CHAPTER 17
UNIVERSITY OF CONNECTICUT

Department of Electrical and Computer Engineering
260 Glenbrook Road U-157
Storrs, Connecticut 06269-2157

Principal Investigators:

John Enderle (860) 486-5521

jenderle@bme.uconn.edu

Brooke Hallowell (740) 593-1356

hallowel@ohiou.edu

AUTOMATIC DOOR OPENER

Designer: Pik-Yiu Chan
Supervising Professor: Dr. John Enderle
Biomedical Engineering
University of Connecticut
260 Glenbrook Road U-157
Storrs, Connecticut 06269-2157

INTRODUCTION

The Automatic Door Opener is a modification of a conventional household door into an automatic door that opens and closes upon user's requests through a remote control, a pushbutton, a keypad entrance, and or a key bypass. This project was designed for clients with poor hand control. With this design, clients will be able to open and close the door with a touch of a button, and the door will unlock and open or close and lock itself. There are many commercial doors that can be operated automatically, but those devices are expensive ($3,000 to $5,000) and are not suitable for household usage. This design, however, is inexpensive and is easy to install and use. (Figure 17.1)

Figure 17.1. Automatic Door Opener.

SUMMARY OF IMPACT

Previously, the client could only get in and out of her house by asking one of her family members to turn the doorknob. With the door unlocked, she had to pull the door open using a long piece of string. However, it was hard for her to reach the string because of the highly sensitive control of the wheelchair she is using. Fine adjustments back and forth to the door on the wheelchair had added another degree of difficulty to the door opening and closing processes. With the new device installed in her house, the client will be able to open and close the door on her own. The client will press the OPEN button on the remote control to unlock and open the door, or she will press the LOCK button to lock the door once it is automatically closed. Other family members can also benefit from this design by using the keypad or the pushbutton to open and close the door.

TECHNICAL DESCRIPTION

The Automatic Door Opener can be accessed via the remote control, the pushbutton (mounted inside the house), and the keypad (mounted outside the house). Upon receiving the signals, a sequence of door opening processes will start: retracting the deadbolt, unlatching the door strike, and powering up the door motor. After closing the door, the door will be locked after a time delay. (Figure 17.2)

The door closing process includes locking the electric deadbolt after the door has automatically closed. The series of actions is controlled by the PIC16F877 40-pin EEPROM microcontroller. The microcontroller was programmed to take in inputs from the LINX receiver (with the matching transmitter as the client's remote control), the pushbutton and the keypad. The microcontroller then sends out signals to the electric deadbolt, the door strike, and the door motor. (Figure 17.3)

The microcontroller check which input component (pushbutton, remote control, or keypad) is used to open or close the door. The remote control sends a signal to the matching LINX receiver on the main control circuit, which then triggers the microcontroller to start the door opening or closing process. The pushbutton also works in a similar way. If the keypad is used, the user has to enter a password for security reasons. The password routine utilizes the EEPROM ability of PIC16F887. If the correct password has been pressed, the door opening sequence will be activated. For locking the door from outside, the users can simply press the "#" sign on the keypad. The PIC program also allows the users to change the password periodically. This password is saved in the FLASH memory of the microcontroller, and it will be stored even if there is a power failure.

The total cost of this design (parts and materials) was $1,500.

	1s	2s	3s	4s	5s	6s	7s
Deadbolt							
Strike							
Motor							

Figure 17.2. Door Opening Sequence.

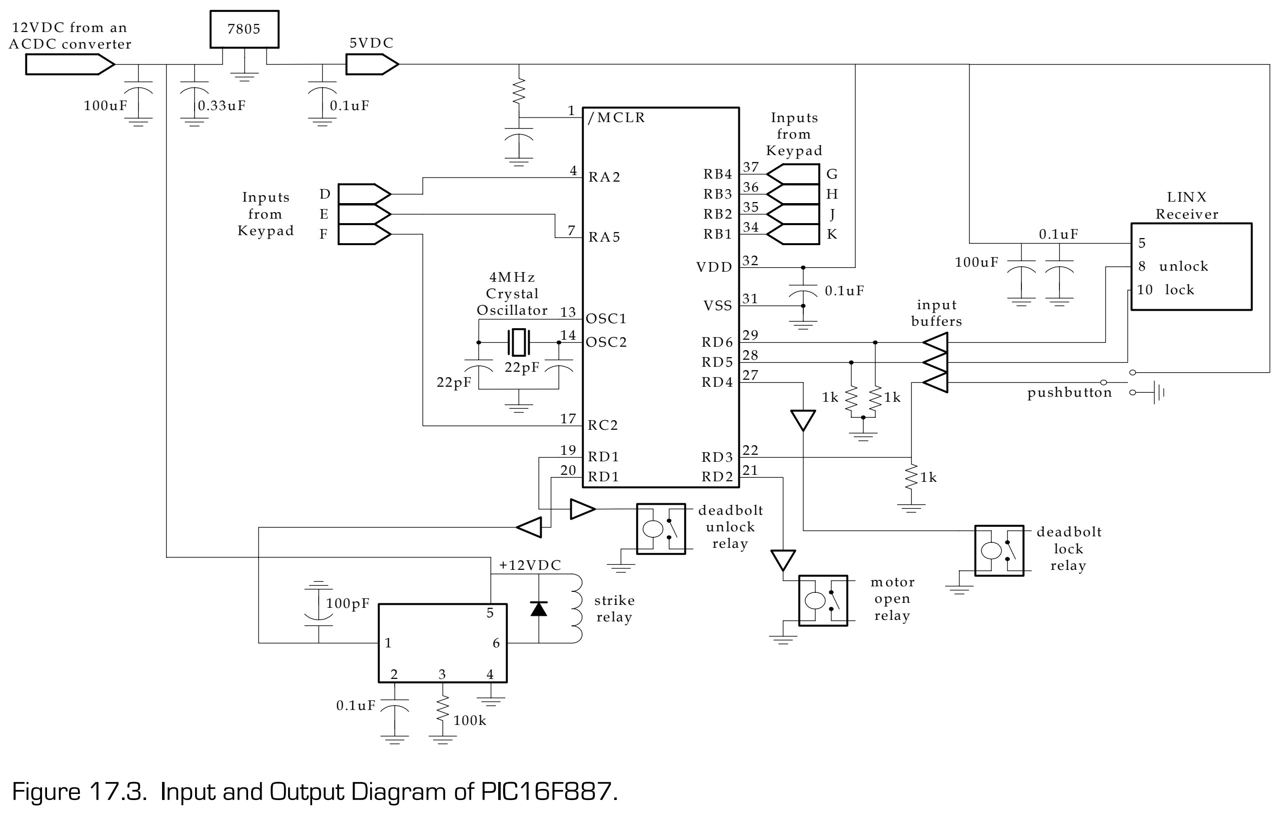

Figure 17.3. Input and Output Diagram of PIC16F887.

AUTOMATIC DOOR OPENER B

Designer: J. Carson Granville
Supervising Professor: Dr. John Enderle
Biomedical Engineering
University of Connecticut
260 Glenbrook Road U-157
Storrs, Connecticut 06269-2157

INTRODUCTION

The Automatic Door Opener is a device intended to give a person with disabilities the freedom of using their front door. The client is in a wheelchair and has use of only one hand. The device allows the client to operate the door via remote control and her family to operate the door using a keypad from the outside or a push plate from the inside. The device gives the client the freedom to enter and exit the house at will, offering more independence to the client and easing the schedule of the family. (Figure 17.4)

SUMMARY OF IMPACT

The specifications for the Automatic Door Opener are a result of interviews with the client and the client's parents, as well as measurements taken at the client's home. Additionally, budget restrictions were considered. The unit is useful to anyone who uses a wheelchair or who does not have the strength to operate a door. The design is flexible in that an unlimited number of remotes may be programmed to operate the unit, so it can be placed in a facility that is home to multiple persons with disabilities.

TECHNICAL DESCRIPTION

The system is comprised of a Stanley Magic Access door opener, HES electronic strike, Weiser Lock electronic deadbolt, a 12 digit keypad, a push plate, Linx transmitter and receiver pair, and a prototype PCB circuit to control the system. Many of the components are readily available commercially and are easily converted to work with the system. The Stanley Magic Access header assembly was used to house the DC power supply so that all the 120VAC connections are made within a grounded metal enclosure. A twisted pair was used for transmission of the 12VDC to the PCB so as to minimize added noise.

The prototype PCB circuit utilizes a 7805 voltage regulator and filtering capacitors to deliver clean

Figure 17.4. Prototype Automatic Door Opener.

power to the circuit devices. The PCB is enclosed in a plastic box so that it can receive and transmit RF signals. An OEM Linx transmitter was used because it is contained in a small waterproof key-chain enclosure as per the user specifications. The PIC features buffered inputs and outputs so that it is not required to drive large loads nor receive as much feedback from noisy external components such as the pushbutton switch (Figure 17.5).

The Stanley Magic Access door opener and electronic deadbolt are controlled using reed relays. Reed relays were used because they are reliable for low current applications, quiet, inexpensive, and easy to replace. The electronic strike is controlled by a solid state current driver with over current protection. The current driver was chosen over a relay because it introduces little noise, is TTL compatible, uses little power, uses over current protection, uses thermal shutoff and is inexpensive.

The Weiser Lock electronic deadbolt is controlled by the circuit using the remote that comes with the deadbolt unit. The remote is modified so that two reed relays in the PCB circuit simulate pressing the lock and unlock buttons. The remote was utilized because it makes it possible to communicate with the deadbolt assembly without making a physical connection to the swinging portion of the door.

The specifications were met so that the door can be installed in its intended location.

The total cost of parts and materials was about $1500.

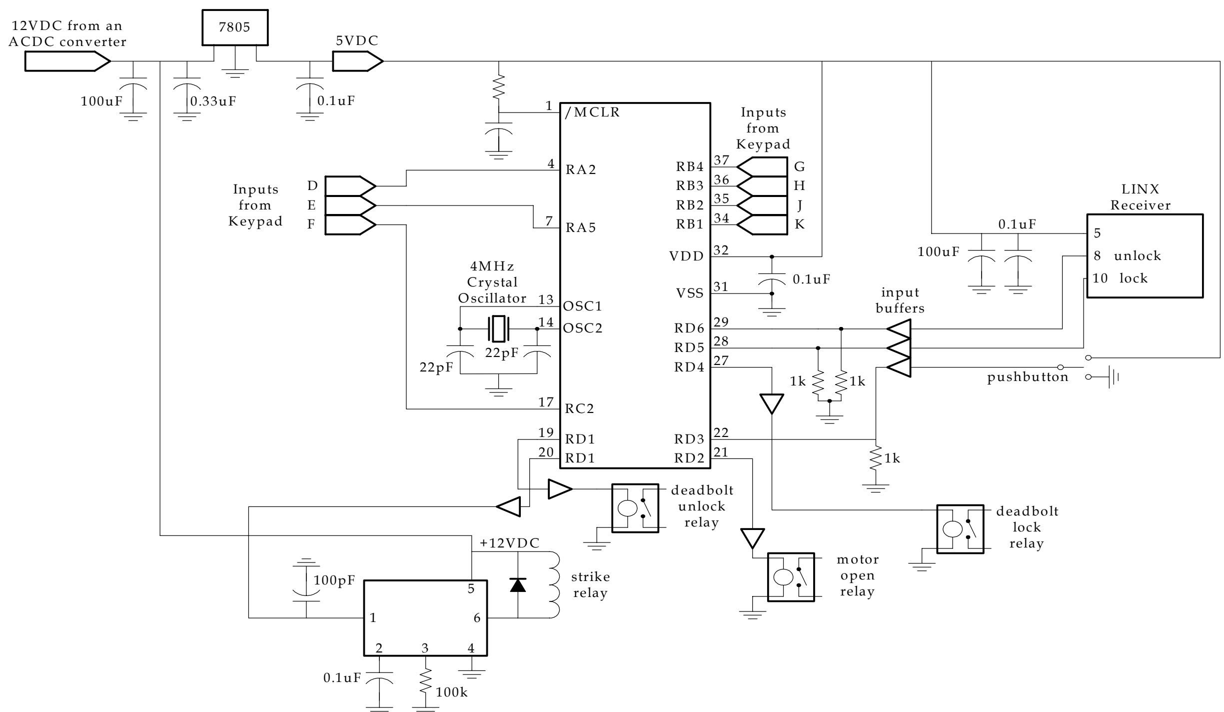

Figure 17.5. PCB Circuit Layout.

BUMP AROUND

Designers: Murtala DaSilva, David Martins
Client Coordinator: Ms. Jennifer Canavan
Supervising Professor: Professor: John D. Enderle
Biomedical Engineering
University Of Connecticut
260 Glenbrook Road, Unit 2157
Storrs, Conn. 06269-2157

INTRODUCTION

Specialized bumper cars were designed for use by children with various disabilities at a school. As a result of physical and cognitive disabilities, the children can not use bumper cars or go-carts available on the market. Teachers and therapists want the children to be exposed to sensory input involving motion, sound and sight in hope that they will have a pleasurable experience. Navigation of the newly designed vehicle is completely automated.

SUMMARY OF IMPACT

The bumper car provides the children with a form of entertainment and fun. In addition, the sound and light effects in the vehicle provide the children with a more exciting ride.

TECHNICAL DESCRIPTION

The most important design considerations concern the safety of the clients, durability of the vehicle, and versatility of operation. The bumper car is to be operated indoors in the gymnasium and it must be able to be navigated in the gymnasium. The seating is critical to the client's comfort and safety. The seat must be able to recline back because the client's spine can not support his or her weight. The seat must also offer excellent head, neck, and shoulder support. The maximum speed of the bumper car is set so that impact will not result in injury to the clients. Since the vehicles are to be operated at a school, it should not be so loud as to disturb the other classrooms.

Ultrasonic sensors were chosen for this project due to their range of detection. An ultrasonic sensor can accurately detect objects within a 10-meter distance, and it serves the purpose of distance measurement more than other forms of measurement. A Polaroid transducer and Texas Instruments sonar ranging module were used. The operation of this unit needs

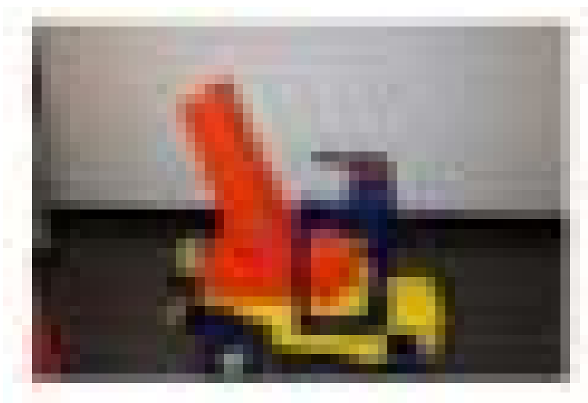

Figure 17.6. Bump Around.

to incorporate additional circuitry in order to achieve the input that is necessary for the PIC16C74B microcontroller.

The central processing unit of the autonomous vehicle is the "brains" of the vehicle. The processor receives inputs from the various sensors located around the vehicle, toggle switch, remote on or off switch, and a push-button switch. The sensors allow the processor the ability to determine the direction of the vehicle’s travel. The toggle switch is used to turn the car on or off. The remote off switch gives the instructor of the child the autonomy of shutting down the ride. The push-button switch is used to drive the car.

The motor control circuitry is responsible for taking commands from the Microcontroller and driving two permanent magnet 12 VDC motors. The entire motor control circuitry contains three circuit block diagrams. The stage-1 circuit block is made up of three components that consist of a frequency to voltage converter, a square wave comparator, and a monostable multivibrator as a frequency-divider network.

The Motor Controller Design also implements a LM 7406N IC for improved current stability, and control over the IRF 3205 N-channel MOSFETs. The upper and lower MOSFETs are in an H-Bridge circuit configuration. The upper and lower MOSFETs are designed to work together in pairs. Therefore, it is advantageous that both IRF 3205 N-channel MOSFETs be equally matched when turned on. The control over the enhancement of the N-channel of the MOSFET improves the performance of the H-Bridge circuit. The LM7406N outputs drive the N-channel MOSFETs in a high side or low-side switching applications. The main function of stage-1 circuit block is to control the DC motor speed by Pulse-Width-Modulation. The pulse width modulated signal is generated by the difference between the current sensing feedback signal from the motor, and the control voltage signal. The motor driver characteristics consist of a digital to analog interface network, current sensing, and 6 Amp max current output capability

The sound and light effects help grasp the client's curiosity and thus the child may pay more attention to the audible and visual stimuli. The voice chip module uses an ISD single-chip voice record/playback device that is often found in telephone answering machines. The actual chip is the ISD2560 (the "60" standing representing the 60-second duration of the voice signal that can be stored). There are two visual light display (LED) features and they are placed at different locations in the vehicle. The first display turns the lights on in sequence from the left and then to the right. The second display turns the lights on in sequence moving in one direction.

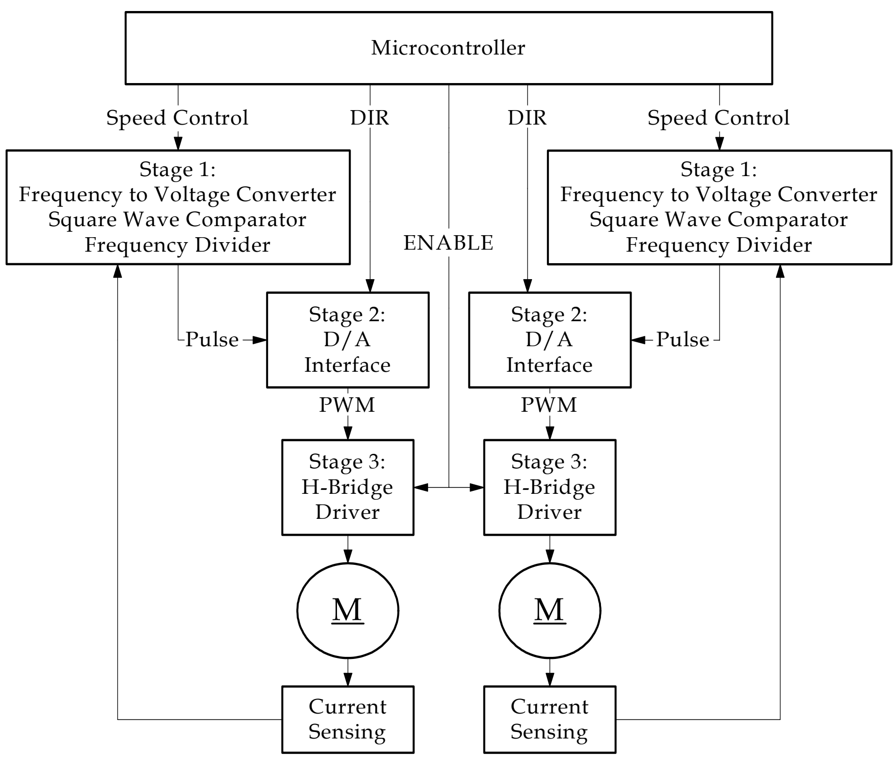

Figure 17.7. Block Diagram for Bump Around.

CHILD MOBILITY CAR

Designer: Anthony Russo
Client Coordinator: Ms. Jennifer Canavan
Supervising Professor: Dr. John Enderle
Biomedical Engineering
University Of Connecticut
260 Glenbrook Road, Unit 2157
Storrs, Conn. 06269-2157

INTRODUCTION

The purpose of this project is to aid the mobility of a six-year-old girl with cerebral palsy. She previously used a large power wheelchair. However, this wheelchair is large and bulky and severely restricts her movement within small areas. In turn, this greatly limits her ability to play with and interact with other children. The Child Mobility Car is a small, motorized vehicle that allows the girl to move about in small places such as a play area, with far greater freedom, facilitating her ability to interact with other children (Figure 17.8). Because the girl can easily manipulate a joystick, a joystick was used for direction control. The car also acts as a form of entertainment for the child.

SUMMARY OF IMPACT

The Child Mobility Car greatly increases the child's mobility within play areas. The girl possesses far greater freedom of movement in play areas, providing her the capability to play with other children to a much greater extent.

TECHNICAL DESCRIPTION

The car has three different systems: a main controller, a drive train system, and a joystick for control of direction. The car also has a total of five boards which include the control board, two H-bridges, and two small boards that assist the interfacing of the control board with the two H-bridges. The drive train consists of two DC motors, two H-bridges, and the two small interfacing boards.

The microcontroller controls all of the different systems in the car. It is inserted into a 40-pin IC socket on the control board and it is programmed in assembly language. It is a PIC16F877 microcontroller that is manufactured by Microchip Technology Inc. It possesses 33 I/O pins and this makes it simple for the microcontroller to control a number of tasks involving input or output. This microprocessor is FLASH programmable, which means it is erased by sending a voltage signal to it. The 5V for the controller is provided by a 7805 voltage regulator whose output is rated at 5V and 1A. This 7805 provides 5V to all of the components that require it. The input to this voltage regulator is 12V provided by a 12V lead-acid rechargeable battery rated at 7.0 Ah. A 4 MHz resonator is connected to the microcontroller in order to allow it to function. Two pins on the PIC output independent pulse-width-modulated (PWM) signals to each of the two H-bridges. Each H-bridge controls one of the two motors, which function independently of each other. The two motors run at 12V and are rated at 50A. The two H-bridges are designed specially for 12V motors that are to be controlled using PWM. It is almost impossible to burn these H-bridges out and the only way to do so is to short-circuit the leads to the motors. This substantially protects the drive train system.

Figure 17.8. Child Mobility Car.

The two front wheels are fixed in orientation and raised slightly above the floor, and they serve no function other than appearance. Underneath the car are two small caster wheels that replace the two front wheels. All of the steering is done through the two rear wheels. To move forward, both rear wheels turn forward. To move in reverse, both rear wheels turn in reverse. To turn right or left, one rear wheel turns in one direction and the other rear wheel in the opposite direction. To go forward and turn at the same time, both wheels rotate in the same direction but at different speeds. The same situation occurs when the car goes in reverse and turns at the same time. This steering system makes the car easily maneuverable. It is capable of turning either left or right while rotating on an axis rather than transcribing an arc.

The PWM signals are square waves of 5V amplitude with duty cycles controlling the rate of rotation of their respective rear wheels. The voltage sent to the motors is proportional to the duty cycles; the greater the voltages, the greater the speed of the motors.

The PIC microcontroller receives input from the joystick. The joystick is a switching joystick rather than one with potentiometers. It has one input and four outputs, where the input is 5V and the outputs are forward, reverse, left, and right. If an output is 5V, then the car moves in the direction to which its voltage corresponds. The car is capable of going in eight different directions: forward, reverse, left, right, forward-left, forward-right, reverse-left, and reverse-right, where the latter four directions are combinations of the first four directions. From the inputs from the joystick, the PIC determines appropriate PWM signals to send to the two H-bridges that in turn control the motors.

The PIC outputs four other signals in addition to the two PWMs. These four signals are each 5V or 0V. Each H-bridge has two pins, one to enable forward and one to enable reverse. For a given H-bridge, if the forward pin is 5V and the reverse pin is 0V, then the corresponding motor turns forward at a speed determined by the PWM. Likewise, if the forward

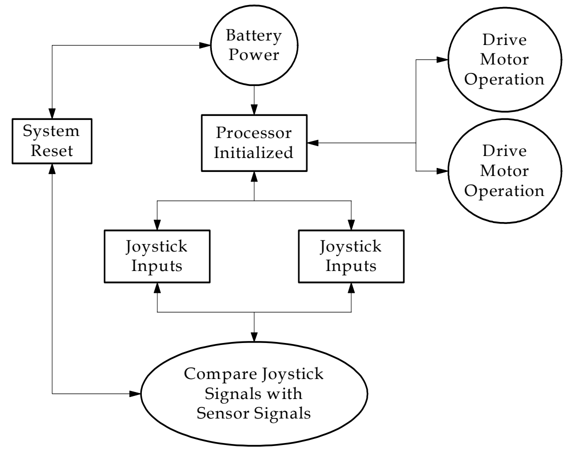

Figure 17.9. Block Diagram.

pin is 0V and the reverse pin is 5V, then the motor turns in reverse. These four signals must be sent to two small driver boards before going to the H-bridges. Each board receives one forward signal and one reverse signal for a particular motor.

The two driver boards are designed as follows. Each driver board has two 3904 bipolar junction transistors, two 330 ohm resistors, and two REED relays. These form two common-emitter amplifiers that amplify current but not voltage. The driver boards are used because the PIC cannot output signals of a high enough current to be used by the H-bridges. The common- emitter amplifiers amplify the current enough in order to activate the two relays. The relay outputs in turn are fed to the H-bridge directional control. Many of the parts of the car, including the battery, the two motors, the H-bridges, and the control board have one common ground. Many parts that require power are connected directly to the battery (Figure 17.9).

E-RACER: AN ELECTRIC GO-KART

Designers: Alex Peslak, Alex Kattamis, and Steve Ricciardelli
Client Coordinator: Dr. John Enderle
Supervising Professor: Dr. John Enderle
Biomedical Engineering
University Of Connecticut
260 Glenbrook Road, Unit 2157
Storrs, Conn. 06269-2157

INTRODUCTION

The E-Racer was designed to give a young man with cerebral palsy some independence and fun. He has limited muscular control except for in his left hand. The project entailed modifying an existing electric go-kart to be controlled through a single joystick. The project was delivered to the client upon completion.

SUMMARY OF IMPACT

The design criteria for the E-Racer were established according to the capabilities of the young man as well as his parents' input. The client enjoys racing his wheelchair, but his wheelchair has limited racing options. The main restriction is the wheelchair's lack of speed. Due to the roll-cage, special racing seat with harness, and the remote kill-switch, the E-Racer go-kart provides him the ability to drive faster and satisfy the need for safety.

TECHNICAL DESCRIPTION

The existing brake that came on the original go-kart was used. It consisted of a frictional band wrapped around a wheel disk. This band was connected to a cable, which was connected to a foot pedal. As the pedal was pressed by the driver, the cable tightened, clamping the band on the disk. The only modification to the original go-kart was the removal of the foot pedal.

A linear actuator was added to apply the new braking power. The actuator motor was attached to the roll-cage behind the driver. The cable was attached to the end of the actuator. As the actuator extended and retracted, the frictional band was loosened and tightened around the wheel disk. The actuator was controlled through limit switches, which stop the movement of the actuator arm, and through switching the polarity applied, which reversed the direction of motion of the actuator arm. This was achieved through the use of relays. These

Figure 17.10. E-Racer Go-Kart.

relays were controlled through a comparator chip that compared the location of the joystick to a preset level. When the joystick was pulled back, a signal was sent to the chip, which in turn activated the relays reversing the polarity to -12V. This retracted the actuator until it reached a limit switch, effectively applying the brake. With the joystick in the center or forward position, the joystick sent a different signal to the chip. The chip then de-activated the relays, reapplying 12V. This extended the actuator until it reached the other limit switch. This fully released the brake. The tension applied to the cable while the brake was applied, was designed to stop the go-kart the fastest while avoiding skidding. This was obtained through trial and error. The relays used had to be high power since the actuator motor could draw up to 8A at full load. An actuator with a 250lb load limit was used to assure long life and accurate braking under extreme conditions.

For safety reasons, a remote kill-switch was implemented as well. When the button on the remote was pressed, it retracted the braking actuator as well as stopping the drive motor, effectively stopping the go-kart. This was done through another relay. The relay was placed between the joystick and the comparator chip. When the button was not pressed, the joystick signal was sent through the relay to the chip. When the button was pressed, the relay switched. This cutoff the signal from the joystick and applied a signal to the chip. This signal would activate the power relays that powered the actuator. The actuator would then apply the brake.

The cost of parts/material for braking was about $300. The cost of parts/material for entire go-kart was about $2500.

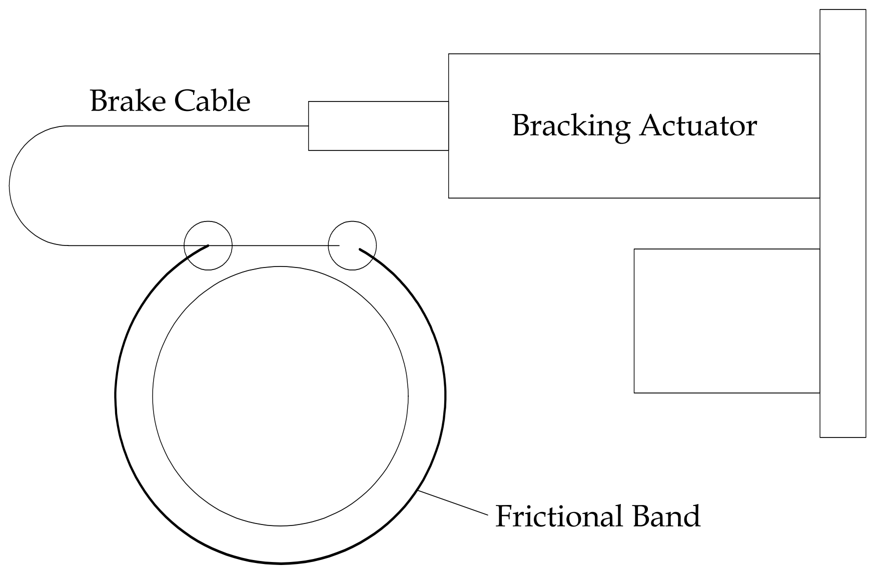

Figure 17.11. Braking Actuator.

E-RACER

Designers: Alex Kattamis, Alex Peslak, and Steve Ricciardelli
Client Coordinator: Dr. John Enderle
Supervising Professor: Dr. John Enderle
Biomedical Engineering
University Of Connecticut
260 Glenbrook Road, Unit 2157
Storrs, Conn. 06269-2157

INTRODUCTION

The E-Racer is a modified, joystick-controlled electric go-kart. (Figure 17.12) The device was built for a teenage male with cerebral palsy. This go-kart has the ability to accelerate up to 25 mph. and to safely carry the client for miles. A drag-style racing seat and 5-point restraint system keep him secure at all times and a steel roll-cage ensures his safety in the unlikely event of a roll over.

SUMMARY OF IMPACT

The go-kart was designed to be controlled by the client. It allows him to play with his friends. Until now the only equipment the client had was an electric wheel chair with a top speed of 7 mph. The device will help with the client's physical therapy, improving his motor skills especially with his left hand.

TECHNICAL DESCRIPTION

The go-kart acceleration system is based on the original electric go-kart, which was purchased from Kango Electric Go-Karts. The go-kart accelerates through a potentiometer. When 30 ohms is applied, the go-kart does not move. As the resistance is increased to 5 kilo ohms, the go-kart increases speed.

The joystick supplies 2.5V, when it is centered. As the joystick is pushed forward, the voltage increases to a maximum of 4V. The voltage is compared to a preset level. As the voltage goes above the preset level, a relay is switched on, placing a new resistor into the circuit. This increases the resistance across the driver circuit. There are four relays leading to four distinct levels of acceleration (Figure 17.13).

By closing a circuit across the original main driver solenoids, the go-kart reverses. This is accomplished by a pushbutton on the top of the joystick. The pushbuttons send a signal to a relay, closing the relevant circuit and engaging reverse drive.

Total cost of parts and material was $2,500.

Figure 17.12. Modified E-Racer.

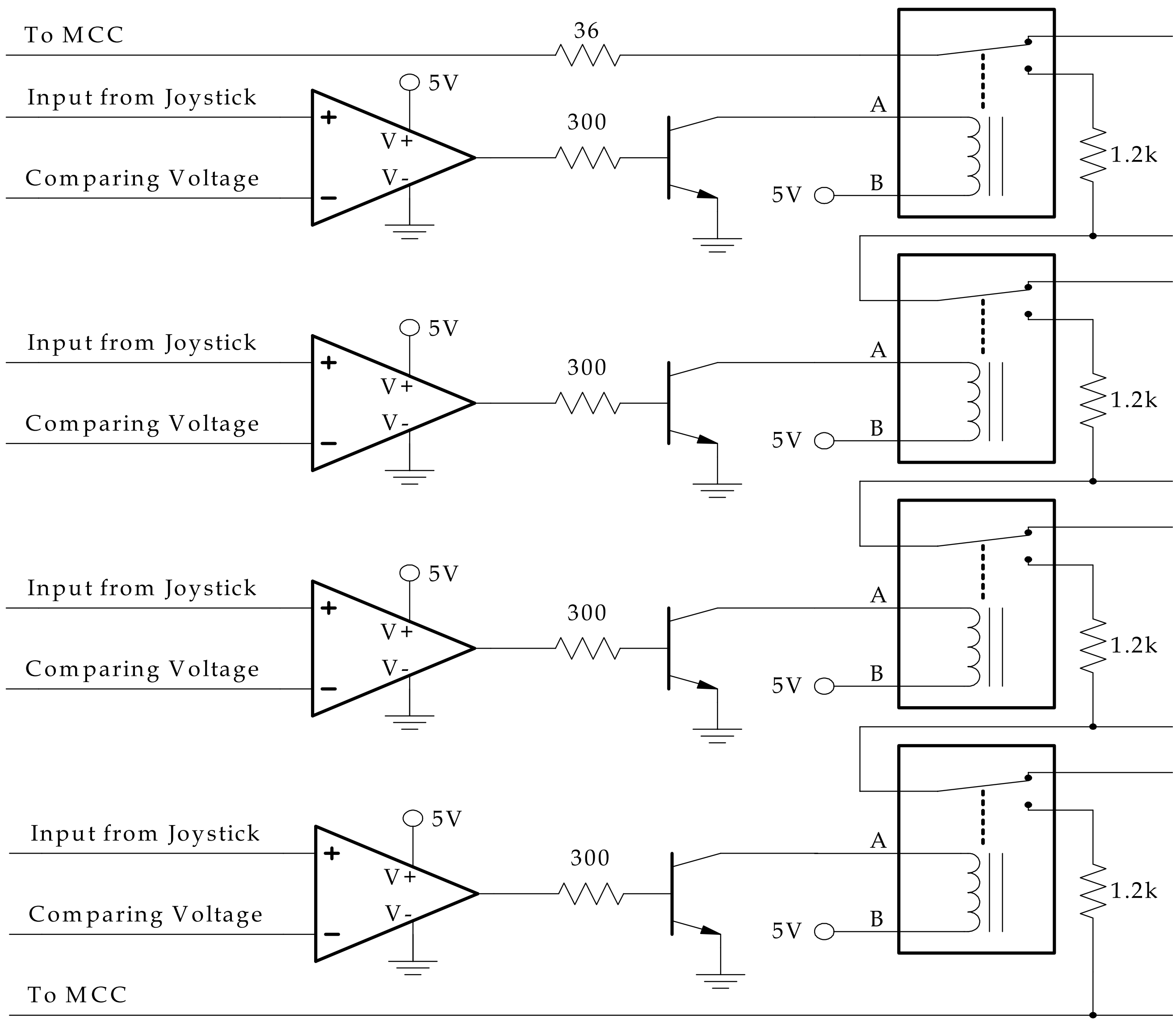

Figure 17.13. Acceleration Circuit.

GET UP AND GO

Designer: Brian A. Shannon
Supervising Professor: Dr. John Enderle
Biomedical Engineering
University Of Connecticut
260 Glenbrook Road, Unit 2157
Storrs, Conn. 06269-2157

INTRODUCTION

A powered wheelchair may enrich the life of a client with limited upper body mobility, who would like to live more independently, performing daily tasks such as clothes washing or household cleaning. The Get-Up and Go device fits the client's existing wheelchair with wheel drive motors. Fitting of a wheel drive system to her wheelchair enables her to move around a greater area without tiring. Additionally, a seat lifting mechanism elevates the client from her normal seated position and places her in a position that is near or slightly greater than what would be her standing height. This higher position allows her to perform various tasks that she would not otherwise be able to perform from a lower seated position.

SUMMARY OF IMPACT

The Get Up and Go project allows the client to perform the daily tasks that she desires without depending on others for assistance. The ability to reach for objects that were previously out of reach has greatly increased the tasks that the client can perform.

TECHNICAL DESCRIPTION

The Get Up and Go design is a modification of an existing wheelchair. It involves an added seat lift and wheel drive units. These two systems are both controlled by a single joystick. The major components in this system are the joystick, wheel drive unit, the seat lift unit, and the batteries. An overall block diagram of the system is shown in Figure 17.15.

The joystick controls both the directional movement and the seat lift functions. The directional control is accomplished by moving the joystick in the desired direction of travel. This sends a signal to the motor control, which turns the motors on. The seat lift control is accomplished by using the rocker switch on the top of the joystick. The joystick is mounted to the right armrest of the wheelchair.

Figure 17.14. Get-Up and Go.

Motor Control Unit

The motor control controls the speed and direction of the two drive motors. This is accomplished by using a microcontroller-based system. The microcontroller processes the signal from the joystick and sends a pulse width modulated signal to the driver board. The driver board then controls the power board which pulse width modulates the drive motors.

Seat Lift Unit

The seat lift control is microcontroller based. It processes the signal from the joystick rocker switch and turns the seat lift motor in the appropriate direction. Pressing the rocker switch forward lowers the seat. Pressing the rocker switch backward raises the seat (Figure 17.16).

The approximate cost for the Get-Up and Go project is $2,500.

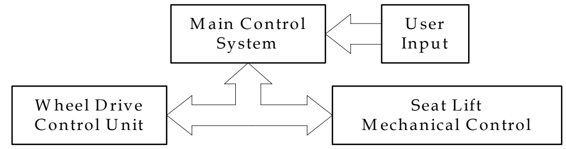

Figure 17.15. Block Diagram.

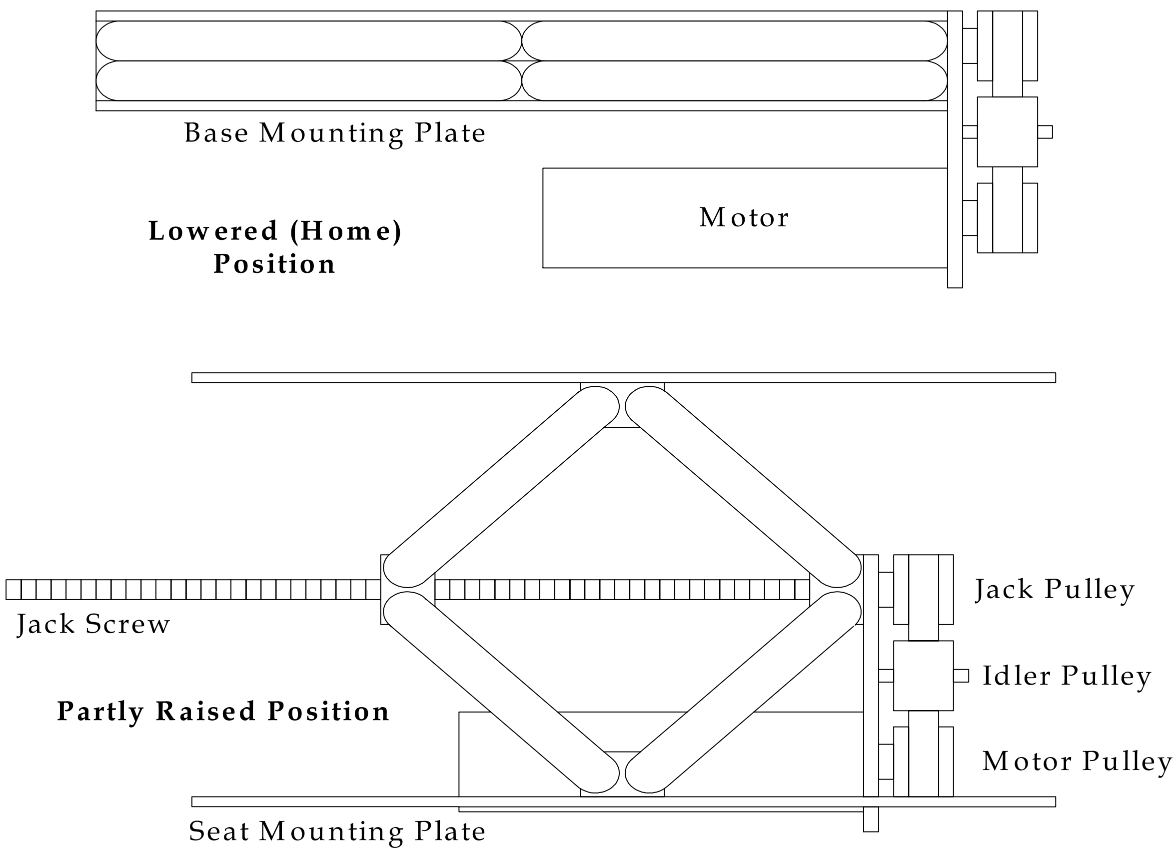

Figure 17.16. Mechanical Drawing of the Device.

LIGHTS ON/LIGHTS OFF

Designer: Jason Lewis
Client Coordinator: Barbara Dybdol
Supervising Professor: Dr. John Enderle
Biomedical Engineering
University Of Connecticut
260 Glenbrook Road, Unit 2157
Storrs, Conn. 06269-2157

INTRODUCTION

The Lights On/Lights Off device was designed to provide easy access to the lights in a client's room. The device is a module into which a lamp can be plugged. Once plugged in, the lamp can be controlled by voice commands. It also has a module that can be used for remote control purposes. This device will help a person who has an inner ear disorder. As a result of this disability, the client is unable to maneuver in the dark. She needs a device that will be able to turn on the lights before she enters the room (Figure 17.17).

SUMMARY OF IMPACT

Previously, the client had to turn on other lights in her room before she could turn on a desired desk lamp. After doing so, she had to turn off the lights she just turned on. This project will help an individual be more independent by enabling her to turn on different lights.

TECHNICAL DESCRIPTION

The most important part of this project was the voice recognition chip. This device had to be trained to recognize commands. As the chip was trained for voice recognition, it was filtered and sent to an A/D, D/A converter. This captured a voice signal and converted it from an analog signal to a digital signal. The message is sent to both a serial EEPROM and a decoder. From the decoder the message is transmitted and the lamp module is turned on or off.

The most problematic part of this project was to gain a high range of chip sensitivity to the voice commands. X10 devices are also apart of this project. They were used as backup along with a remote control, which provided a manual control for the lamps in the room. The remote control is a transmitter that sends out the X10 commands, which is then captured by the receiver. This receiver is the plug-in X10 module.

The cost for this project is about $50.

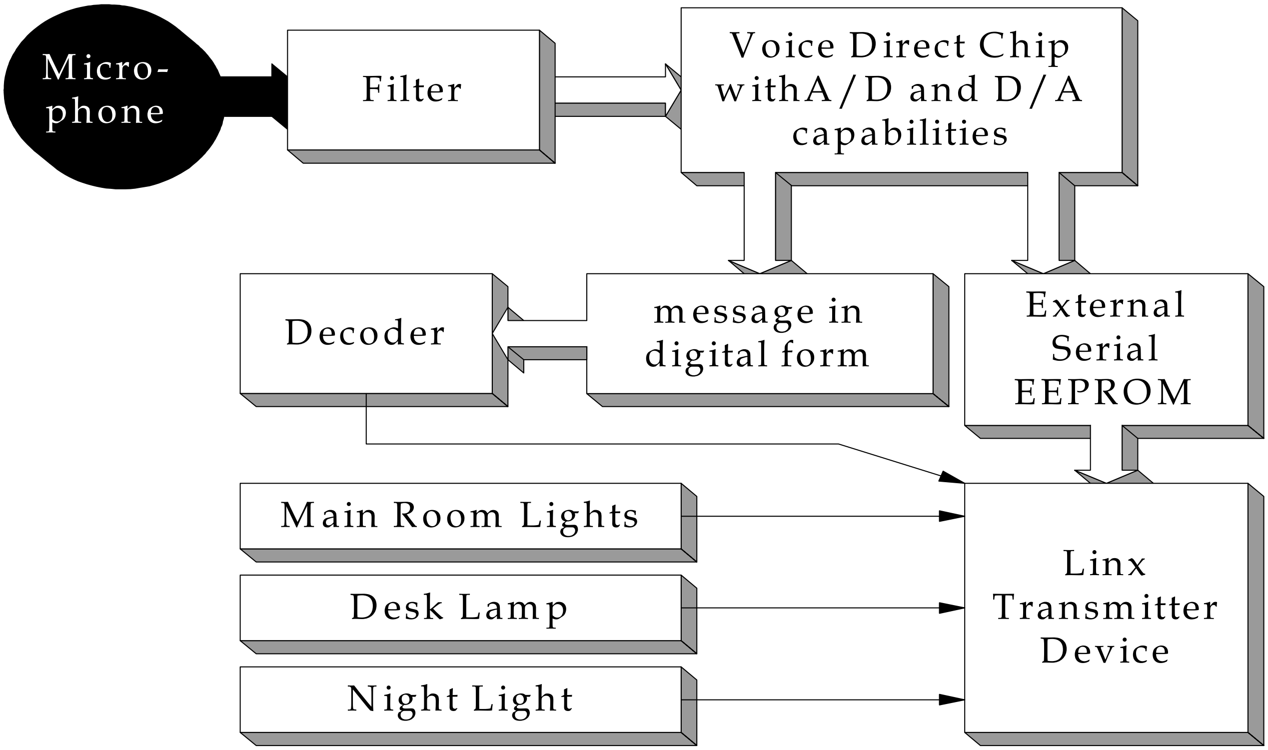

Figure 17.17. Lights On/Lights Off.

DIRECTED MOTORIZED CHAIR

Designer: Hayden Callender
Supervising Professor: Dr. John Enderle
Biomedical Engineering
University Of Connecticut
260 Glenbrook Road, Unit 2157
Storrs, Conn. 06269-2157

INTRODUCTION

The LED Directed Motorized Chair is a standard wheelchair that has been converted into a motorized wheelchair for a person with cerebral palsy. An LED display and head switch is incorporated to allow hands free control of the chair. The client has limited control of her lower body, arms and hands and requires assistance to move. The client uses voice synthesizing equipment and software to communicate, operated mainly by a switch that is activated with her head. This design has motors and a gear and pulley system mounted connected to the wheels of a standard non-motorized chair. Each wheel has microcontroller-based circuitry to allow independent movement. The microcontroller input consists of a head switch. An LED display is the visual direction indicator (Figure 17.18).

Figure 17.18. LED Directed Motorized Chair.

SUMMARY OF IMPACT

With the LED Directed Motorized Chair, the client has increased independence. No longer does the client need the help of another to move from place to place.

TECHNICAL DESCRIPTION

The main components of the LED Directed Motorized Wheelchair's motorized wheel system consist of batteries, motor circuits, the LED display/pre-motor circuit, motors, and the pulley/gear system.

Batteries

Two lead acid batteries that supply 12 volts are placed in the series. This is done because the two motors require 24 volts at 13.5 amps to run. The batteries will be mounted inside the wheel hub with the motor and other accessories. Two batteries can be recharged using a battery charger provided.

Motor Circuits

Two motor circuits are used. These circuits control the speed and direction of the motors that in turn control the direction of the wheelchair's wheels. Each individual motor circuit controls its own independent wheel. The circuits were manufactured by Diverse Electronics and are able to handle up to 30 volts and a continuous 20 amps. For the high voltage and amperage the motors require, these circuits suit the design.

Head Switch

The head switch is the only part of the system that the client will use to control the wheelchair. The head switch (in tandem with the LED display) replaces the joystick on most motorized chairs on the market. These two parts allow the client to choose the direction of the wheelchair.

LED Display/Pre-Motor Circuit

The integral part of the LED Directed Motorized Chair is the LED Display/Pre-Motor Circuit. This circuit consists of two PIC microcontrollers, an 8-channel multiplexer, a quad two input AND IC, a quad two input OR IC, 5 LED's and resistors. The LED Display circuit controls the order and time in which the LED's light up. The program lights up the LED's as follows: Forward, Right, Left, Backward. When the head switch is compressed, the chair goes in the desired direction and Stop lights up on the display. When the head switch is pressed again, the rotation continues as the wheelchair stops. The Pre-motor part of the circuit controls the direction that the motors will run. The motors spin in either a forward or reverse direction (Figure 17.19).

Motors

The two motors are rated for 12 volts at 13.5 amps and 1200 RPM. The motors control the direction the chair travels. The two motors work in tandem to go forward or backwards. When the chair turns right or left, the chair acts as an army tank in that one wheel pivots as the other rotates.

Pulley/Gear and Hub System

Due to the high speed (RPMs) of the motors, a dynamic system was created. This was done by incorporating a system using both pulleys and gears. This requires a ratio of 25 to 1 from the motor to the wheel to produce 5 mph. The primary part of the system implements two gears. The first gear of 1.0 in. diametric pitch is connected to the shaft of the motor. The second part is a gear of 6.0 in. diametric pitch which connects to the first gear and is held by a gear stand. The secondary part of the system implements two pulleys. The first pulley of diameter 1.0 in. is welded to the 6.0 in. gear. The pulley connects to the hub of wheel via a 4.2 in. diameter pulley welded onto the inner hub of wheelchair's wheels. When the pulley/gear System connects the motor to the hub of the wheel, a speed of less than 5 mph is attained.

The total cost of the LED Directed Motorized Chair is $1000.

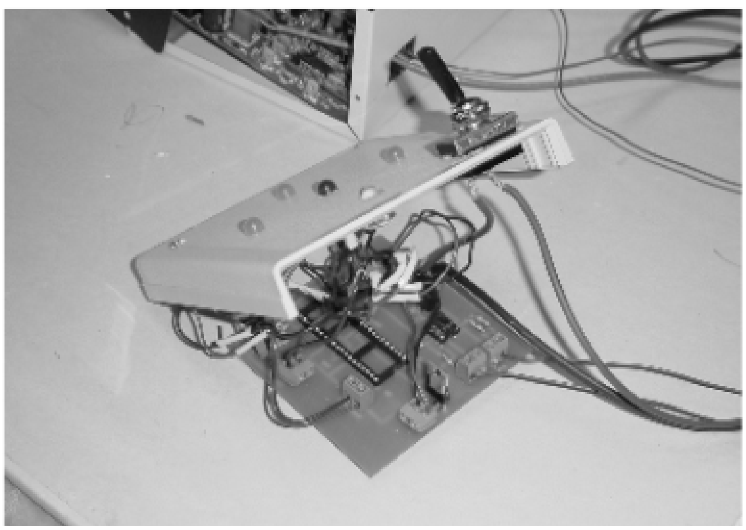

Figure 17.19. LED Display and Circuit.

RISE AND SHINE

Designers: Harold Haugland, Michael Lindstrom, Michael Melinosky
Client Coordinator: Dr. Brooke Hallowell
Supervising Professor: Dr. John Enderle
Biomedical Engineering
University Of Connecticut
260 Glenbrook Road, Unit 2157
Storrs, Conn. 06269-2157

INTRODUCTION

As a result of cerebral palsy condition, an 11-year-old child has decreased strength in his legs and depends on a wheelchair. He needs help with bathing and toileting at all times. Due to his age, the client wants more privacy. The new device allows him to move from his wheelchair to the toilet, bathtub, bed, and back again by himself.

The device is based off of a Hoyer lift design with a few modifications. This device aims to replace the usually needed health care assistant. Instead of using a person to move the device, a remote control is operated by the user. If the user wants to use the device, he simply steer it over to himself via remote control and puts on the harness.

The remote controlled Hoyer lift is quite different than the ones currently on the market today. Two of the distinguishing features are the ability to rotate the mast and the ability to increase the width of the base. Standard lifts have a fixed mast and the whole unit is pushed to the desired patient location. With the current design, the user does not need to be close to the desired location. He can widen the base (from the 28 inches needed to get through a doorway to about 60 inches). He can then rotate the mast and move where he wants.

SUMMARY OF IMPACT

This project will allow the client to move from his wheelchair to his bed or bathroom without assistance from another person. He will not have to rely on a health care worker to be there every time he needs to get up in the morning and perform tasks of daily living.

TECHNICAL DESCRIPTION

Given the client's needs, it was determined that a Hoyer lift would be the best place to start the design. Since Hoyer lifts are quite expensive, a similar, but les expensive product was modified. Car engine lifts serve a very similar purpose to the Hoyer lifts with the added bonus that they are built of tubular steel and are rigid. To provide forward motion to the device, two 1/10 horsepower motors were used. If the device were inputted to move forward, then both motors would rotate in the same direction. Similarly, turning is accomplished by rotating the motors in opposite directions from each other. Rotation is accomplished by mounting the mast of the device on a large chain driven sprocket. The sprocket was mounted on a cylindrical steel shaft supported by two bearings. The two stabilizer legs were mounted parallel to the lift's legs, and they are spread out and taken in by linear actuators. A winch replaced the original hydraulic pump used to lift the boom.

The user operates the device via remote control. The remote control has four pushbuttons and a selector switch. The selector switch allows the device to be focused on one particular task while the pushbuttons allow for operation within a task. The three tasks are motion (forward, back and turn), stabilizer leg control (legs out and in), and winch and boom control (move the winch up and down and rotate the mast). For example, if the user wishes to make the device move forward, he must put the remote control into the motion position and then he can make each motor move forward and backwards. The user will not, however, be permitted to rotate the mast or move the legs due to safety precautions.

The remote control contains a Basic Stamp 1 (BS1) continuously monitoring the buttons. If there is no button pressed, the BS1 will serially output an ASCII character. Each button has a character associated with it so that if it is pressed, a different character is transmitted. This serial data is sent to a Linx RM series transmitter operating on the 433 megahertz band. This data is received on the device via Linx receiver and is analyzed by a Basic Stamp 2SX (BS2).

The BS2 looks at the incoming data and waits until two of the same character are received. It then turns an output pin high which activates a transistor wired to a DPST relay. The relay takes care of the higher current needed to operate the motors of the devices (Figure 17.20).

The device costs approximately $3500.

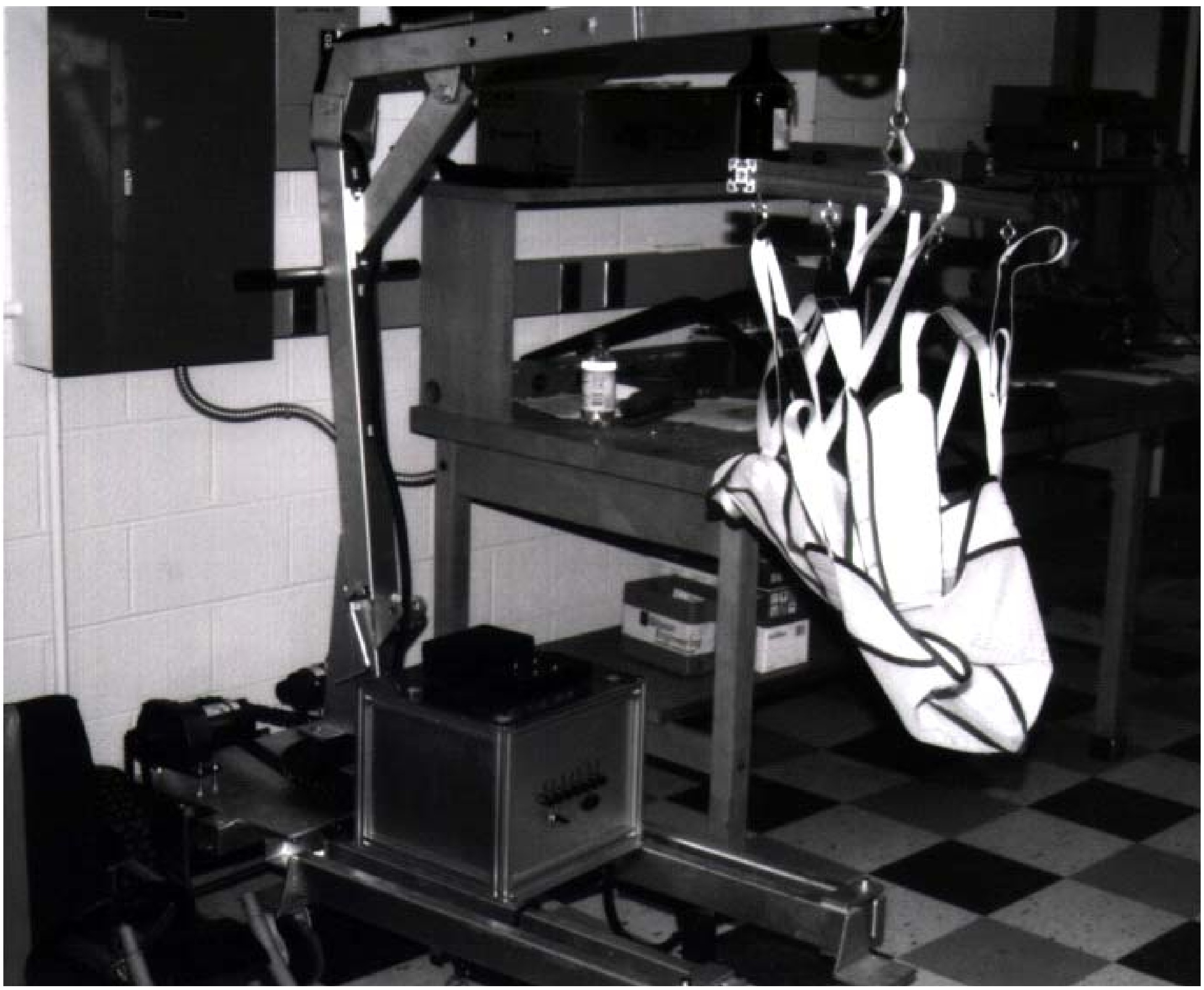

Figure 17.20. Completed Device.

TELESCOPIC OBJECT RETRIEVER

Designer: David Pham
Client Coordinator: Ellen Fultz and Dr. Brooke Hallowell, Athens, Ohio
Supervising Professor: Dr. John Enderle
Biomedical Engineering
University Of Connecticut
260 Glenbrook Road, Unit 2157
Storrs, Conn. 06269-2157

INTRODUCTION

Wheelchair Assist Devices was designed to meet the specific needs of a child with cerebral palsy by equipping his wheelchair with a variety of useful devices. One such device is the Telescopic Object Retriever (TOR). The TOR is a power extension arm that allows an individual in a wheelchair to pick up objects that lie outside his immediate reach. The TOR has a maximum reach of 4.5 feet and it can be reduced to a compact length of 1.8 feet. A motorized grip at the end of the arm is used to grasp the object.

SUMMARY OF IMPACT

From his wheelchair, the client is at a distinct disadvantage when reaching for anything outside of arm's length. Consequently, the client is dependent on the help of others when encountering obstacles of this nature. The Telescopic Object Retriever will provide the client with the means to be more independent in this area of his life.

TECHNICAL DESCRIPTION

In order to make the TOR extendable and retractable, the arm consists of four interlocking, spring-loaded cylinders. There is a steel cable that runs inside the cylinders.

The cable originates from a reel at the base of the largest diameter cylinder and is connected to the base of the smallest diameter cylinder. A 26-oz. 24VDC motor is used to rotate the reel. Once the motor stops moving, the position of the reel is held in place by gears.

A motorized grip is affixed to the end of the arm. A 9-oz. 24VDC motor is used to open and close the grip. The shaft of the motor is screwed to a worm gear. The worm gear is aligned with a second gear,

Figure 17.21. Telescopic Object Retriever.

which is in turn connected to a long screw. Rotation of this long screw is what opens and closes the grip.

The TOR is able to angle downward at an angle of about 56 degrees and upward at an angle of 18 degrees by hinging one end of the largest diameter cylinder and connecting the other end of the cylinder to a small linear actuator. There are three control circuits that are used to drive the three motors of the TOR (Figure 17.22 and Figure 17.23).

In addition to allowing the user to change the direction of the motor, the design prevents the motor from exceeding its full load condition. When the motor reaches its full load condition, the circuit initiates dynamic braking, which brings the motor to an abrupt halt and reduces the current to zero. This feature eliminates the using of fuses to prevent the motors from overloading.

There is one limit switch in the TOR. Once the arm is fully extended, the reel must stop unwinding. Failure to do so will cause the arm to retract since the unwound cable will be drawn back in, this time in the opposite direction. The limit switch assures that once the arm is fully extended, the forward signal is interrupted thus causing the reel to stop turning.

The cost of parts and material is $3800.

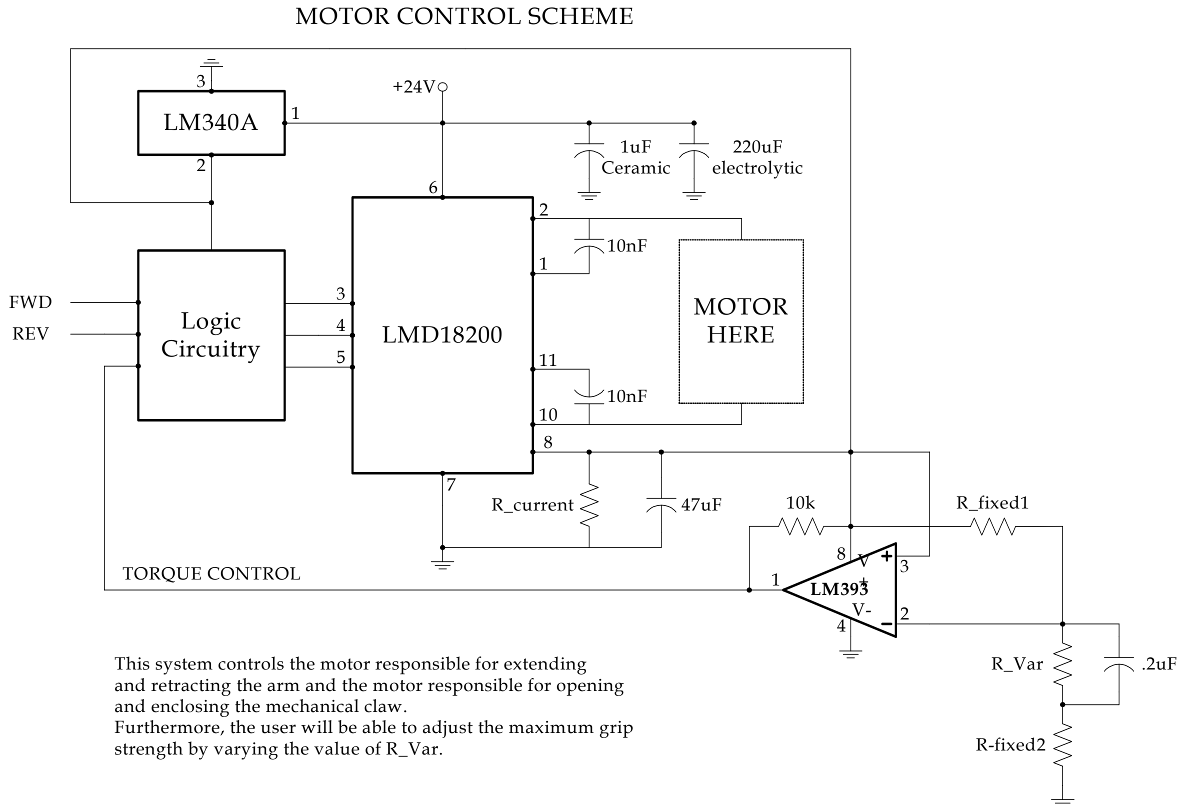

Figure 17.22. Control and Driver Circuit

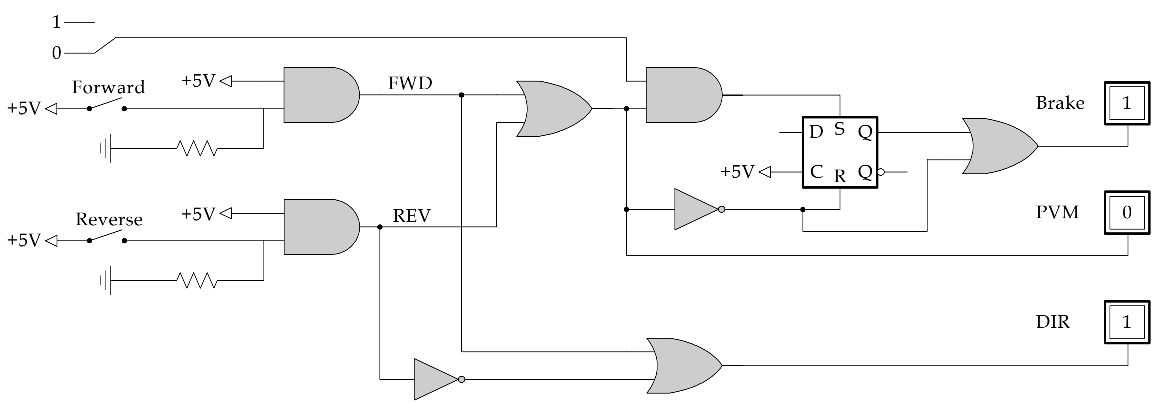

Figure 17.23. Logic Circuitry to Control LMD18200 H-Bridge

AUTOMATIC DOOR OPENER

Designer: Amol Jain
Client Coordinator: Ellen Fultz and Dr. Brooke Hallowell, Athens, Ohio
Supervising Professor: Dr. John Enderle
Biomedical Engineering
University Of Connecticut
260 Glenbrook Road, Unit 2157
Storrs, Conn. 06269-2157

INTRODUCTION

The Automatic Door Opener automates the process opening and closing of a front door. A child with cerebral palsy is unable to open and close the front door of his home. This problem was solved in two parts: first, the door opens (and closes) and unlocks (and locks) using motors. Second, the only feasible method by which this child could control these motors is via remote control. A keypad and a pushbutton are also integrated to allow the rest of the family to use this system. A microcontroller is at the heart of this system; it receives the requests to open the door, and activates the circuits that drive the motors. There are no other automatic door openers similar to this project (Figure 17.24).

Figure 17.24. Automatic Door Opener.

SUMMARY OF IMPACT

The project will provide the child some independence in his daily routine; he can now open and close the front door by simply pressing a button on his remote control.

TECHNICAL DESCRIPTION

In the input control circuits for the keypad/pushbutton and the remote control, (Figure 17.24 and Figure 17.25) when the keypad's or the remote control's buttons are pressed, then the output to the microcontroller goes LOW (normally the output to the PIC is HIGH). The microcontroller senses this change from HIGH to LOW, and starts the program. First, it activates the solenoids motors that will unlock the door; the output control circuit 6ses LMD18200 current driver.

Next to open the door, a relay control circuit activates the door motor (Figures 17.26, 17.27, and 17.28). When the microcontroller supplies +5 V, the transistor saturates and turns on the relay.

The total cost of this project was $1350.

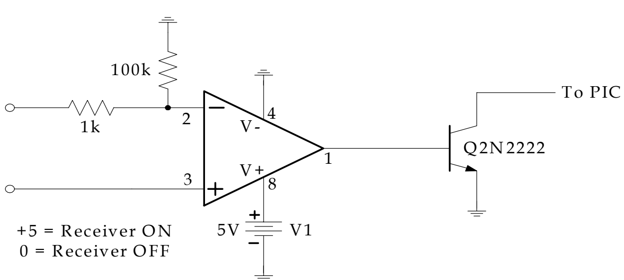

Figure 17.25. Input Control Circuit.

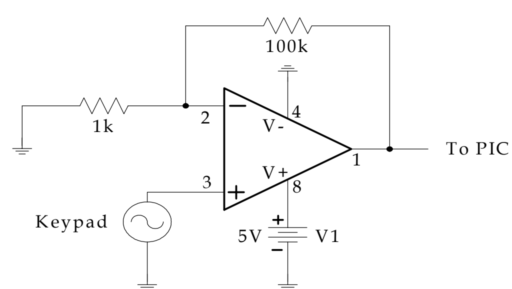

Figure 17.26. Keypad circuit.

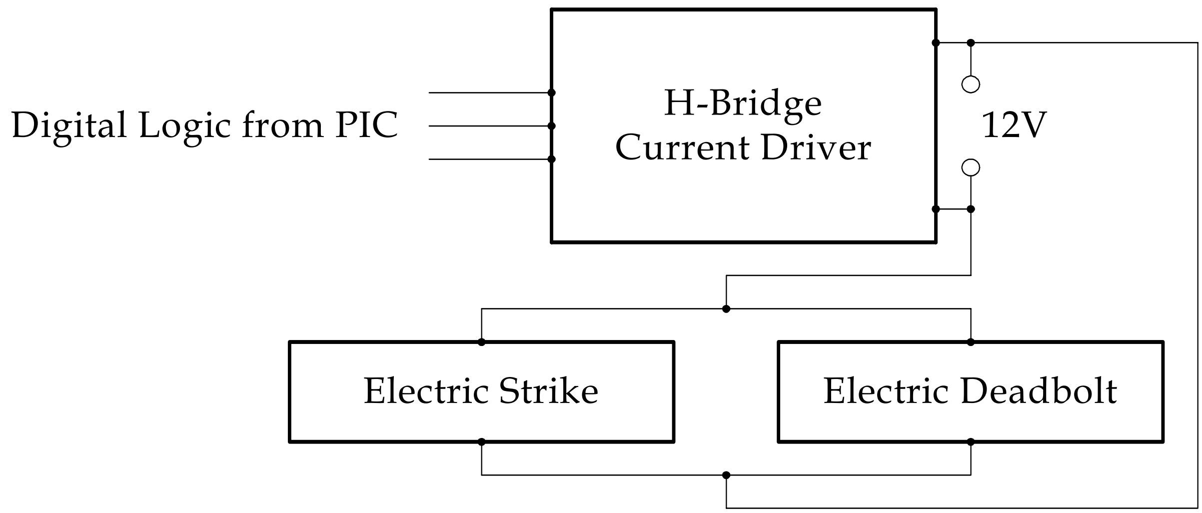

Figure 17.27. Block Diagram.

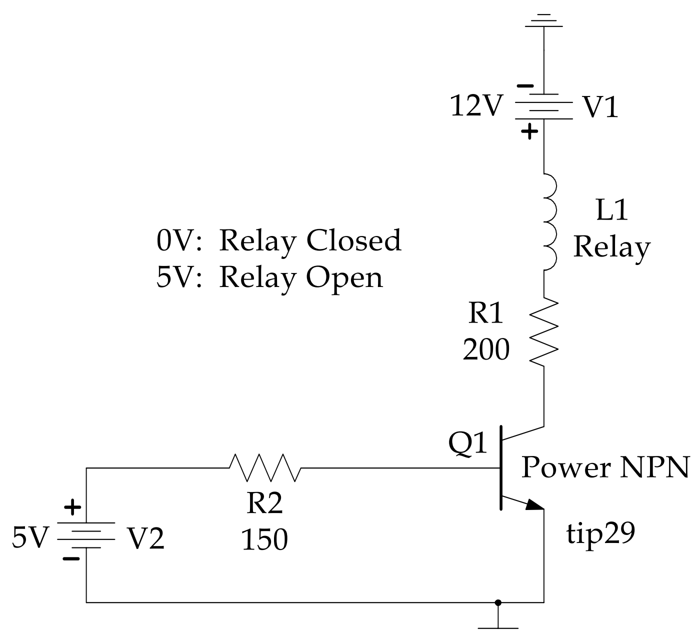

Figure 17.28. Door Relay Circuit.

VERTICAL MOTION FOR THE OBJECT RETRIEVER

Designer: Sergio Chanchavac
Client Coordinator: Ellen Fultz and Dr. Brooke Hallowell, Athens, Ohio
Supervising Professor: Dr. John Enderle
Biomedical Engineering
University Of Connecticut
260 Glenbrook Road, Unit 2157
Storrs, Conn. 06269-2157

INTRODUCTION:

The Vertical Motion for the Object Retriever system was designed to work along with a mechanical object retriever to help a child with cerebral palsy reach objects from his wheelchair. The system uses a linear actuator to move up and down in a vertical motion. The object retriever is operated electronically (Figure 17.29). The linear actuator is attached to the object retriever which is supported by the wheelchair. This approach is different from existing inventions, such as pure mechanical methods for the vertical motion of a mechanical arm. These available methods require a great deal of strength by the user to operate. Instead, this design is electronically controlled by the user with the push of a switch.

SUMMARY OF IMPACT

The client simply pushes a switch to operate the object retriever in the up and down motion. The client can reach higher objects than the level of his wheelchair, such as a cereal box on a kitchen counter or a glass in the middle of a table. As a result, the client can reach higher objects without the need for someone to do it for him, enhancing his independence.

TECHNICAL DESCRIPTION

The design uses an H-Bridge from Diverse Electronic Services Company. This H-Bridge is the MC6 – 24/12 which is capable of delivering up to 30 amps; however, in this design only 7.5 amps are required by the (12VDC, 250 lbs, 8" stoke) linear actuator from Thomson Saginaw. Such current is more than enough to lift the object retriever and at the same time to support it with a 4lb load.

The actual up and down motion of the linear actuator is controlled by a double pole single throw switch. This is a pushing switch that when not activated goes back to the off position.

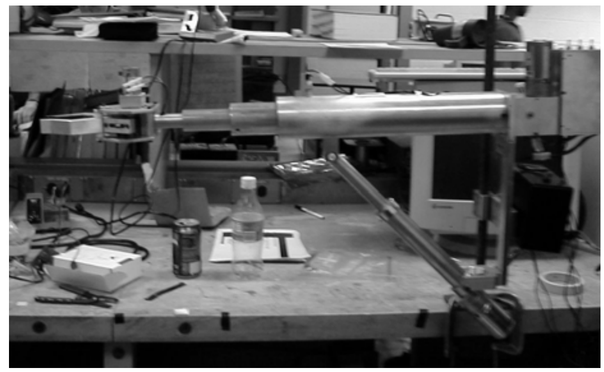

FIGURE 17.29. Object Retriever with Linear Actuator for Vertical Motion.

A linear actuator was picked for this design because there is no need to control the speed of the vertical motion. However, the speed of the actuator can be set by a potentiometer that controls the current in the H-bridge. At 4.7 kilo ohms, it allows the actuator to move at a constant speed of 8 in per 12 seconds. Also, this actuator has its own breaking system so that when it reaches its full extension it stops, ensuring safety of the motor.

Aside from the MC – 6 H-Bride, this circuitry uses a 24/12 VDC adjustable voltage regulator (Figure 17.30) rated at 7.5 amps. This regulator is required to bring down the voltage from 24 VDC to 12 VDC of the wheelchair's battery. In addition, a 7.5 amp fuse is used to prevent the voltage regulator from burning.

The cost of parts and material was about $320.

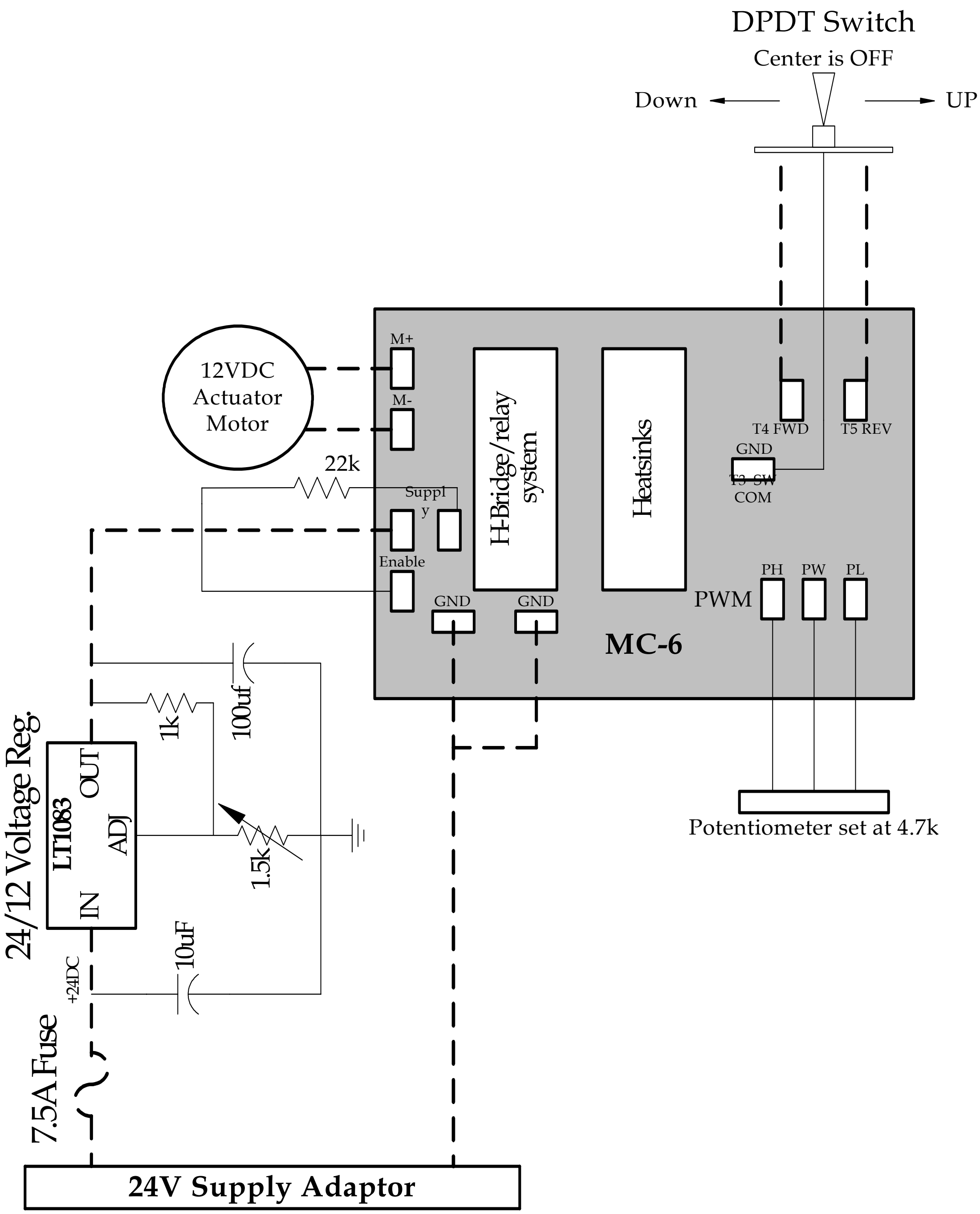

Figure 17.30. Vertical Motion Circuitry for Linear Actuator.

ELECTRONIC DOOR OPENER

Designer: Vincent J. Berkun
Client Coordinator: Dr. Brooke Hallowell, Ohio University
Supervising Professor: Dr. John Enderle
Biomedical Engineering
University Of Connecticut
260 Glenbrook Road, Unit 2157
Storrs, Conn. 06269-2157

INTRODUCTION

The Electronic Door Opener is part of a group of three modules designed to facilitate independence for a client with quadriplegia who spends much of his time in a wheelchair. Going in and out of his house can become a burden because the client has limited mobility. The electronic door opener solves this problem by automatically opening the front door of the client's house at the push of a button on a remote control or by a keypad. The door opener will also allow the client to leave the house by pushing a large button or by the remote control. An electric strike and an electric deadbolt work in conjunction with the door opener. These unlock when the trigger events happen to allow the door to open. The whole project is controlled with a microcontroller that runs assembly code. A brief flowchart is included to show the operation of the project (Figure 17.31).

STATEMENT OF IMPACT

The client has trouble with conventional door handles, which makes coming in and out difficult. The door opener solves this problem.

TECHNICAL DESCRIPTION

The main feature of the door opener is that it has a remote control that is bundled as part of another project. The remote control works up to approximately 20 feet. There is also a keypad that is attached outside the door of the house. The keypad takes a four digit password consisting of the numbers one through nine. The code is them followed by the '*' symbol. After a correct code is entered, the door will open. To enter a new code, a correct code must first be entered and then the '*' symbol. Then the new code is entered followed by the '#' symbol. The new code will then be stored. The client can also open the door from inside the house by pushing a large indoor button.

All of this is controlled by a Microchip PIC16F877 microcontroller. It is a 40-pin microchip that runs at 4 kilohertz. The code has several sections. One section scans the keypad, which is a 3X4 matrix. Each row and column of the keypad is connected to the PIC. It puts power on one row, and then it looks to see if a column goes high. If the code knows the row and the column, then the code can figure out which button was pushed. Another section poles the

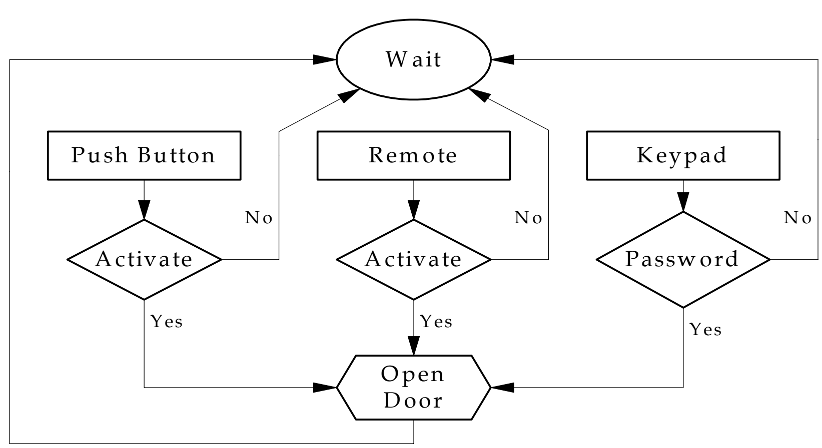

Figure 17.31. Flowchart from Door Opening System.

push button's input to see if it was pushed. If it does find that the input was high, it waits and sees if the input is still high. If it is not still high, it resets the waiting sequence. If it is still high, it carries out the opening sequence. Thus, the button is de-bounced with code. Another section of code stores and retrieves the password from EEPROM. This allows the password to be retained in case of a power failure.

The main circuit board, another supporting circuit board, and the receiver for the remote, were all fabricated and designed in house. The relay board is a group of three relays and driver circuits that is triggered by the PIC. When a trigger event happens, the PIC sends the correct pins high. These pins turn on three parallel NPN transistors (one for each relay). The emitter of the transistor goes to a ground state and is also tied to one side of the coil of a relay. The other side of the relay is tied to +12V. When this happens, the relay is tripped and 12V can go to the electric strike and deadbolt. The other relay shorts two wires that are tied to two pins of the Stanley Magic Access door opener.

The boards are mounted in a fiberglass 12X12' fiberglass enclosure. The project runs off of standard house 120VAC and comes with an external un-interruptible power supply. The leads for the electric deadbolt and electric strike can source 12V at 900 mA and are fused with 1A fuses (Figure 17.32).

Figure 17.32. Project and Demonstration Door.

BACKPACK RETRIEVER

Designer: Jorge Perez
Client Coordinator: Dr. Brooke Hallowell, Ohio University
Supervising Professor: Dr. John Enderle
Biomedical Engineering
University Of Connecticut
260 Glenbrook Road, Unit 2157
Storrs, Conn. 06269-2157

INTRODUCTION

Currently, a client relies on assistance from others to access his school materials, which are placed on the back handles of his motorized wheelchair. The backpack retriever is designed to enable the client access to his school materials without the assistance of others. The backpack retriever consists of a book bag attached to a motorized-arm, and a custom designed mounting bracket. The arm is mounted on the back of the wheelchair (Figure 17.33). The arm will swing from the back of the client's wheelchair to the side of the wheelchair making the materials carried in the book bag accessible for the client. The client, via a wired remote control, easily operates the backpack retriever bringing the book bag to the side of the wheelchair for access to his materials or to the back for the carrying position.

SUMMARY OF IMPACT

Due to a tragic accident at the age of 19, the client has quadriplegia and relies on the assistance of others to accomplish common and routine tasks. The design of the backpack retriever was intended to provide the client with enhanced independence. Therefore, self-operation of the module by the client is the most important factor considered in the design of the backpack retriever module.

TECHNICAL DESCRIPTION

The backpack retriever is designed to address the needs of a specific client. This module is designed to mount on the back of the Lancer 2000, Everest and Jennings motorized wheelchairs. The module is mounted to the frame, on the back left-pole of the wheelchair, using a custom designed bracket. The back left-pole on the frame of the wheelchair is compressed between two support plates using wing nuts and steel bolts that run through these two plates.

The backpack retriever module mainly consists of three parts: the custom designed mounting bracket, an L shaped arm, and a modified book bag that

Figure 17.33. Backpack Retriever.

slides easily in and out of the L shaped arm. The L shaped arm is attached to the shaft of a 24Volt DC motor. This motor rotates the arm making the book bag travel through a 270° motion accessible to the client. (Figure 17.34)

The client can operate the backpack retriever module through a wired remote control. The client can bring the book bag to an accessible position by pressing the button labeled "Backpack" in the remote control. Pressing this button once more will move the book bag to the carry position, in the back of the wheelchair. The motion and positioning of the backpack retriever is accomplished with the use of a microcontroller, a motor driver circuit, and position sensors. The position sensors provide the microcontroller with information on the position of the module, either in the back of the wheelchair or in the side of the chair. The microcontroller provides the direction and the Pulse Wave Modulation (PWM) required to drive the motor through the motor driver circuit.

To ensure that the module is capable of moving and carrying 25 pounds of book bag loads, one inch steel tubing is used to create the backpack retriever arm.

The cost of the project was $785.

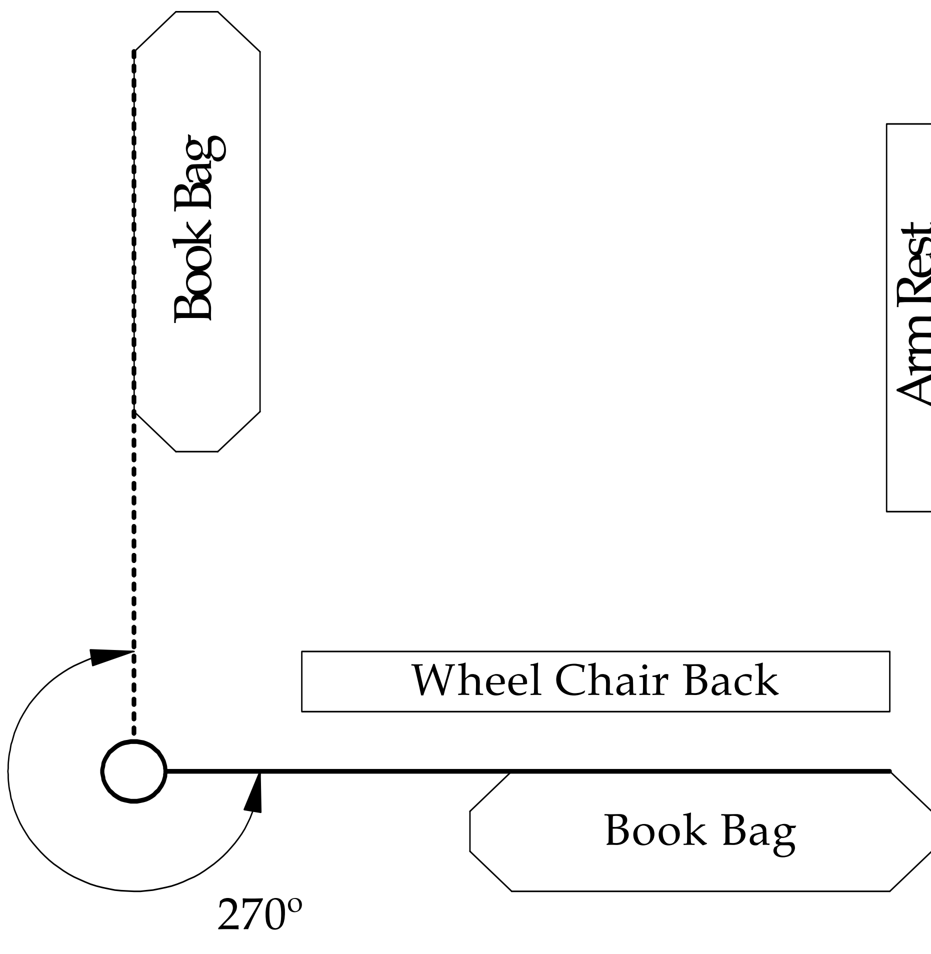

Figure 17.34. Backpack Retriever Arm Movement.

TRAY PLACER

Designer: Javier Santiago
Client Coordinator: Dr. Brooke Hallowell, Ohio University
Supervising Professor: Dr. John Enderle
Biomedical Engineering
University Of Connecticut
260 Glenbrook Road, Unit 2157
Storrs, Conn. 06269-2157

INTRODUCTION

The Electronic Tray Placer places a surface in front of a client seated in an electric wheelchair. Once the tray is in place, the client elevates the angle of the tray to his liking, up to 20°. Currently, the client relies on assistance from others to place and remove a tray from his wheelchair. This tray is non-portable. The Tray Placer is designed to provide the client with a surface that is removable. Wheelchair size prevents the client's access to any table or desk. The tray is mounted on the right side of the wheelchair (Figure 17.35). The arm rotates 180°, swinging from the 'Store' position to the 'Upright' position. The client then manually lowers the tray placing it in the 'Ready For Use' (Figure 17.36). The angle of the tray surface is now ready for adjustment. Tray Placer control is accomplished via a wired remote control.

SUMMARY OF IMPACT

Due to the disabilities resulting from a tragic accident, the client relies constantly on the assistance of others to accomplish common and routine tasks. The design of the Tray Placer provides the client with a higher degree of independence. Therefore, operation of the module by the client is the most important factor in the design of the Tray Placer module.

TECHNICAL DESCRIPTION

The Tray Placer is designed to address the needs of a specific client. However, this module may be used with other motorized wheelchairs. The module is mounted to the frame, under the right armrest. It is fastened by a horseshoe clamp and bolts. The Tray Placer module consists of three parts: the custom designed tray, the 24Volt DC motor, and the circuitry.

The client operates the Tray Placer module through a wired remote control. The client can bring the tray to an accessible position by pressing the button labeled "Tray" on the remote control. Once the tray is accessible, the client lowers the tray into the 'Ready For Use' position (Figure 17.35). Adjusting the angle of the tray is accomplished through the use of a linear actuator. Pressing the "Up" button on the controller increases the tray angle while pressing "Down" decreases the tray angle. The linear actuator

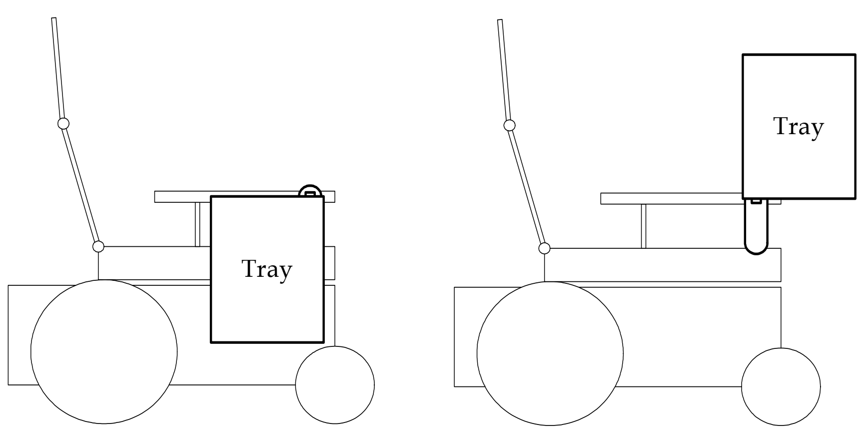

Figure 17.35. a) Tray Placer in Store Position, b) Tray Placer in Upright Position.

has built in limit switches to prevent the device from over- extension or retraction. Pressing the "Tray" button once more will move the tray to the store position, on the right side of the wheelchair. However, the tray will not try to return to the 'Store' position if the tray is currently in the 'Ready For Use' position. This is intentionally done to prevent damage to the module.

All positions and direction of motion of the module are determined through limit switches, which electrically feed signals directly to a microcontroller. The motion of the Tray Placer is accomplished with the use of the microcontroller, a motor driver circuit, and position sensors. The microcontroller provides the direction and the Pulse Wave Modulation (PWM) required to drive the motor through the motor driver circuit.

The cost of this project was $525.

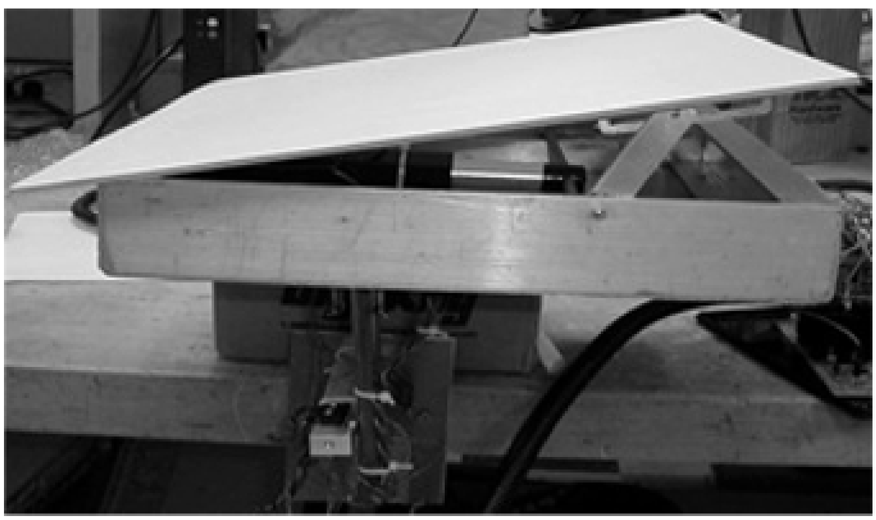

Figure 17.36. Tray Placer.

FRONT WHEELS MAGIC

Designer: Saed Elahmad
Client Coordinator: Heather Harrison
Supervising Professor: Dr. John Enderle
Biomedical Engineering
University Of Connecticut
260 Glenbrook Road, Unit 2157
Storrs, Conn. 06269-2157

INTRODUCTION

The aim of the project was to design a device that allows a patient with reflex sympathetic dystrophy syndrome (RSDS) to adjust the front wheels of her wheelchair easily, with no need to move her body, while minimizing vibrations. The device (Figure 17.37) is affordable and comfortable. It is removable in order to not affect any other parts of the wheelchair.

SUMMARY OF IMPACT

This project is designed to help a specific individual control the front wheels of their wheelchair without the need of any extra strength or external aid.

TECHNICAL DESCRIPTION

Many factors are considered in the design such as weight, material consideration, user friendliness, and cost.

The device is composed of two similar components, each of which includes three major parts: the linear actuator, the toggle switch, and the mechanical assembly (including a cylinder and handle).

There is one mechanical assembly for each individual front wheel. This device functions by using the toggle switch as the signal generator This device is designed to help the client adjust her front wheels when they get locked in a 0/180 degrees. A simple touch switch by the client allows +12 volts to go through the linear actuator pushing the wheels inside. By touching the switch again, an opposite voltage will go through, forcing the linear actuator to pull the wheels to the outside.

The total cost of this device is approximately $330.

Figure 17.37. Front Wheel Controller Attached to the Wheelchair.