat is a one size fits-all head band that enables the users to play, run forward, backup and stop the MP3 player. The device consists of a headband, a transmitter unit mounted on the wheelchair and a boom box. It was presented to the Shore Educational Collaborative in Chelsea, MA. Clients at this center have a variety of disabilities. Most are unable to eat or wash by themselves. The Smart Hat is intended for a teenager who is unable to voluntarily move any body parts other than his head. It will help him to gain independence.

SUMMARY OF IMPACT

Although there are some changes to the physical structure of the device, the effectiveness of the device is maintained and client's safety is ensured by shielding the sensor mounted on the head band. The adapted device allows him to take part in the decision-making process concerning his interaction with his environment. The device was delivered to Shore Educational Collaborative. The final result of the project has fulfilled the client's request of controlling an MP3 player using specific head motions. The client is now playing and stopping the music by himself as opposed to asking an assistant to help him. One of the caretakers commented that the client is enjoying the device very much. She added that he is listening to music more frequently just because he likes the device.

TECHNICAL DESCRIPTION

A dual-axis accelerometer is used as a motion detector. It is mounted on a headband and is

Fig. 16.6. The Smart Hat.

Fig. 16.7. Picture of inside of the transmitter.

connected to the transmitter unit by an USB cable. The transmitter unit consists of a microcontroller, an encoder, DIP switch, and a RF transmitter. A switch found on the transmitter's unit is used to activate

and deactivate the transmitter. The microcontroller (BASIC Stamp 2) is used to read the values of the tilts. It compares the readings to a specific threshold (x1=2700, x2=2100, y1=2700, y2=2100) and triggers high output signals. Each of the BASIC Stamp's pins had a 220 ohms resistor to protect the chip from burning out. The unused pins are grounded. A decoder decodes the BASIC Stamp's output and the signal was transmitted by the RF transmitter.

The receiver unit mounted in the radio consists of an RF receiver with a decoder to decode the signal. In addition, a 4066 IC is used to control the four buttons of the Mp3 player: play or pause, stop, forward and backward buttons. The 4066 contains four switches with four control signals. When any of the control signals is excessively high, the corresponding switch closed. A voltage regulator is used to reduce the power coming from the radio's AC/DC converter from twelve volts to five volts. The encoder's address is set by an 8-DIP switch. The address pins of the encoder and the decoder are set to the same logic level in order to communicate with each other. The 10K pull-up resistors are connected at the DIP switch's output pins.

The cost of parts and materials is about $173.

Fig. 16.8. Picture of the client with the device.

THE MUSIC MACHINE: A DEVICE THAT ALLOWS PHYSICALLY AND MENTALLY HANDICAPPED PEOPLE TO PLAY DRUMS

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INTRODUCTION

The music machine (MM) is designed to give persons with physical and mental disabilities a simple and easy way to play the drums. This device is comprised of a panel of five buttons that are used as inputs to a microcontroller. When pushed, each button causes a drum stick to strike one of the five drums. The drum stick is moved by a solenoid and spring. Once completed, the MM will be delivered to the Nashua Center in Nashua, NH. The MM provides persons with disabilities with an opportunity to engage in a social and a creative activity such as playing drums in sing-alongs. This device also provides a cause and effect example that may be beneficial as a form of therapy.

SUMMARY OF IMPACT

The design criteria for the MM are based on the abilities of the clients that visit the Nashua Center. Many of these clients experience physical restrictions of coordination and dexterity. By controlling the movement of a drumstick with an array of buttons, more standard movements are required to interact with the device. By using the MM, the clients can join in with sing-alongs and engage in social interactions with peers.

TECHNICAL DESCRIPTION

The MM is constructed by attaching platforms to each individual percussive part of a child's drum set. There are five parts to the kit which include a snare drum, a kick drum, a rack mounted tom, a high hat cymbal, and a rack mounted cymbal. The platforms are made of wood and attached using L brackets and hose rings. Structures in the shape of H's are made standing on the platforms top surface. The sides of these H structures are made of aluminum and their center lines were screws. The

screws are driven through one end of a drumstick. The other end of the stick is positioned over the percussive part to which the platform is attached. Between the H's frames and percussive part, the drumstick is attached to a rod that is extended downward to the tops of solenoids which are mounted on the platforms top surface.

The solenoid moves the rod up and down, which moves the drum stick up and down. This movement strikes a drum or symbol and makes a sound. The movement of each solenoid is controlled by pulses sent form a Basic Stamp 2 (BS2) microcontroller IC. The BS2 is programmed in PBasic language to send out a high-low pulse. When the pulse is high, the solenoid rod is pulled down by a magnetic field and a percussive part of the drum set is struck. When the pulse is low, the magnetic field is turned off and a spring returns the rod to its upward position. The lengths of the pulses are controlled through a rotary switch setting. Each position sends 5VDCone of the pins of the BS2. These voltages are programmed to dictate the lengths of the pulses.

Each solenoid is made to correspond to a different button on a control panel. When one of the buttons is pressed, it takes voltage away from one of the pins of the BS2. This makes the BS2 send out a pulse to move the corresponding solenoid. These pulses are connected to the base pins of transistors. When the pulses are high, 24VDC is allowed to run through the transistor's collector pin, to an emitter pin, which powers the inductor of one of the solenoids. These inductors generate the magnetic fields the pull the rods down.

A power switch in series with a 120VAC to 24VDC power supply is used to activate the device. Once set to on, an LED lights up to indicate the device is on

and the power supply sends 24VDC to the circuit with the solenoids and transistors and a circuit that turns it into 5.6VDC that is used to power the BS2 The BS2 requires 5.5-15VDC to be activated. Eight 1N4004 diodes in series are used to make this voltage because each diode has a 0.7VDC drop across it. When in series, these voltage drops add up to 5.6VDC.

The cost of part and materials is about $400.

Fig. 16.9. Client with final product.

THE PIVOTING BALL KICKER: A DEVICE THAT PROVIDES RECREATION TO CHILDREN WITH AMBULATORY HANDICAPS

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Client Coordinator: Bob Wierzbicki, Shore Educational Collaborative, Chelsea, MA
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INTRODUCTION

The pivoting ball kicker is designed to provide recreational entertainment to children confined to a wheelchair. The basic premise is that a wheelchair user can join in when their peers are kicking a ball around or to each other. The device enables them to do this. The pivoting ball kicker is a kicking device mounted on a rotating platform. Rotation (aiming) of the kicker is controlled by a device similar to a joystick.

Once the kicker is pointed in the desired direction a separate button on the controller causes the ball to be kicked. In order for the ball to be kicked again it must be placed by hand back in the kicking slot of the device. This can also be done by rolling the ball accurately back into the kicking slot. Ultimately, the pivoting ball kicker can be used as an interactive game involving several players positioned around the kicker who each try to roll the ball back into the slot after it is kicked to them.

SUMMARY OF IMPACT

The design of the pivoting ball kicker is based on the requests of the client coordinator and defined by the abilities of its intended users. The children at the facility have various physical and behavioral disabilities. Each day at playtime, several of the students are only able sit along the sidelines and watch while the other children participate in various activities including kicking a ball to each other. The therapists wanted a way to include everyone in playtime activities. The pivoting ball kicker allows all students to be able to experience the fun physical activities available at playtime.

Fig. 16.10. The Pivoting Ball Kicker, Clients and Designer.

TECHNICAL DESCRIPTION

The main structural components of the pivoting ball kicker are 15/32″ interior grade plywood, and 11, 12 and 17 gauge steel. The materials are chosen for their structural integrity and availability as salvaged material from a local sheet metal shop. Plywood comprises the platforms of the assembly. A bottom platform is stationary to the ground while a second platform pivots above it. The two platforms are separated by a bracket assembly containing the hub and axle of a 20″ bicycle wheel. The second platform contains the kicking assembly. The main frame of the kicking assembly is built of 11 gauge steel which has been formed into a 3 1/4″ by 3 7/16″ rectangular tube. Two identical solenoids sit on top of this which power the kicking arm. The kicking arm is made of ¾″ wide 12 gauge steel. The pivoting of the top base is accomplished by two identical DC gearhead motors with 4.9″ wheels. These are mounted on opposite sides of the top base

along a center line perpendicular to the kicking direction. Power to the system is supplied by two identical rechargeable 12 volt sealed lead acid batteries. The solenoids use the full 24 volts of the two batteries in series. The pivot motors operate at 12 volts. This voltage provides the desired pivot speed without the need of any additional modification. The pivot motors also need direction control so an Infinion TLE-5206-2 H-Bridge chip is used. This chip also protects against back EMF that may be caused by sudden changes of direction in the motors. Four AA batteries provide the 6 volts that control this chip. Stop switches are also inserted into this circuit to limit the pivot range to approximately 80° from center in either direction.
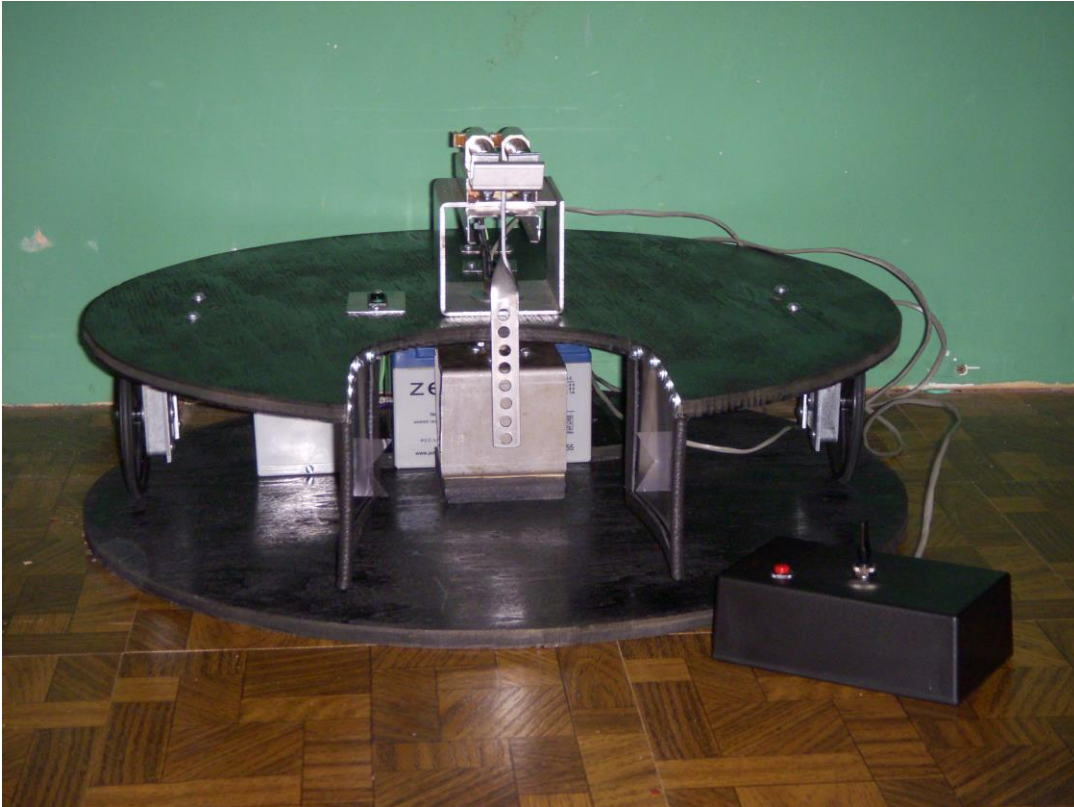
The total cost of parts and materials is about $160.

Fig. 16.11.The Pivoting Ball Kicker.

THE INGREDIENTS MEASURING SYSTEM: A KITCHEN AID FOR INDIVIDUALS WITH GROSS MOTOR CONTROL

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Client Coordinator: Lisa Szewczyk, The Nashua Center, Nashua, NH
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INTRODUCTION

The Ingredients Measuring System (IMS) is designed to enable individuals who lack fine motor control to accurately measure different types of liquid and dry ingredients. The system consists of four electromechanical fluid pumps and valves for measuring four different types of liquids and six specifically designed sleeve valves for measuring two different types of dry ingredients. The entire setup is implemented in a Plexiglass box. After completion, the IMS was given to the Nashua Center in Nashua, New Hampshire. The individuals at this center have a number of different physical and mental disabilities, which include gross motor control of their hands. In particular, a simple task, such as measuring flour or water, can be quite cumbersome for someone who experiences spasms or other difficulties controlling movement in their hands. Therefore, the IMS is intended to provide assistance in measuring various ingredients.

SUMMARY OF IMPACT

The IMS is designed for those with dexterity issues at the Nashua Center. The center plans to incorporate the IMS into cooking classes taught to individuals having only gross motor control and other physical and mental handicaps. These cooking classes are intended to teach food preparation and facilitate communication while preparing food skills. Through the use of the IMS system, individuals will be able to accurately measure wet and dry ingredients, while reinforcing cognitive skills such as following a recipe.

TECHNICAL DESCRIPTION

The IMS is constructed using ¼ inch clear acrylic Plexiglass, which is precision-cut using a Trotec Speedy 300 Laser Cutter/Engraver. This material is
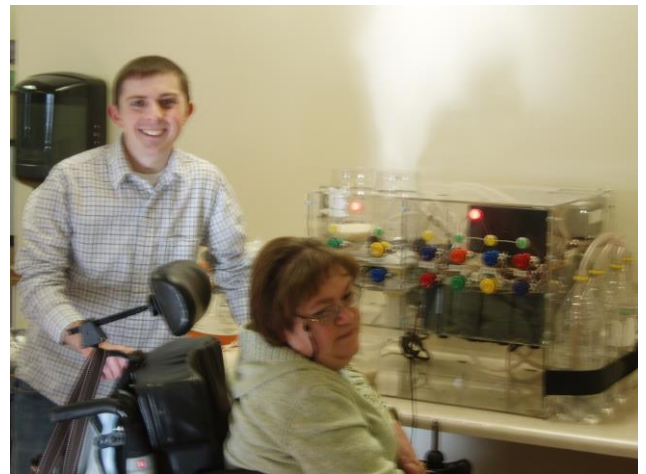

Fig. 16.12. Student Delivering Product to Client.

chosen because of durability and off-the-shelf availability. The overall box is designed with mortise and tendon style joints to further increase durability, while aiding in the assembly process. Between each joint a ¾ inch 10-32's screw and nut are incorporated using a cross notch.

To implement a means for measuring liquid ingredients, four beverage style valves and pumps are taken from a fountain machine similar to the ones seen at many fast food restaurants.

Each valve operates on 24VAC, which is controlled through a solid state relay. The solid state relays are then triggered by a PIC microcontroller. The pumps are fully automatic and supply a constant pressure of 45psi without the need for any microprocessor control.

For the measurement of dry ingredients, sleeve valves are included using Plexiglass and stainless steel sheet metal. Essentially, a stainless steel sleeve

is sandwiched between two pieces of Plexiglas, which slide on matching tracks. The sleeve valves are positioned to slide into a plastic graduated cylinder. They are actuated using hobby style servos, which is interfaced with a servo controller triggered by the PIC microcontroller. Using a combination of three sleeve valves per cylinder, all six major units of measure are obtained (¼, 1/3, ½ 2/3, ¾, & 1 Cup). That is, between the top sleeve and bottom sleeve is 1/3 of a cup, and between the top sleeve and middle sleeve is ¼ cup. For all other units of measure, the aforementioned are repeated.

The logic circuit for the project is implemented using a 40-pin PIC18F4520 microcontroller. This device operates at 32MHz, and has 32KB Memory, along with USART serial communication capabilities. The serial communication is necessary to talk to the Pololu 727 Servo Controller for controlling the dry ingredients setup. The PIC microcontroller utilizes 13 user inputs; six units of measure and six types of ingredients to select from, and one service mode switch. The code for the microcontroller is structured to vary the valve flow timing needed to measure liquid. The valves have a constant flow rate. For example, when triggered for one second, they will dispense up to 3.5oz of liquid depending upon the adjustment to the valve.
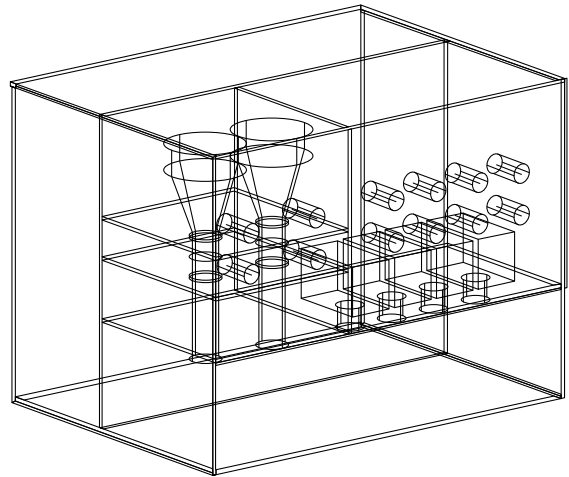
The cost of the parts and material is about $900.

Fig, 16.13.The Ingredients Measuring System.
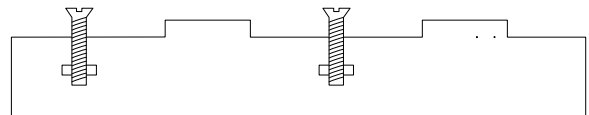

Fig. 16.14. Example of Mortise (Top View).

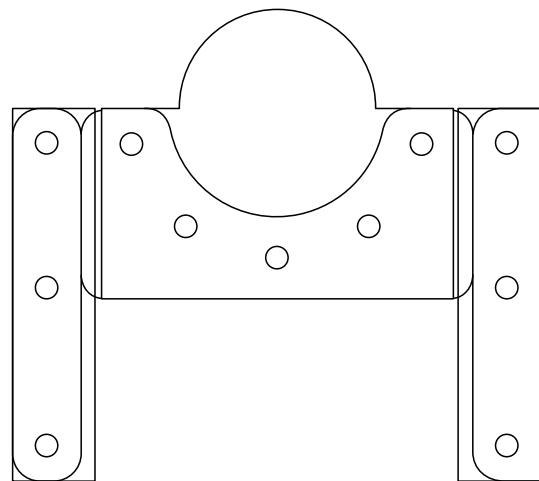Fig. 16.15. Example of Tenon with Screws (Side View).

Fig. 16.16. Dry Ingredients Sleeve Valve.

WIRELESS TIMER AND CLOCK: A WALL MOUNT CLOCK WITH A WIRELESS CONTROLLER FOR A TIMER UNDER THE CLOCK

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INTRODUCTION

The Wireless Timer and Clock is built to time seizures while the client is in a wheelchair. This product will be used to time the duration of a client's seizures. The clock and timer will be on the wall and the start and stop buttons will be located on the wheelchair. The teacher will start the timer at the beginning of the seizure and stop it at the end of the seizure. This device will be delivered to the North Shore Collaborative, MA upon completion. This facility is a school for students who have physical and mental disabilities.

SUMMARY OF IMPACT

The client requires wireless means to time seizures of a particular student. The device has a clock and a timer which can be used to indicate the length of a seizure. At different durations, it will be the assistant's responsibility to give medication to the student that fit requirements of his physician. This is important because medication has to be given to the client if the seizure lasts over 10 minutes. This device allows the assistant to more quantitatively time the seizure and therefore administer more adequate care. The device is used to start timing the seizure from the wheelchair and the wall mounted Clock and Timer is large enough to be seen from the entire room.

TECHNICAL DESCRITION

The lay out for the timer and clock circuit consists of three pic24s and two SAA1064 LED drivers and is designed to fit in a wall mounted box with the dimensions H7.5",W10",D3". The clock is located at the top of the box while the timer is at the bottom. The timer is controlled by a wireless transmitter that is supplied with 3.3 volts for its pic24 on the wireless controller. The wireless signal is transmitted to the timer board where it is received by the receiver chip. This will turn on the timer and the LED's then begin counting. The two buttons on the wireless transmitter are start or stop/reset.

At the start of a seizure, the teacher will initialize the timer that is located on the wall by pushing the start button located on the wheelchair. This starts the timer once it reads the wireless signal that is sent to the wall mounted box. At this point, the teacher can then pay full attention to the student until the seizure is over. They will then push the stop button on the wheelchair to stop the timer. The time can then be recorded into the student's log book that travels with them all day.

The clock circuit is a standalone circuit that uses the pic24 to keep time and use the driver to send the 9 volts to the display. The clock runs on its own pic24 at 3.3volts, while the SAA1064 is supplied with 9 volts with a current that can be varied within the programing. The code written to the pic 24 includes seconds, minutes, hours, days, weeks, months and years. With a built in calendar, the program can also accommodate for daylights savings time. If the clock was to lose time, there are buttons to reset the time.

The two seven segment displays interface with the SAA1064 by dual inputs from two seven segment LED's to the same pins. The driving current and voltage are controlled by two NPN transistors, that cycle through the four LED's, so that none of the LED's are on at the same time. Thus, saving power that would otherwise be lost if all the LED's were on at the same time.

The power for the wireless controller is supplied by two AAA batteries. With the pic controller working on energy saving mode, the batteries will not drain

over a short period of time. As for the power for the clock and timer, circuits can be plugged into the wall because the seven segment LEDs will source to much current for batteries.

Cost of parts and material is about $250.

Fig. 16.17. Completed Device.

WIRELESS SWITCH ACTIVATED SLIDE PROJECTOR: AN ENTERTAINMENT DEVICE THAT PROVIDES VISUAL STIMULATION TO A PERSON WITH CEREBRAL PALSY AND MENTAL RETARDATION

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INTRODUCTION

The Wireless Switch Activated Slide Projector (WSASP) is designed to provide visual stimulation to a person with cerebral palsy. Our client, named Cheryl, is a student at the Nashua Center.

The device is basically a slide projector with a wireless remote. The wireless remote has two capability switches for forward and reverse operation. The wireless remote control also has a mode switch for switching into manual mode and slideshow mode. Upon completion, the WSASP was presented to the Nashua Center in Nashua, NH. The children and adults at this center have multiple mental and physical disabilities. Most depend on one of the employees at the Nashua Center to help them for many daily tasks. The WSASP is intended to provide children and adults an opportunity to access entertainment independently.

SUMMARY OF IMPACT

The design for the WSASP is based upon the capabilities of the clients and the needs of the center. The employees at the Nashua Center are always encouraging the children and adults to do things on their own in order to improve their quality of life. Consequentially, the employees wanted an easy-to-use entertainment device. This device is visually stimulating and also gives the client a sense of independence and improves their quality of life.

TECHNICAL DESCRIPTION

The WSASP is made from a KODAK Ektagraphic III slide projector. The slide projector comes equipped

Fig. 16.18. Wireless Switch Activated Slide Projector.

Fig. 16.19.Transmit and receive modules.

with a wired remote control.   To allow for portability and ease-of-use, the wired remote control

is converted to a wireless remote control using an RF transmitter and receiver. Its control buttons are replaced with capability switches.

To advance slides, the client presses one of the large jelly buttons on the transmitter end of the remote control. This sends a signal to the receiving end which is connected to the slide projector. There are two solid-state relays at the receive end. When voltage is applied to one of the solid-state relays, the connection is closed for either forward or reverse operation. Due to the low voltage requirement to power the transmitter and receiver, a DC power supply comprised of four AA batteries is used.

The WSASP has three switches, two power switches and a mode switch. The power switches turns the transmitting and receiving modules on and off. The mode switch allows the client to select either manual mode or slideshow mode. The use of manual mode or slideshow mode is determined by the client's caregiver. If the client can operate the WSASP easily, then the client's caregiver can choose manual mode. If the client fatigues easily, then the client's caregiver can choose slideshow mode. The transmit module is equipped with two mono adapters to allow the client to plug in their own capability switches. The transmit module is also equipped with a piezoelectric speaker which generates a sound when one of the capability switches is pressed, in order to generate auditory stimulation for the client.

The WSASP has two modes: manual and slideshow. Manual mode allows the client to display the next slide by pushing the forward button on the wireless remote control. Manual mode also allows the client to display the previous slide by pushing the reverse button on the wireless remote control. In slideshow mode the client pushes the forward button causing the slide projector to display the next three slides in ten second intervals. Slideshow mode also allows the client to push the reverse button which causes the slide projector to display the previous three slides in ten second intervals.

The cost of parts and materials is about $350.

Fig. 16.20. Cheryl with the WSASP.

ELECTRIC PUSHER FOR A STANDARD WHEELCHAIR: AN ALTERNATIVE TO MOTORIZED WHEELCHAIRS

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INTRODUCTION

The Electric Pusher (EP) is designed as a low-cost alternative to motorized wheelchairs that allow wheelchair users to navigate with ease. Motorized or electric wheelchairs are more than a thousand dollars per chair but with this design, the cost is about a quarter of that price. The EP unit consists of two DC motors, two wheels, a control box, a joystick and two batteries. The EP frame is constructed from a salvaged frame off an old wheelchair. Two motors are attached to either side of the frame, and a set of wheels and tires are attached to the motors. The joystick is used to control the motors via the control box and thus allows for all range of motion. Two 12-volt batteries powers motors. They are also the power source for the control box. The batteries and control box are attached within the framed unit. The EP unit is mounted on the back of a standard wheelchair. The joystick can be placed on the back of the wheelchair or on the armrest. These two locations are for either the caretaker or the individual, respectively.

SUMMARY OF IMPACT

At Shore Educational Collaborative, there are many wheelchair users that have functional use of their arms. Propelling oneself in a manual wheelchair can be tiresome. With the electric pusher, this workload is greatly reduced. Also, the cost with this device is greatly reduced, making it a product that can be available and beneficial to a wider group of individuals.

TECHNICAL DESCRIPTION

The frame of the EP is salvaged from the lower portion of a motorized wheelchair called the Quickie P100. The motors and wheel assembly are also salvaged from the Quickie P100. A PIC microcontroller, PIC16F876A, is chosen because of its dual Pulse Width Modulation (PWM) channels to control two H-Bridges, which drives the motors. The H-Bridges are made up of power transistors and optoisolators. The PIC takes the analog signals from the joystick, which consists of two five thousand ohm potentiometers. The analog signals are converted to digital signals with the built in analog to digital converter on the PIC. A program is written to compute the joystick location and send the correct speed and direction to the H-Bridge circuit. Also on the joystick is a button that is used for releasing the electrically engaged motor brakes.

The costs of parts and materials is about $200.00

Fig. 16.21. Frame Assembly.

Fig. 16.22. Electric Stroller.

VOICE ACTIVATED REMOTE CONTROL: A BOX THAT IS CONNECTED TO TOY CAR REMOTE SO THAT IT CAN BE ACTIVATED BY VOICE

Designer: Nirak So
Client: Bary Dussalt- Veteran Hospital, Bedford, Massachusetts
Supervising Professor: Alan Rux
James Francis College of Engineering
University of Massachusetts- Lowell
Lowell, Massachusetts 01854

INTRODUCTION

Voice Activated Remote Control (VARC) is designed to help patients that are unable to use both arms and legs to play with a toy car. The device is comprised of a voice recognition box and the toy car remote control. Upon completion, the device was presented to the Veteran Hospital in Bedford, Massachusetts. For a patient who is unable to use arms or legs, operating a remote control toy, such as a car, can be somewhat challenging. The VARC is adapted to provide the client ease of use and simplicity. The VARC ultimately is intended to give the patient a sense of relaxation and joy. It also offers the client independence.

SUMMARY OF IMPACT

The design criteria for the VARC are defined by the capabilities of the patients and the needs of the hospital. The client at Veteran Hospital has physical disabilities which prevent him from operating standard remote controls. The caretakers are often very busy and are not able to spend long periods of time with any one patient. Instead of relying on the caretakers to operate the toy car for him; with the help of the VARC, the patient is now able to operate the toy car and change the speed as he desires by himself. The VARC provides the patient a control over the toy car and as new form of interaction with their environment.

TECHNICAL DESCRIPTION

The physical structure of the project consists of a box and a remote. The 9 volt DC adapter is the power source. A 9 volt back up battery may be used if the patient is away from AC outlet.

A 5 volt-Regulator regulates 5 volts to all the components in the block diagram. The data is
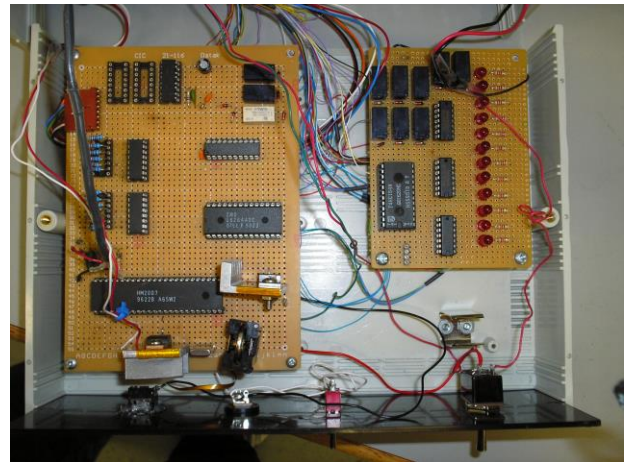

Fig. 16.23. Remote control and voice recognition box.

received through the microphone. The HM 2007 voice recognition chip recognizes the data stored in the SRAM memory. There are two options for back up memory power: LM 317 or 3 volt Lithium Battery. The LM317 is not used because it is more complex than the 3 volt Lithium battery.

The Octal D Latch relayed the data to the Seven Segments and to the Decoder. The Seven Segment has a built in decoder that can convert the binary digits to decimal. The decimal number displays in the LED.

The Decoder had 15 outputs. When one output is on, the rest of the output must be "off". Only one output is "on" at the time. The decoder is active low, so the inverter is added to each output. The relay requires minimum 2.4 volts and 16.7 milliamps for switching. The output voltage and current of the decoder is 3.12 volts and 37 milliamps. The relay is initially open. When the output of the decoder is zero, there is no function. However, when the output of the

decoder is one, the jumper is shorted. To control the speed and angle, a combination of wires is used. Some functions require only two wires while other functions require three wires. Each wire is connected between the relay and the toy car remote switch.
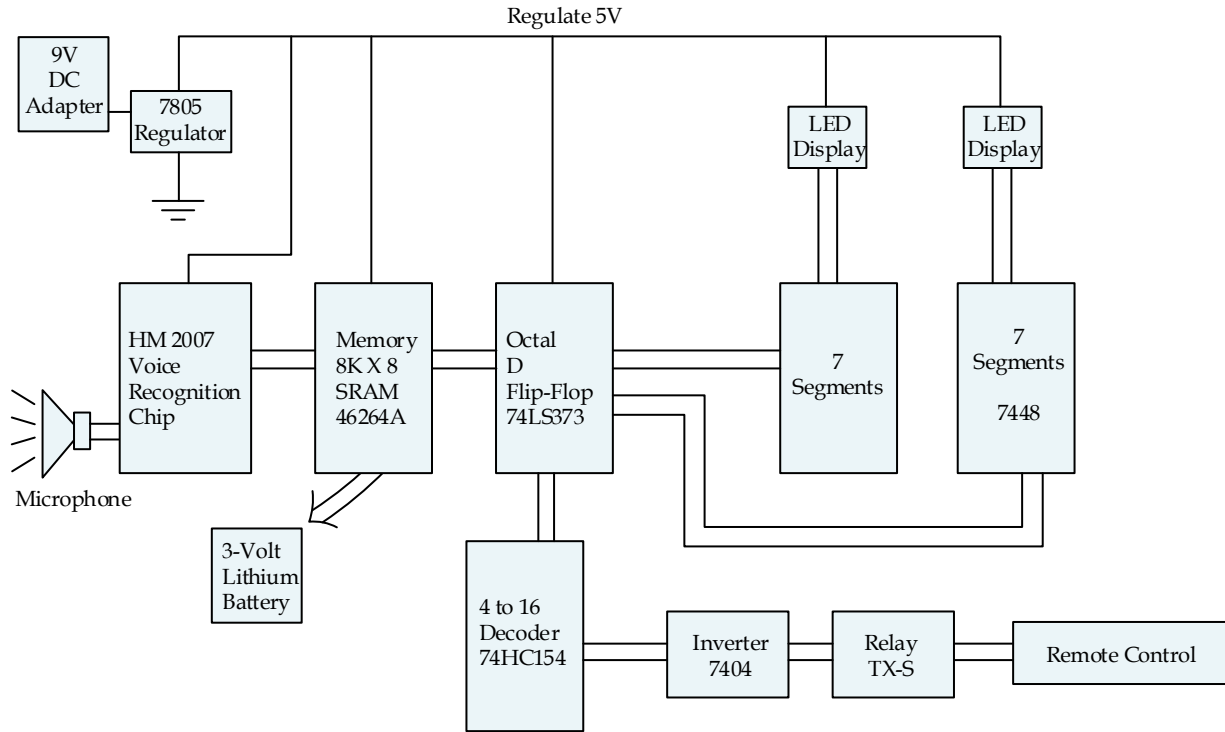
The cost of parts and material is about $219.

Fig. 16.24. The block diagram.

Fig.16.25. The client with completed device.

INTERACTIVE SENSORY MUSIC BOX: A DEVICE THAT PROVIDES VISUAL AND AUDITORY STIMULATION TO A PERSON WITH MULTIPLE HANDICAPS, WHILE ALLOWING THEM TO PARTICIPATE WITH MUSIC

Designer: Seth Tardiff
Client Coordinator: Mindy Kates, Lowell High School, Lowell Massachusetts
Supervising Professor: Jim Drew
Computer and Electrical Engineering Department
University of Massachusetts Lowell
Lowell, MA 01854

INTRODUCTION

The Interactive Sensory Music Box (ISMB) is designed to provide visual and aural stimulation to people with multiple handicaps. Some of the children, in Mindy Kate's class at Lowell High School in Lowell Massachusetts, have a limited range of motion and poor motor skills. Thus, they lack the coordination to play a musical instrument. The ISMB is intended to provide the students with the enjoyment of playing a musical instrument along to music at the touch of a button. The ISMB box has six buttons and ten lights on the top and three speakers on the front. It enables the user to play along with the music which the ISMB provides as the user watches lights blink to the beat of the music. Upon completion, the ISMB was presented to Mindy Kate's classroom for use in their sensory room.

SUMMARY OF IMPACT

The design criteria for the ISMB are defined by the capabilities of the students in Mindy Kate's classroom at Lowell High School. In Mindy's classroom there is a sensory room which contains devices which provide different kinds of stimuli to the students for recreational purposes. The caregivers require a new device that plays music and blinks lights while also giving the children the chance to control and interact with the device. The ISMB provides the children with an opportunity to have a positive interaction with music. It also provides a lesson in cause and effect. As the students press the buttons they can stop and start the music as well as press buttons that make music.

Fig. 16.26. The Interactive Sensory Music Box.

This shows the students that their actions can have an effect on their external environment.

TECHNICAL DESCRIPTION

The ISMB has three primary functions. Firstly it provides auditory stimulus by playing preloaded music. Secondly it provides visual stimulation by blinking LED lights to the beat of the music, and thirdly it provides musical interaction by allowing the user to press four buttons which trigger samples of percussion instruments. To complete these functions, a series of electrical and mechanical components were utilized.

The electrical components can be broken into three sections including the instrument sample storage circuit and amplifier, the Mp3 module and amplifier, and the beat detection circuit and LEDs.

Fig. 16.27. Client with project.

The instrument sample storage circuit uses four ICs as its main components. These are a Parallax SX-28 micro controller, a 24LC16B EEPROM chip, an ISD4004 sound recording and playback chip, and an NJRM2073D audio amplifier chip. The SX-28 is used to control the ISD4004. It is programmed to record the instrument samples onto the ISD4004. It is then used to play back those samples. The EEPROM chip is used to store the locations of the sound clips on the ISD4004 so that when a certain sound on the chip needs to be accessed, the SX-28 will know where to look for it. The NJRM2073D in conjunction with an 8 ohm speaker load is connected to the output of the ISD4004 so that the instrument sample sounds can be heard at an audible volume. The MP3 module is a device that stores songs in the MP3 format. It has switches which control the volume, select the next track, and play and pause the music. To hear the music being played, the MP3 module is connected to another NJRM2073D chip with two 8

ohm speakers as the load for a stereo configuration. The beat detection circuit utilizes an NTE1549 dot/bar display driver IC as its main component. This chip senses analog voltage changes by use of comparators. It drives ten LEDs which flash in consecutive order as volume changes within the audio itself occur, usually corresponding to the rhythm of the song. The output on the amplifier is connected to the MP3 module which also provides the input for the NTE1549.

The ISMB is powered by four 1.5 VDC two thousand nine hundred milliamp-hour alkaline batteries in series to provide a total of 6VDC. This is used to power the amplifier ICs and the beat detection circuit. A 3 VDC Bel Power DC/DC converter is used to provide a steady three volts to the instrument sample storage circuit. This is because of the 3VDC for which the ISD4004 needs to operate. From the three volts that the DC/DC converter provides two voltage regulator diodes in series provide the 1.6 VDC that operates the Mp3 module.

The mechanical components of the ISMB include seven switches. Six of these switches are 2.5 inch large arcade style switches. These switches are mounted to the top of the box and are the main control switches. Four of these switches connect to the input of the SX-28 and are used to access the instrument samples that are stored on the ISD4004. The other two switches are connected to the Mp3 module and are used as a play and pause button and a next-track button. The seventh switch is a toggle switch, that is mounted to the back of the box, and used as the on and off switch for the device.

The cost of parts and material is about $210.

THE SWITCH-ACCESS CONTROLLED AIRBRUSH: A DEVISE THAT ENABLES INDIVIDUALS WITH LIMITED HAND DEXTERITY TO PAINT WITH AN AIRBRUSH

Designer: Shawn M. Proulx
Client Coordinator: Latha Mangipudi, Nashua Center, Nashua, NH
Supervising Professor: Allan Rux and Senait Haileselassie
James Francis College of Engineering
Electrical and Computer Engineering Department
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Lowell, MA 01854

INTRODUCTION

The Switch-Access Controlled Airbrush (SACA) is a painting work bench/station designed to be used for recreational painting activities by individuals with limited hand agility. By touching and pushing or rocking a large single button, the airbrush will spray paint and move vertically and horizontally. A ventilated fume-hood is constructed on top of a push cart with wheels so the device can be easily moved around within the activities room at the Nashua Center. Upon completion, SACA was presented to the Nashua Center for Severe/Multiple Handicapped Individuals in Nashua, New Hampshire. Many of the Nashua Center's clients have cerebral palsy and other disabilities that prohibit them from fine motor control of their hands. Presently, the painting activities are carried out by hand-over-hand guidance with the help of an assistant or teacher. Ultimately, SACA is intended to aid an individual with limited use of their hands to move an airbrush by themselves while enabling them to paint.

SUMMARY OF IMPACT

The design criteria for SACA are defined by observing the clients and their current level of painting capabilities. The aid of a staff assistant provided hand-on-hand instruction in applying paint to a paint brush and moving it around on paper. As a result, the in-home coordinator desired an airbrush that would spray paint by touching a switch and having the airbrush move around with directional control. With an airbrush, paint can continuously be applied and only needs to be refilled periodically. The SACA device allows the

Fig. 16.28. Stepper Motor Drive Assemblies.

user control over painting by simply touching and pushing a button. Furthermore, the SACA paint station provides a stimulating, safe, and rewarding opportunity for artistic creativeness and independent development.

TECHNICAL DESCRIPTION

The fume hood is constructed from a piece of sheet metal 36x36x24-inch. Large axial fans are installed in the back of the hood with filter material to catch and

vent any overspray from the airbrush. The device uses non-flammable, water-based paint. Inside the fume-hood there is a 2-foot fluorescent lamp for light. The master switch located on the side of the fume-hood powers both the lamp and power to the circuit board enclosure. The fume hood is fastened on top of a push cart with wheels so that is mobile. The cart has a bottom shelf where the 1/3 horsepower air-compressor for the airbrush is located. Fastened underneath the fume hood to the cart is a steel cabinet enclosure measuring 12x12x4-inch that houses the control circuit boards and power supply. On the front of the enclosure are switches for the two axial fans, power supply, and speed control knob for the movement of the airbrush. It is important to note that at least one of the fans has to be on in order to switch on the power supply. This is to ensure that there is proper ventilation when the airbrush is spraying paint. Also, there are two 2-amp fuses for the fans and the power supply. Line voltage 120-Vac is supplied to the fans, light, air-compressor, and enclosure. A 120-Vac to 12-Vdc/3-amp power supply inside the enclosure is used to power the motor circuit board and switch circuit board.

The airbrush is mounted on two sets of metal rail drive assemblies installed inside the fume-hood. The vertical drive assembly is 24-inches in length and the horizontal drive assembly is 30-inches in length. Stepper motors are used to drive the airbrush left-to-right and up-and-down. Stepper motors are chosen for their micro-stepping capability.

Inside the steel cabinet enclosure there is a power supply and two circuit boards. There is a motor-drive circuit board and a switch circuit board to implement logic inputs from the button and limit switches. The transmittance beam limit switches are mounted on both ends of each drive assembly to detect and disable the stepper motors when the airbrush is driven to the end of the drive assembly. The limit switches prevent the user from continuously driving the motors when the airbrush is pushed to the end of the drive assemblies. The switch-circuit board contains a sensor circuit that detects touch on the button which opens a pneumatic solenoid attached to the air-compressor controlling the paint spray. Both circuit boards contain 12VDC to 5VDC converters for 5V logic supply. The motor drive circuit board also contains a variable voltage regulator, regulated at 9V for the motors.

The cost of parts and material is about $783.00

Fig. 16.29. Student Showing Project to Art Class Teacher.

THE AUTOMATIC PAGE TURNER: A DEVICE THAT ASSISTS CHILDREN AND ADULTS WITH LIMITED OR NO MOVEMENT OF THEIR ARMS

Designer: Thomas A. White
Client Coordinator: Shore Education Collaborative
Supervising Professors: Professor James Drew and Professor Alan Rux
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James Francis College of Engineering
Department of Electrical and Computer Engineering
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INTRODUCTION

The Automatic Page Turner is designed to assist people with limited or no movement of their arms in turning the page of a book. The device is designed to be used for books of varying sizes. The Automatic Page Turner is a wooden book holder with small motors attached to the sides which perform various functions.

One of the motors lifts the page using an aluminum rod with two fans attached that creates suction. A second motor turns the page using a steel metal rod as a wiper similar to that of a windshield wiper. A final motor holds the pages down while the device is in standby mode. The Automatic Page Turner was delivered to the Shore Education Collaborative in Chelsea, MA upon completion. Most of the previous designs cost over one-thousand dollars. The cost of this device is about half of that. This design offers an economic and affordable solution to previous designs.

SUMMARY OF IMPACT

This project is designed for the needs of some of the residents of Shore Education Collaborative. The main purpose of this project is to help children with limited or no arm movement in turning the page of a book while reading. This will give them more independence from their caretakers and perhaps encourage reading. This design employs the use of the wall outlet due to complexity.

TECHNICAL DESCRIPTION

The template of the Automatic Page Turner is a wooden book holder made by Levenger called the Cubi Agenda Stand. It is basically a wooden box
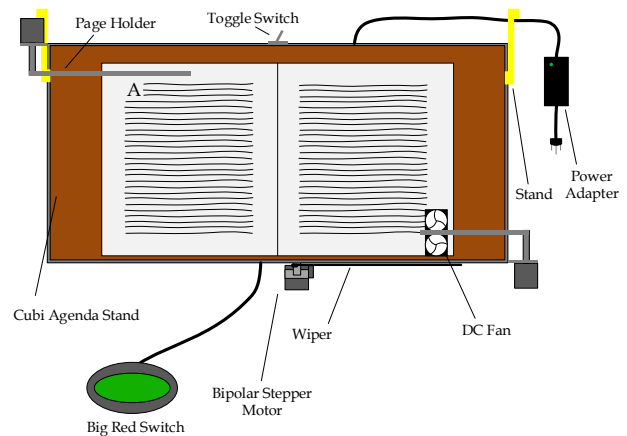

Fig. 16.30. Diagram of Page Turner.

with a wooden stand attached to the top. It comes with a compartment for book storage which is modified to be the storage area for the circuit board. The stand part of the book holder is screwed to the box. The back has a small stand so that the Automatic Page Turner can be used at an angle.

All of the mounted parts are attached to a piece of steel strapping. Three bipolar stepper motors are mounted to the book holder. One strip is laid out on the front of the book holder which holds one of the motors to the right side of the project. There is an identical strip attached to the back. A smaller strip is placed in the front to hold one of the motors. One of the motors is used to lift the page using two small 40mm x 40mm x 6mm 5V DC fans to generate a vacuum. Another motor is used as a wiper to sweep underneath the page once it had been lifted. The

last motor is used to hold the pages down while the user reads.

The motors use rods of various sizes to perform their given functions. The wiper uses a 1/8 inch steel rod to sweep underneath the pages. Steel is chosen because of its bending property; it is easy to shape the wiper into the desired shape. The other motors use 1/4 inch diameter aluminum rods to hold the fans and to hold the pages down. The fans are attached to pieces of aluminum. Aluminum is very rigid and light which made lifting the rods easier for the motors. These rods are lifted upwards against gravity whereas the wiper only moves clockwise or counterclockwise. All of the aluminum rods are adjustable in the horizontal direction for various book widths. The fans are glued onto the rod using epoxy. The fans have a guard glued onto them to prevent accidents and enhance safety features.

The device is turned on using a toggle switch and is activated using the large push button. All the user needs to do is touch the button and the device will perform its operation. This button is free-moving. The button attaches to the circuit via a jack similar to that of a headphone jack. This means that the buttons can be easily replaced if the current one is damaged, or another button, that may be more suitable to the user, is desired.

The circuit is stored inside the wooden box portion of the book holder. There is another 5V DC fan mounted on the side of the device to keep the circuit board cool during operation. The circuit itself is mounted on the drawer that is inside the box, allowing for easy access. The circuit is made up of three microcontrollers to driver to motor setups. One microcontroller controls setups, and two BJT drivers to control the three fans. The micro-controller used is the PIC16F684.

The device can only be powered by the wall outlet. The wall outlet uses a 9V, 4A, AC to DC adapter. The battery option would have used eight D-sized rechargeable batteries and would have needed to have been stored in a separate container which would plug into the project. The inclusion of batteries made the overall device extremely large, so only an outlet adapter is included in this design.

The cost of the parts/materials is approximately $250.
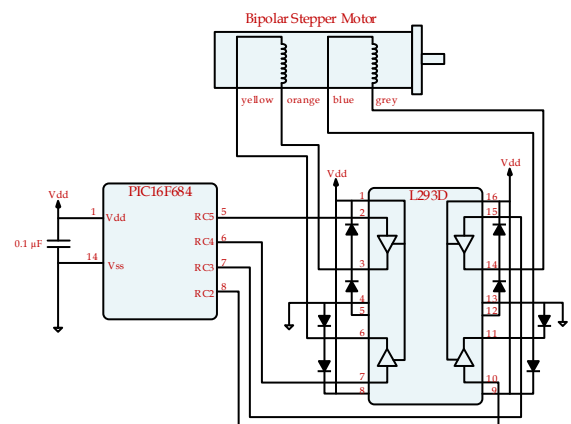

Fig. 16.31. Client Using the Automatic Page Turner.

Fig. 16.32. PIC16F684 to Bipolar Stepper Motor

MICROPROCESSOR CONTROLLED POWER SPLITTER (MCPS): A DEVICE THAT PROVIDES CONTROL OF FIVE GROUND FAULT CIRCUIT INTERRUPTER (GFCI) OUTLETS TO ASSIST INDIVIDUALS WITH MULTIPLE DISABILITIES

Designer: Zenon Lis
Client: Lisa Szewczyk, Vocational Coordinator, Nashua Center, Nashua, NH
Advisor: James Drew
Electrical and Computer Engineering Department
University of Massachusetts Lowell
Lowell, MA 01854

INTRODUCTION

The Microprocessor Controlled Power Splitter (MCPS) is designed to assist individuals with multiple handicaps.

The client requires a power-supply apparatus that offers a broad range of multiple use capabilities.

The MCPS allows for the safe operation of high-voltage equipment through the use of low-voltage momentary switches. This custom designed unit gives the user independent control of five Ground Fault Circuit Interrupter (GFCI) outlets by manipulating five color-coordinated low-voltage momentary switches. The unit is equipped with an independent programmable timer for each outlet as well as a remote kill-switch. The primary purpose of the MCPS is to allow individuals to interact with and experience change in their environment.

SUMMARY OF IMPACT

The Nashua Center provides specialized care and support to individuals of all ages with developmental or acquired disabilities, including poor cognitive and motor skills. The design criteria, as requested by the vocational coordinator, serve to support the capabilities and varying skill levels of the clients they serve. The MCPS device will be used to assist individuals with various tasks such as cooking for example, facilitating the individual's control over kitchen appliances through the toggling of jelly bean switches. The jelly bean switches also allow the user to start, stop or reinitialize a programmed time sequence. In addition, the MCPS comes with five independent timers that power

Fig. 16.33. Microprocessor Controlled Power Splitter (MCPS).

devices requiring a limited time of operation, for example, massage devices, heating blankets or lights. It will be stimulating and convenient for the individuals to have some control over the devices plugged into the MCPS. It allows them to take part in the decision making processes concerning their interactions with the environment.

TECHINCAL DESCRIPTION

The MCPS is enclosed in a portable steel box weighing 16 pounds and measuring: Height - 5″, Width -14″, Depth – 10″. The unit works in two modes, Passive and Timers. In the Passive mode a Liquid Crystal Display (LCD) shows five different color outlets.

Each GFCI outlet is controlled by a color-matched, single-momentary switch. Individuals press the 2ND and the CLEAR buttons on the keypad and the MCPS switches to Timers mode. The LCD shows five different timers.

The MCPS is turned on by pressing the white button protected under a transparent cover on the back of the unit. The MCPS is initialized in the passive mode. At this stage, the outlets can be operated by the momentary jelly bean switches.

To use equipment that requires time limits, the key pad is used to set the time frames. The user first presses the 2ND key and then the CLEAR key. The LCD then shows the time set and the time remaining screen. The user presses the white arrow keys to navigate to the desired timer and selects which outlet to set a time for. Then 2ND key is pressed again which enables the red arrows. The red arrows are used to navigate the curser to the desired digit setting. When the cursor is on the desired digit setting the number is keyed in. The ENTER key is then pressed to begin the time count. Each timer controls the color-coded corresponding outlet.

The CLEAR key is pressed to clear the "Time Set". The "Time Remaining" can be deleted by pressing the CLEAR button on the key pad. Pressing the momentary switch stops the progress of the timing function, pressing it again, allows the time to reset and begin again.

The MCPS is comprised of three main components. The Main Control Circuit is responsible for controlling the device, the RF Circuit provides remote power cut-off, and the Cooling Circuit, which provides cooling of the unit.

The Main Control Circuit is based on a PIC32 microcontroller; three 16F684 microcontrollers, and a QVDA display with a built in microchip driver-SSD, 1906.

Microcontrollers U2, U3 and U4 are responsible for scanning the five Momentary Switches, the key pad and the drive Solid State Relays (SSR's) through BSS 100 transistors respectively.

The U1 microcontroller operates the MCPS in two modes. In the Passive mode, the U2 microcontroller performs a function to determine which momentary switch was pressed and then transmits this data to the U1 microcontroller. The U1 microcontroller makes the decision as to which outlet needs to be enabled and then transmits the data to the U4 microcontroller, which drives SSR through BSS 100 to enable an outlet. The U3 microcontroller determines which buttons are pressed on the key pad and transmits the data to the U1 microcontroller. The U1 microcontroller reads the data and decides which timer and outlet needs to be set active. When a timer is activated, the U1 microcontroller transmits data to the U4 microcontroller, whose function is to turn an outlet ON through transistor BSS100 and SSR respectively.

When the momentary switch is pushed, the U2 microcontroller detects it and transmits a serial signal to the U1 microcontroller. The U1 microcontroller executes an interrupt, which resets the time on the "Time Remaining" to zero. When the "Time Remaining" is set to zero the U1 microcontroller transmits data to the U4 microcontroller to turn the outlet OFF. The same momentary switch pressed a second time will start a timer using a previously set time.

The RF circuit is comprised of receiving and transmitting circuits respectively. When the momentary switch is pressed the U8 encoder sends data to the U7 transmitter. The U7 transmitter transmits signals to the U5 receiver. The signal from the U5 receiver goes to the U6 decoder, which activates the BSS 100 transistor and works as a switch. When the gate of the BSS 100 transistor is set high, a circuit breaker with a remote trip signal (Schurter TA45-ABDWK 150A4-AZM01) is tripped through the SSR.

The cooling cycle is designed by using a U11 microchip TC 620 with a built in thermistor, a U10 TC 4469 Logic-Input CMOS quad Driver and two cooling fans. The U11 microchip is set to sense temperature in ranges of 0°C-25°C (Fan Off), 25°C-50°C (Fan Low), and 50°C-Up (Fan High). This design gives dual speed temperature control. A signal from the U11 microchip goes to U10 TC 4469 which is responsible for driving two cooling fans. The fans are arranged to work in a push-pull configuration. This allows the forcing of a stream air through a heat sink.

The cost of parts and materials is $1200.00.

Fig. 16.34. Client using the device.