CHAPTER 14
UNIVERSITY OF CONNECTICUT

School of Engineering
Biomedical Engineering
260 Glenbrook Road
Storrs, Connecticut 06269

Principal Investigators:

John Enderle (860) 486-5521

jenderle@bme.uconn.edu

Brooke Hallowell (740) 593-1356

hallowel@ohiou.edu

FREELY ACCESSIBLE AND ADJUSTABLE KEYBOARD WITH MOUSE PAD

Designers: Stephen Heussler and Nolan Skop
Client Coordinator: Miriam Kurland, Hampton Elementary School
Supervising Professor: Dr. John Enderle
Biomedical Engineering Department
University of Connecticut
Storrs, CT 06269

INTRODUCTION

The Freely Adjustable and Accessible Keyboard and Mouse Pad was designed for an elementary school student with cerebral palsy who lacks fine motor control and is unable to use a standard keyboard and mouse. The main goals of the device were to increase the client's ease, speed, and accuracy of typing. The device (Fig. 14.1) contains fewer keys than an average keyboard, which allows more space between the keys and improved typing accuracy for the client. The keys are also more durable than those of a typical keyboard. The keyboard rises to a greater angle than a standard keyboard. Seven buttons on the keyboard replace a standard mouse. A USB port provides easy transport of the device between computers.

SUMMARY OF IMPACT

This device helps people who lack fine motor control to use a computer with less difficulty. The placement and spacing of the keys make it easier to select the right key. The mouse pad incorporated into the keyboard improves navigation of the computer.

TECHNICAL DESCRIPTION

Cherry MX switches were used for the keys to lengthen the life of the keys and increase durability. All of the switches and electrical components are mounted on a printed circuit board and the signals are wired to a control board (Fig. 14.2 and 14.3). The control board interprets the signals from the switches and sends the signals to the CPU through a USB connection.

Fig. 14.1. Top View of Keyboard

LEDs were placed behind the mouse pad to provide backlighting. The power for the LEDs comes from the computer through the USB connection. A switch is on the front of the device that turns the LEDs on and off. Diodes were placed after each switch to eliminate ghosting. The final dimensions of the casing are 15.7" by 6.5". To prevent sliding, rubber sheeting was placed on the base.

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

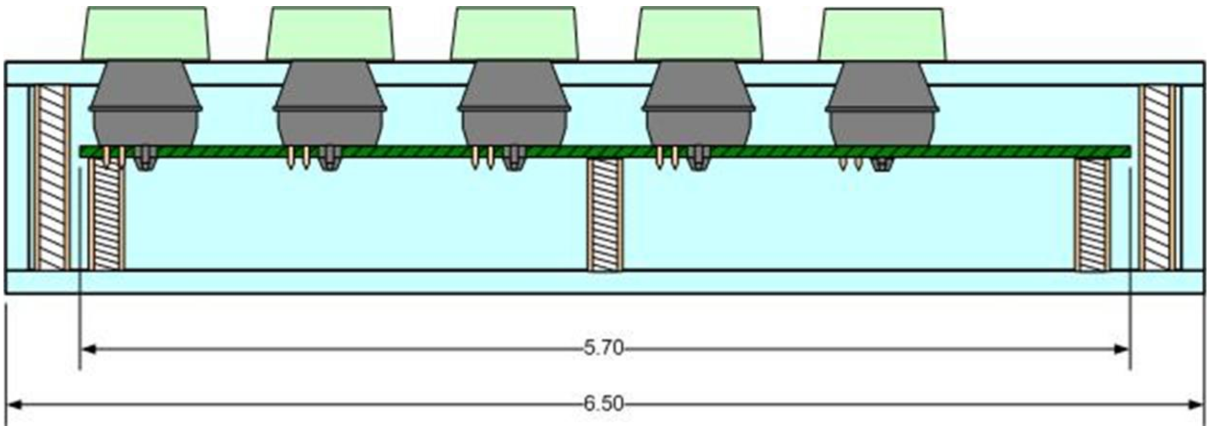

Fig. 14.2. Cross-Section of Keyboard.

Fig. 14.3. Internal View of Keyboard.

ASSISTIVE ROBOTIC ARM

Designers: Asma Ali, Megan G. Madariaga, and Danielle C. Mcgeary
Client Coordinator: Merriam Kurland, Hampton Elementary School, Hampton, CT
Supervising Professor: Dr. John D. Enderle
Department of Biomedical Engineering
University of Connecticut
Storrs, CT 06269

INTRODUCTION

The intent of this design was to create an artificial robotic arm to help an elementary school student with quadriplegic athetoid cerebral palsy to eat independently. The arm allows the client to eat lunch with his peers without the constant supervision from an aid.

SUMMARY OF IMPACT

The device provides the student, who has impaired fine motor skills, a way to eat independently. The device also provides a grip mechanism resembling the human hand. The device also closely resembles the movements of the human arm by providing a full range of motion about the x, y, and z axes.

TECHNICAL DESCRIPTION

The Assistive Robotic Arm (Fig. 14.4 and 14.5) consists of the following subunits: 1) a base; 2) upper arm; 3) lower arm; 4) wrist; 5) gripping device; 6) motors; 7) batteries; and 8) circuitry. The base houses a motor and a rotating plate, which rotate the entire device. To ensure safety, the base has a mechanical constraint that only allows for 120 degrees of rotation. The base securely mounts to the client's chair via strong clamps.

The upper arm attaches to the base. An elbow joint connects the upper arm and the lower arm. The elbow joint can move from zero to 90 degrees vertically. The 90-degree limit prevents the device from over-rotating and harming the client.

The upper and lower arms are connected by a pulley system. When in motion, the lower arm follows the motion of the shoulder joint and stays parallel to the ground. The shoulder joint rotates via a motor located at the connection of the shoulder to the base. The motor inserts through the base connection by an aluminum shaft. This shaft also connects to the pulley system. On the shaft is a long rod that limits the rotation of the entire base.

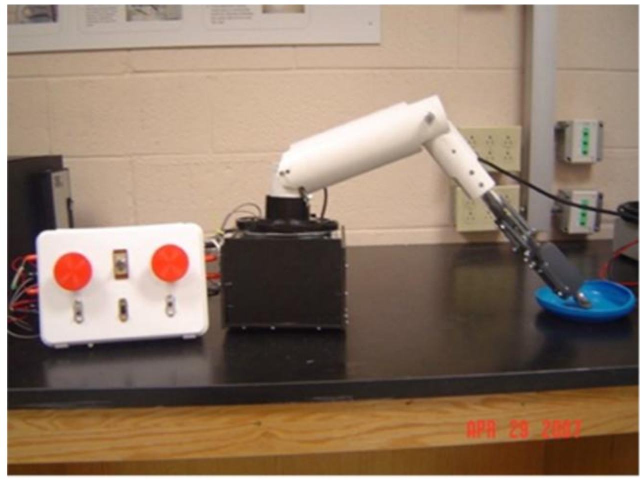

Fig. 14.4. Assistive Robotic Arm.

When both of the vertical joints are extended to 120 and 90 degrees simultaneously, a maximum extension of 25" is added to the client's reach.

The lower arm is connected to the grippers by a wrist joint. The motion of the gripping device is controlled by two gears. One of the gears is rotated via a motor.

The grippers are designed to hold a metal spoon bent at a 30 degree angle. A specialized soup spoon is the only spoon that can be attached. Slits in the grippers that fit the handle of the spoon ensure safety.

The device is controlled by a keypad. The keypad consists of six switches that are durable and simple to use. The client can orient the device to a desired position by operating the keypad. The keypad is responsible for turning on and off the voltage source from the batteries. The keypad is also responsible for controlling bidirectional movement of the arm by reversing the voltage.

The cost of the parts and materials was about $650.

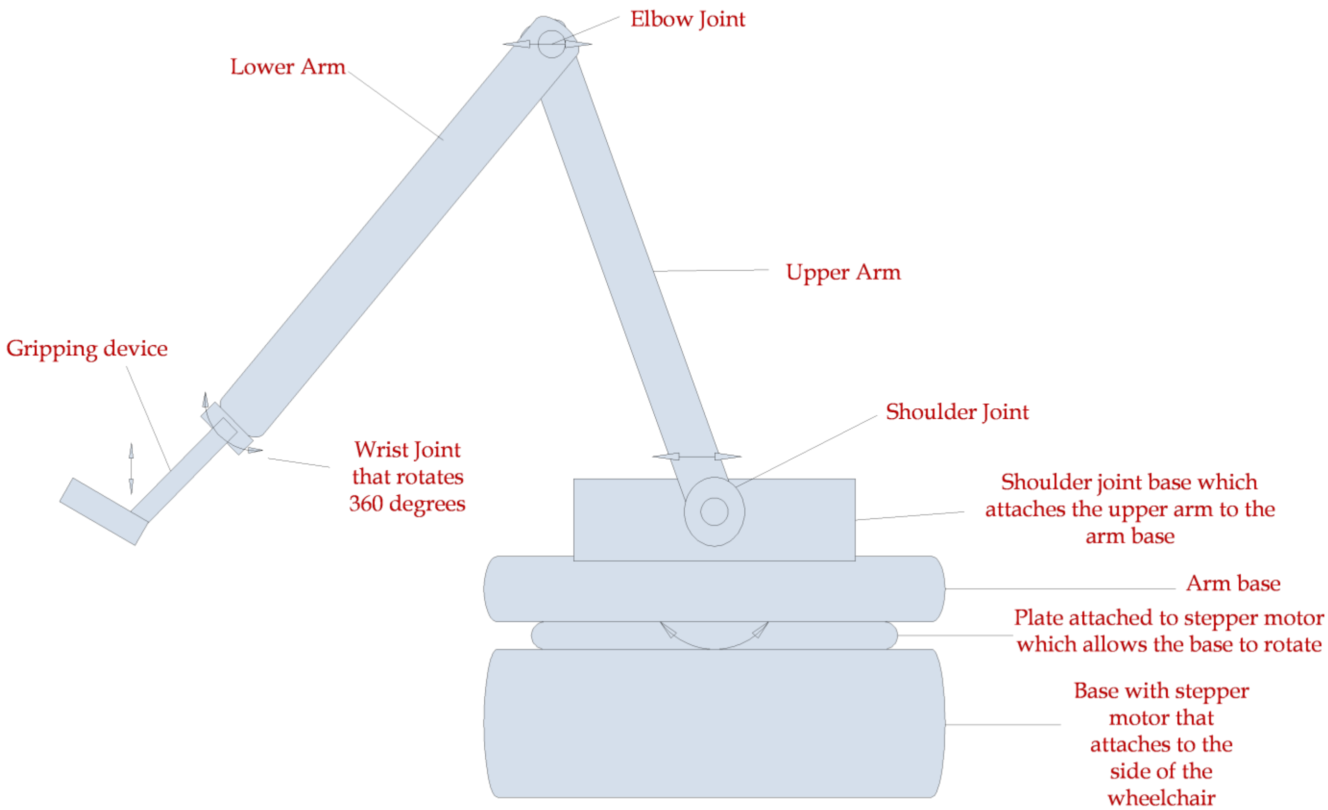

Fig. 14.5. Drawing of Arm.

HEAD AND ARM MOUNTED ART DESIGN SYSTEMS

Designers: Rebecca Lussier, Sirisha Muppidi and Nemi Kotadiya
Client Coordinator: Dr. Brooke Hallowell, Ohio University, Athens, OH
Supervising Professor: Dr. John Enderle
Biomedical Engineering Department
University of Connecticut
Storrs, CT 06269

INTRODUCTION

The Head and Arm Mounted Art Design Systems were designed for an individual to help create works of art in an art studio for people with developmental disabilities. The client has limited motor skills due to cerebral palsy and hydrocephaly. The devices are rotating cables that turn a compass that fits multiple sizes of art utensils, including pencils, crayons, markers, and paint brushes. The devices are attached either to the head or arm of the user (see Fig. 14.6 and Fig. 14.7). The systems are turned on or off by sensing purposeful blinks provided by the artist using an eye-blink controller circuit. The Head and Arm Mounted Art Design Systems allow users to draw and paint independently.

SUMMARY OF IMPACT

The devices allow the client to draw without assistance and independently to turn the devices on and off. The adjustable design of the systems makes it possible for other artists at the studio to use the devices as well.

TECHNICAL DESCRIPTION

The main subassemblies of the Head and Arm Mounted Art Design Systems were fabricated from a rotating speedometer cable within a flexible, yet rigid, gooseneck tube. The rotating cable rotates an adjustable compass piece in order to fit multiple sizes of media. The use of aluminum for the intermediate pieces makes the devices light enough to wear.

The rotating motion of the compass on both systems is provided by a 12-volt DC reversible motor. The motor has high enough torque power to rotate anything attached at the compass end. A reversible feature is incorporated in the design of the motor and the controlling button so that the user can increase the number of his or her designs. The motor is run by rechargeable AA batteries and requires minimal wiring.

Fig. 14.6. Head Mounted Art Design System.

Fig. 14.7. Arm Mounted Art Design System.

The devices use an infrared eye-blink switch. If the user purposefully blinks for a second, the circuit processes the signal and then powers the motor on (Fig. 14.8). Conversely, if the user blinks for another second, the system powers off. The infrared sensor and receiver use safe levels of infrared. The sensor is mounted to a pair of eyeglasses worn by the user while the devices are in operation. Soft switches are included in the circuit to ensure safety and so the user can control the direction of the motor. The switches are foam and fabric covered DPDT switches and use large internal plates to facilitate actuation. An overriding switch was placed in both systems so that caretakers can turn the systems on or off as well.

The cost of the parts and materials was about $1200.

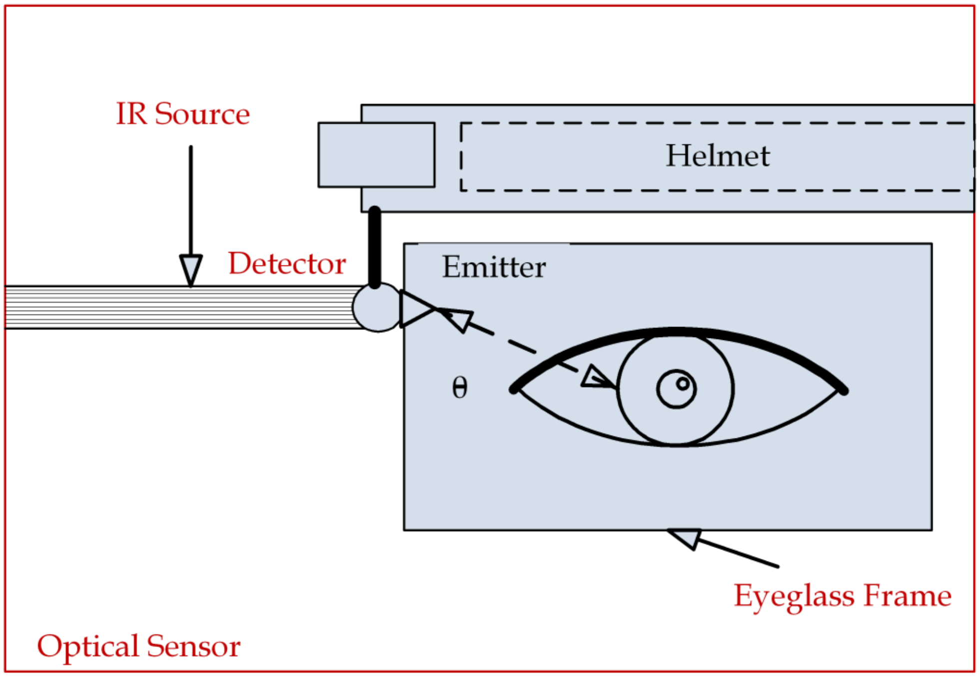

Fig. 14.8. Eye Blink Sensor.

MEDICINE REMINDER DEVICE

Designers: Sheldon Bish, Karla Sittnick, and Kenta Umetsu
Supervising Professor Dr. John Enderle and Bill Pruehsner
Client Coordinator: Dr. Brooke Hallowell, Ohio University, Athens, OH
Biomedical Engineering Department
A.B. Bronwell Building
260 Glenbrook Road, Unit 2247
University of Connecticut
Storrs, CT 06269-2247

INTRODUCTION

The Medicine Reminder Device was designed for an elderly woman with multiple medical conditions who needs to take medicine twice a day. The client has an impaired ability to monitor her own medication schedule and required a way to independently take her medication. The medication reminder was designed to provide independence to the client from her caretakers and give her the capability to stay on her medication schedule. This device is a simple model Personal Digital Assistant (PDA) modified with a program to keep track of her dosing schedule, as well as keep a record of when and how often she takes her medicines.

SUMMARY OF IMPACT

The Med-Rem application used along with the Palm device provides the patient independence from family and caretakers in her daily medication routine. Med-Rem provides a dependable reminder for the patient when it is time to take her medications, which medications to take, and in what amounts. It also requires a response from the user. The caretaker is able to double-check the patient's ability to use the device as a reminder by using the Dose Count and Medication Log features. The device is aesthetic and is readily available on the market. The patient or caretaker can select games and other applications to be added to the device to increase the patient's positive association with the device.

TECHNICAL DESCRIPTION

The PDA casing is made from plastic designed to be lightweight and impact resistant (see Fig. 14.9). The casing (ABS) thickness is 1/8" to provide more impact resistance then an average thin metal sheet casing. The window screen of the casing is made from clear polycarbonate material.

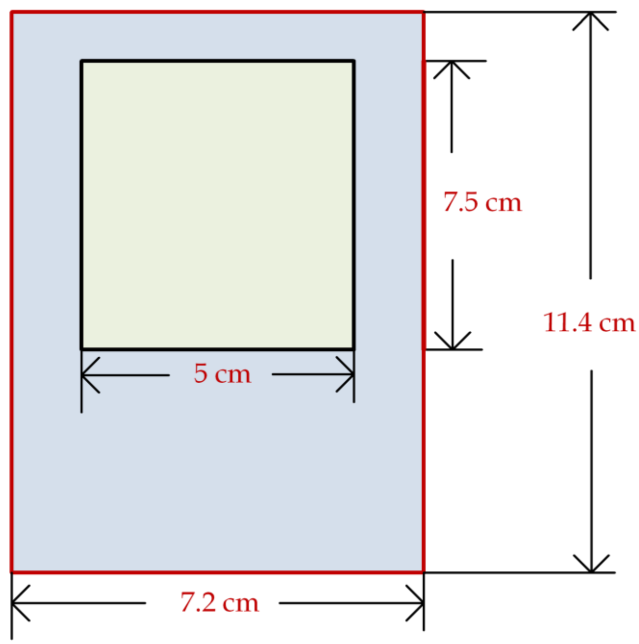

Fig. 14.9. Case Size for Medication Reminder PDA Device.

The Medication Reminder Application, "Med-Rem", allows the caretaker to store five independent medication sessions for the patient. Each medication session is capable of being set for a time chosen by the caretaker along with dosage type and amount. All medications can be added to a main medication list prior to being entered into an individual medication session. The device also has a "dose count" feature, which continuously monitors remaining medicine available for dosage. The caretaker may also view a medication log of patient interaction. The medication log is able to store an unlimited number of records, and each record is created upon patient interaction through a scheduled Medication Session. The log stores the: 1) date; 2) time; 3) medication name; 4) dosage type; 5) dosage amount; and 6) user response for each medication alert. Upon reaching a scheduled medication session, the palm: 1) turns on (if off); 2) starts the med-rem application; 3) produces a visual alert on the screen; 4) sounds an alarm (see Fig. 14.10).

The initial alert asks if the client is ready to begin her medication session. The patient is given the option to continue or snooze. The patient is allowed to snooze a total of three times and is then forced to continue with the session or skip the session entirely. If the session is skipped entirely, the user response is stored as "skip." When the patient chooses to continue with the medication session, alerts containing medication name, dosage amount, and dosage type are displayed to the user one at a time for each medication contained in the specific medication session. The device requests a response of "Yes" or "No" regarding whether or not the patient has consumed the medication. Once the last medication on the list is shown in an alert and the patient has responded, a final completion message for the medication session is displayed to communicate to the patient that the Medication Session has been completed.

The cost of the parts and materials was about $130.

Fig. 14.10. Alert Screen on Med-Rem.

SHAMPOO AND CONDITIONER IDENTIFICATION DEVICE

Designers: Sheldon Bish, Karla Sittnick and Kenta Umetsu
Client Coordinator: Dr. Brooke Hallowell
Supervising Professor: Dr. John Enderle
Biomedical Engineering Department
University of Connecticut
Storrs, CT 06269-2247

INTRODUCTION

The Shampoo and Conditioner Identification Device (Fig. 14.11) was designed for an elderly woman with visual and cognitive impairments. The client requested a way to differentiate her shampoo and conditioner bottles while in the shower. The Shampoo and Conditioner Identification Device is a lightweight, waterproof, and shock-proof device that emits an auditory voice signal of "shampoo" or "conditioner" when certain colored bottles are scanned in front of the device.

SUMMARY OF IMPACT

The purpose of the device is to reduce the client's confusion and frustration and thus make the client's shower experience easier and more enjoyable. The device also ideally saves the client's family members time and energy of having to identify bottles for her. Additional design considerations for future work on such a device include a smaller and lighter device that does not hang on the shower curtain rod and more stable wiring for consistent functioning if and when the device is moved.

TECHNICAL DESCRIPTION

The casing of the Shampoo and Conditioner Identification Device was fabricated from an opaque polypropylene 12" x 12" block. The polypropylene casing has a hard, smooth surface that prevents bacteria build-up and provides chemical resistance. The window for the color sensor was made from clear polycarbonate in order to provide translucence while having high impact resistance.

The color sensor is a light to frequency sensor that is fully programmable with computer software (see Fig. 14.12). The output of the sensor is customizable for optimal compatibility with the microcontroller in the device circuit.

Fig. 14.11. Shampoo-Conditioner Identification Device.

The microcontroller contains a frequency counter program that distinguishes between the color sensor's output signals for red and blue. The microcontroller communicates with tan SP03 voice module and indicates which of the pre-programmed phrases to repeat as a signal of red or blue is detected. The audio signal from the SP03 is sent through a speaker. The audible responses are "Shampoo" and "Conditioner." An illustration of the circuit is in Fig. 14.13.

The cost of the parts and materials was about $680.

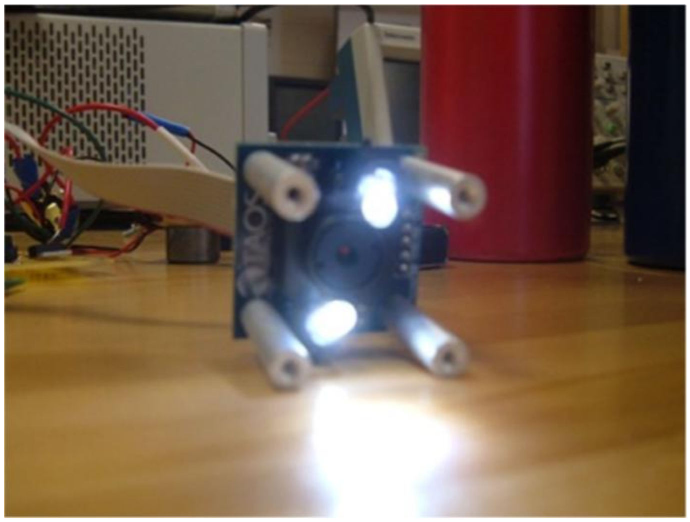

Fig. 14.12. Light to Frequency Color Sensor.

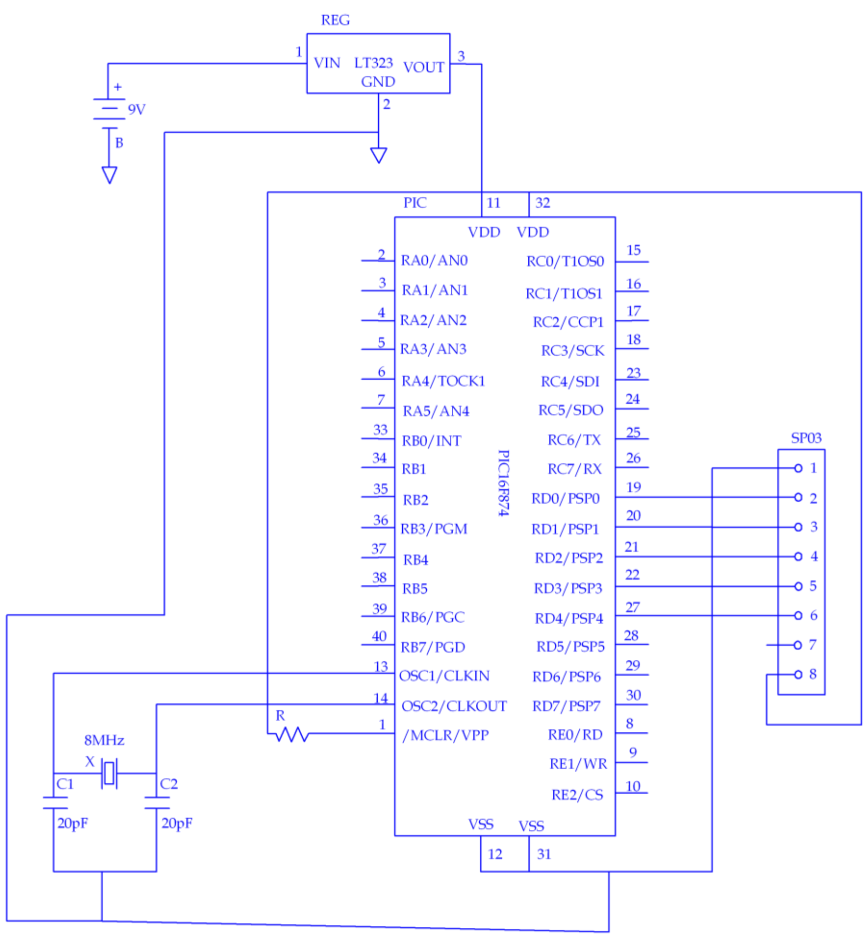

Fig. 14.13. Frequency Counting Circuit.

INTERACTIVE WHEEL OF FORTUNE GAME

Designers: Kristen M. Gingras, Meghan E. Schmidt and Yadverinder Singh
Client Coordinator: Dr. Brooke Hallowell, Ohio University, Athens, OH
Supervising Professor: Dr. John Enderle
Biomedical Engineering Department
University of Connecticut at Storrs
Storrs, CT 06269

INTRODUCTION

The Interactive Wheel of Fortune Game was designed to be used in a workshop for adults with developmental disabilities. The clients requested a form of entertainment that accommodates limited mobility and dexterity and also allows them to socialize in a fun and visually stimulating environment. The Interactive Wheel of Fortune Game includes: 1) bright colors on the exterior of the game; 2) Light Emitting Diodes (LEDs) that light up with activation of the game; 3) audio comments that are spoken at initial power of the game and when the wheel spins; and 4) two different methods to spin the wheel (a one-button push button wireless remote and a motion sensor).

SUMMARY OF IMPACT

The portability of the game allows it to be moved around the room and to other locations. The game ideally engages the adults in social interactions while ensuring safety. The clients are able to spend their time in a positive manner that allows them to enjoy themselves.

TECHNICAL DESCRIPTION

The base of the game is fabricated from high density polypropylene to prevent movement while the wheel is spinning. To provide further support, a support system was constructed for the inside of the base. The support system was made out of a wooden block. The wooden block was fastened onto the base and secured on each side using 2′ x 4′ wooden planks (see Fig. 14.15). The motor is attached to the top of the wooden block by use of an aluminum plate.

The wheel was made from polypropylene in order to ensure high strength and high heat capacity while spinning. The colors red, blue, yellow, and green were used on the wheel (Fig. 14.14) to make high contrasts. Shiny silver stickers indicate the point values on each section. Dowels are attached at the base of the wheel, and they assist in the indication of which point value the player lands on.

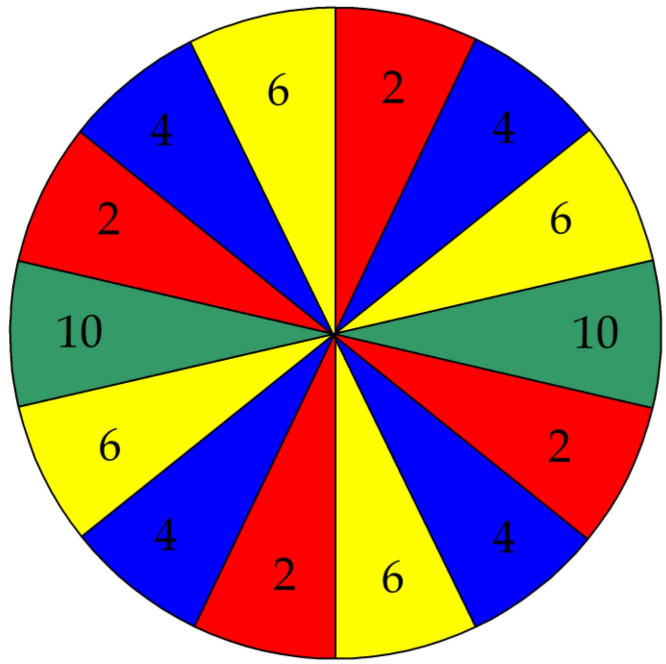

Fig. 14.14. The Wheel of Fortune Game.

A clicker system is part of the design and is on the side of the base. The clicker was fabricated from elastic tubing that has flexibility when coming into contact with the dowels. The clicker indicates the final point value. An SP03 audio response system gives audio feedback to the players. The entire device operates on six nine-volt batteries.

A wireless communication capability exists between the remote and the microcontroller for the motor. The remote activates the spinning of the wheel for those who have difficulty approaching the device. A light sensor also activates the device to turn when a user waves his or her hand in front of it.

The cost of the parts and materials was about $685.

Fig. 14.15. Support System.

MODIFIED COMMUNICATION SYSTEM ACCESSORY DEVICES

Designers: Philip Licitra and Stephanie Santos
Client Coordinator: Madeleine Kineavy
Supervising Professor: Dr. John Enderle
Biomedical Engineering Department
University of Connecticut
Room 217, A.B. Bronwell Building
260 Glenbrook Road, Unit 2247
Storrs, CT 06269-2247

INTRODUCTION

A joystick control device and a secondary viewing screen were used to operate and enhance the client's existing augmentative device, developed by DynaVox Technologies®. The client required a more durable and reliable selection device and needed an auxiliary liquid crystal display (LCD) screen for others to provide more active and personal conversations. The two devices allow the client to interact more effectively with others. The joystick: 1) has a large gripping surface; 2) is durable; 3) provides a faster and more efficient means of communication.

SUMMARY OF IMPACT

The devices improve the client's quality of life by increasing the ease and efficiency of his augmentative device and allowing the client to more naturally and quickly communicate with friends and family. The addition of the head switch to the joystick helps the client maintain better posture, and the size of the joystick grip improves his hold.

TECHNICAL DESCRIPTION

The mechanical design of the joystick reduces wear and fatigue. The joystick is designed to operate efficiently under repeated force applications of up to 250 pounds to accommodate the client's high tone and movements. The device has a one-touch selection feature, which gives the client the option to use either a hand-grip mounted button or an externally connected head switch (developed by AbleNet®). The joystick control connects to the augmentative device through a USB connection and can be used as a cursor control on any cursor-controlled device with a USB port. The head switch is connected through an integrated panel mounted mono-jack port. The mono-jack port is located on the back side of the joystick encasement. The joystick (Fig. 14.16) is mounted on the left armrest of the client's wheelchair. The joystick was mounted by permanently attaching an aluminum T-slot extrusion to the armrest of the wheelchair and sliding a linear bearing, which is permanently attached to the joystick, over the t-slot extrusion.

Fig. 14.16. Joystick in Encasement with Attached Optional Head Switch.

The seven-inch secondary viewing screen is self-contained in an ABS plastic enclosure (see Fig. 14.17). The screen is powered by a rechargeable NiMH battery pack, which provides battery life for ten hours before needing a recharge. A green LED was installed to indicate that the screen is powered. The LCD screen connects to the DynaVox® via a VGA video card in the video output port. A clearly labeled rocker switch designates whether the battery voltage is being directed to power the LCD screen or to the Universal Smart Charger, where the battery can be recharged. The central position on the rocker switch is designated as the "OFF" position.

The cost of the parts and materials was about $750.

Fig. 14.17. LCD Screen in Custom Enclosure.