CHAPTER 8
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LOW-COST SCIENTIFIC CALCULATOR WITH VOICE OUTPUT

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INTRODUCTION

The talking calculator was designed as an economical alternative to commercially available calculators that incorporate voice output features. To make this option as affordable as possible, available technology was modified to include voice output capabilities. The linking capabilities of many current scientific calculators allow programs and other information to be transferred from calculator to calculator and from device to calculator. By having a user interface that prompts the user for a mathematical expression, the link port of a CASIO cfx-9586G is then utilized to send that information to a BASIC Stamp II microprocessor. The microprocessor sorts and transfers the data to an ISD 1000A voice chip that plays the information corresponding to the mathematical expression. Headphones could be connected to the output of the voice chip to produce the final audio output.

SUMMARY OF IMPACT

Sight is a sense many people take for granted, but for those with visual impairments, it is a consideration in everyday tasks. Individuals with visual impairments may choose to go into most any discipline or career, and they usually are able to find ways to deal with their own limitations. In some disciplines, such as engineering or mathematics, a sight-impaired person could be at a disadvantage by not being able to use scientific graphing calculators. Recently, these tools have become widely used in high school level math and science through college level physics and engineering classrooms. By designing a scientific calculator with a voice output, individuals with visual impairments who need verbal reinforcement for visual stimuli would not be handicapped by their impairment.

TECHNICAL DESCRIPTION

A scientific calculator with a voice output could be beneficial to anyone with difficulty seeing the gray

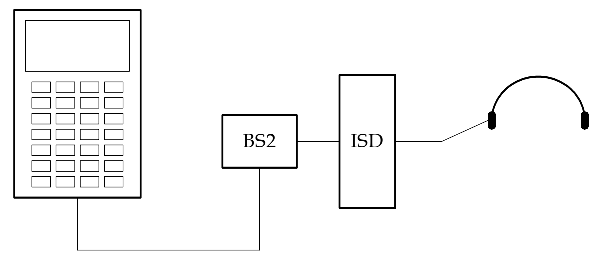

Figure 8.1. Low-Cost Scientific Calculator with Voice Output.

tone screen of current calculators. The major design requirements considered were:

The system had to be portable, to allow use in a classroom setting;

It needed to be reasonable in terms of time and effort to implement; and

It had to be more economical than the commercial systems currently available.

Originally a TI-83 was used in the design prototyping, but due to the speed it transmitted data, it would not work with the rest of the system and was replaced with a CASIO-cfx9856G. The CASIO transmits data at 9600 baud with a standard protocol that enables the microprocessor to receive data and the calculator to acknowledge the microprocessor. This step is necessary in establishing the timing for the data transmission. The user interface of the calculator utilizes the programmability of the calculator to prompt the user for a mathematical expression, execute that expression, and send the resulting information to the link port of the calculator.

The BASIC Stamp II was programmed to accomplish the handshaking signals necessary to get the calculator to send the data. The data was then parsed out to play an appropriate and corresponding pre-recorded data location on the ISD 1000A voice chip.

During experimentation, the basic transmission of data from the calculator to the microprocessor was accomplished, resulting in an appropriate audio output for numerics.

The goal of portability was met with the circuit confined to two circuit boards and their power supplies.

The design system cost approximately $81, and the CASIO calculator cost an additional $75. The total system cost is $156.

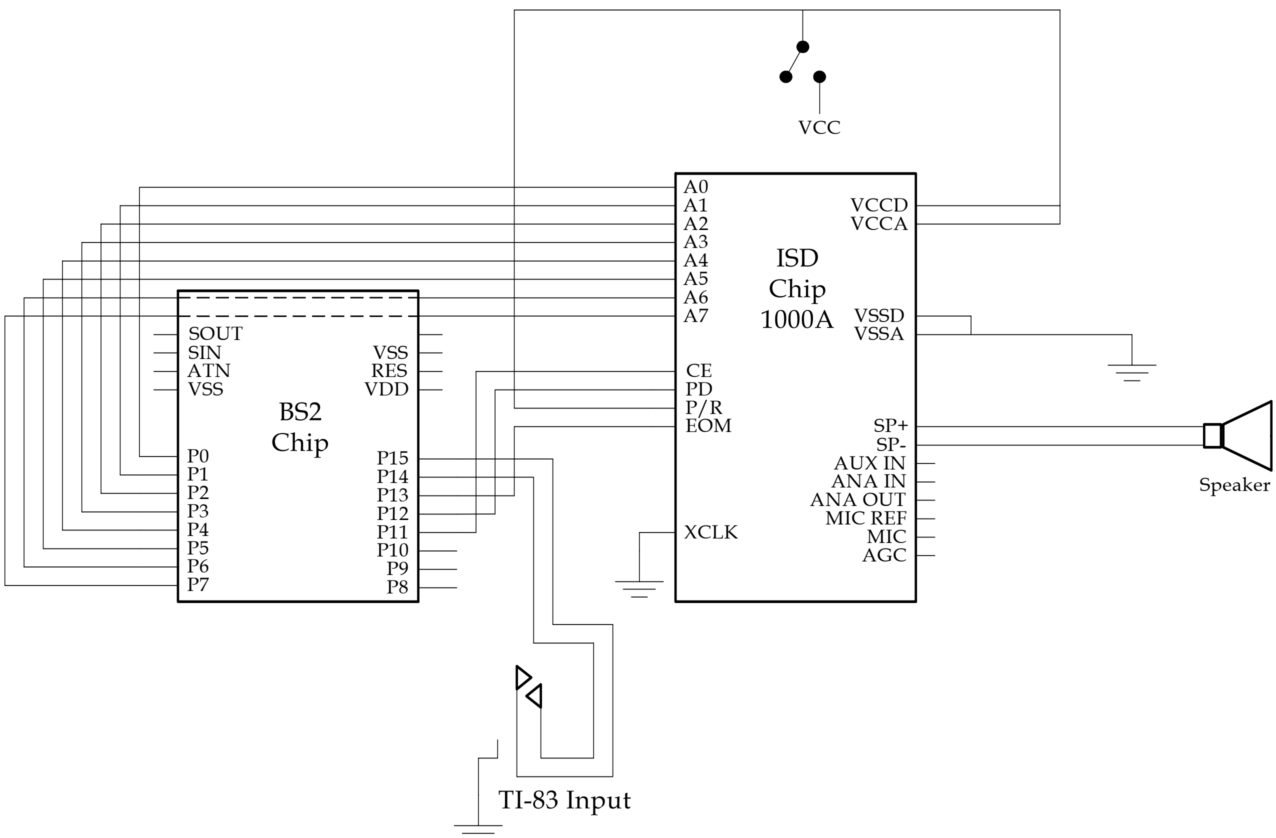

Figure 8.2. Voice Output Components.

ONE-HANDED BRAILLE INPUT DEVICE

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INTRODUCTION

A keyboard for one-handed Braille input was designed. The keyboard consists of seven lever switches with rollers, an Acrilonitrile-Butadiene-Styrene Polymer (ABS) plastic enclosure, and 10 round rubber tabs. The lever switches are mounted under the ABS plastic in an arrangement that allows one hand to make enough keystrokes necessary to support the Braille language. The ABS is cut in a fashion that allows it to bend in the appropriate places, therefore acting as buttons to depress the levers underneath. The rubber tabs are mounted on top of the ABS, and they are the actual button surfaces.

SUMMARY OF IMPACT

Braille keyboards are available on the market today, and these devices have been very successful in enable users with to input Braille efficiently. However, if a user with visual impairments has the use of only one hand to type input, these devices are not very effective. Although some of the Braille keyboards available have modes for one-handed operation, the keyboard layouts on these devices greatly decrease their efficiency while in this mode.

TECHNICAL DESCRIPTION

This keyboard was designed for input from the right hand, but the device could be easily re-wired to facilitate left-handed input. The following were the main objectives for the development of this device:

- It had to create enough chords for one hand to produce all the characters of the Braille language;
- It had to have a logical chord set;
- It had to enable the user to comfortably make keystrokes; and
- It had to be wired to a display device to show the Braille characters as they are input.

The keyboard layout chosen for this device is called the "stack" layout. It is so named because it consists of a space bar and two horizontal rows of three buttons each, with one row stacked above the other. Each of these buttons represents one of the six dot positions in a Braille cell. The two rows of buttons are stacked very close together by using the lever switches. The lever arms on these switches extend into the area between the two rows, and they almost touch. This proximity enables both levers to be activated when the user strikes this area (double activation). This double activation allows the user to chord all 63 different combinations in the Braille language with the middle three fingers of one hand.

The buttons on this keyboard are numbered 1 through 3 in the top row, and 4 through 6 in the bottom row. Since the standard Braille cell is numbered 1 through 3 in the left column, and 4 through 6 in the right column, this stack layout provides a logical chord set for the user to learn. The one is chorded with the four, the two with the five, and the three with the six. These same combinations are seen side-by-side in the Braille cell. The user will benefit from the similarities in the arrangement of keys and the positions in a cell.

This layout of buttons also provides for short stroke distances, allowing for more comfortable usage. This comfort will allow the user to type more quickly and efficiently. Instron compression tests were performed to determine how much force is required to depress each button. An average of .86 pounds was measured. The desired force measured on an existing two-handed keyboard was .36 pounds. Using these results, the strips of ABS under each button could be re-sized to decrease the resistance force of the buttons. This decreased resistance force would be desired to increase ease of use.

Many available devices are very proficient in handling two-handed Braille input, and the primary fault in the one-handed mode of these devices is the layout of the keys. As a result, the main focus of this design was the development of arrangement of keys that will facilitate the one-handed input of Braille. The Braille characters that are input into this device are shown on a display containing seven light emitting diodes (LEDs). Six of these LEDs are positioned to represent a standard Braille cell, and the seventh represents the space character. When any combination of these LEDs is lit, they represent the combination of raised dots in a particular Braille character. Obviously, the LED display is not useful for a user who is blind, but its purpose in this project is to validate the keyboard's arrangement of keys. This keyboard could then be used to interface with other devices, such as a personal computer, to facilitate one handed Braille input, therefore expanding the capabilities of these devices. Figure 8.3 shows this keyboard, with a combination of buttons depressed, and the corresponding LEDs activated.

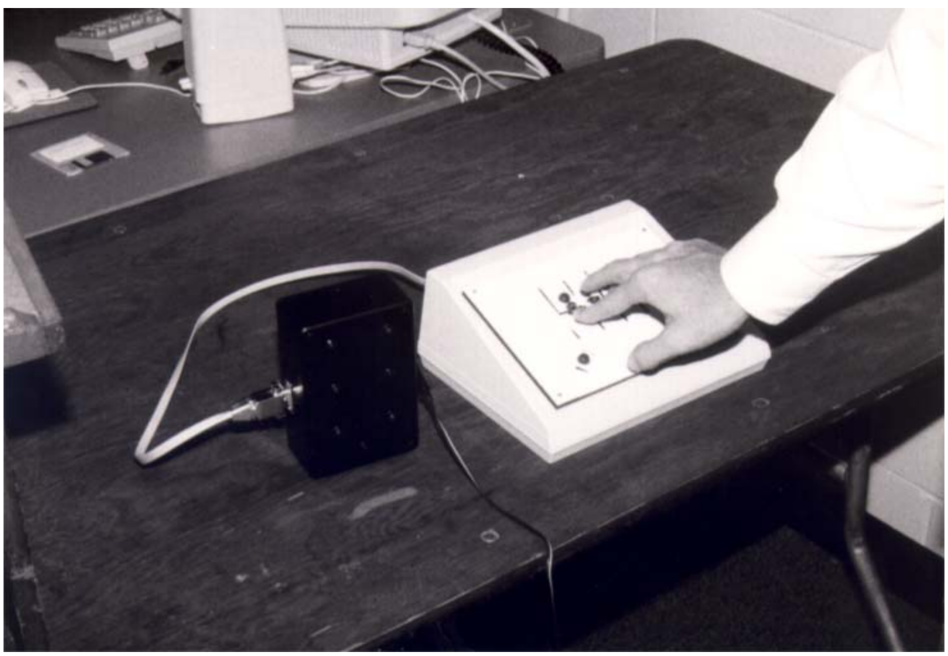

Figure 8.3. One-Handed Braille Keyboard.

A NOVEL CHAIN-DRIVE MECHANISM FOR AN OFF-ROAD WHEELCHAIR

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INTRODUCTION

Conventional wheelchairs utilize only part of the total muscles available in the upper body. An off-road wheelchair requires a greater amount of propulsion than a chair that is used on smooth surfaces because ground coverings such as gravel or grass consist of impede the free rotation of the wheels. This causes the user to work harder and leads to fatigue. Adding muscle groups other than the upper arms to apply force helps to distribute the load and decrease muscle fatigue. A new design is needed to increase the number of muscle groups used and minimize fatigue of the user. In this design project, a push-pull motion for off road wheel chair propulsion is proposed to take advantage of an increased number of muscle groups and enable a workout that will not exhaust the individual.

SUMMARY OF IMPACT

Due to the growing popularity of extreme sports, an increasing number of active people may suffer from spinal cord injuries. People with paraplegia do not want to be limited by the design of their chairs. Since many of these individuals were physically active prior to their injury, many desire to continue their active lifestyle even though they now use a wheelchair. Since many of the off-road wheelchairs currently available do not satisfy the recreational desires of individuals who use them, a great need exists for improvements in off-road wheelchairs.

TECHNICAL DESCRIPTION

The final design is composed of the following parts:

1. A rear axle,
2. Hand levers and drive lever arms,
3. A frame,
4. A front Axle, and
5. Brakes.

This design employs two independent rear axles made of 9/16 inch steel rod, each 20 inches long. These axles are located inside the existing sleeves, which already contain roller bearings. Two 52-tooth sprockets were placed on each axle, spaced 3/4 inch apart, so that the two chains do not interfere with each other. This dimension was sufficient spacing for the chain, while it did not add unnecessary length to the axle. The sprockets have an inner diameter of 1 inch; therefore, an aluminum hub was machined for each sprocket to attach it to the axle. The 26-inch mountain bike wheels are attached to the axle by an aluminum hub, which is fixed by a pin. The wheels are fitted with 26-inch mountain bike tires.

The hand levers are made of 1-inch aluminum pipe and are 34 inches long. The pivot point is 22 inches from the top of the hand lever, and consists of an L-shaped joint, the hand lever, and a 3/8-inch aluminum bearing casing. The cylinder rod is welded to the inner corner of the L-shaped joint. The casing is welded to the outer side of the L-shaped joint so that the middle of the casing lines up with the center of the cylinder. These casings are used so that when the hand lever is moved, the bearings allow the lever to move in a more fluid manner. These hand levers are attached to 34-inch lever arms constructed of 1-inch aluminum pipe. Originally, two aluminum plates were welded to one end of the drive lever arm in order to form a fork, which would hold the freewheeling sprocket in place. This caused problems for installing and removing the chain; as a result, one side of the fork was cut off, and attached the sprocket only to one plate.

The frame of the Low Rider recumbent bicycle was modified to accommodate the proposed chain-drive mechanism. A 30 in. length of 7/16-inch diameter steel rod was inserted through and welded to the frame at a point 16 inches from the rear axle. This rod serves as the pivot point for the hand lever described in the previous section. Twenty-two and 24.5-inch sections of steel square pipe are welded to the frame approximately 15 inches from the front axle. Each section of square pipe is notched in order to facilitate welding to the recumbent frame. Four-inch sections of 1/4 inch threaded steel rod are welded to the inside corner of each end of the steel pipe. Attached to each 1/4 inch threaded rod is a 1-inch pulley that provides a place for the chain to attach in front.

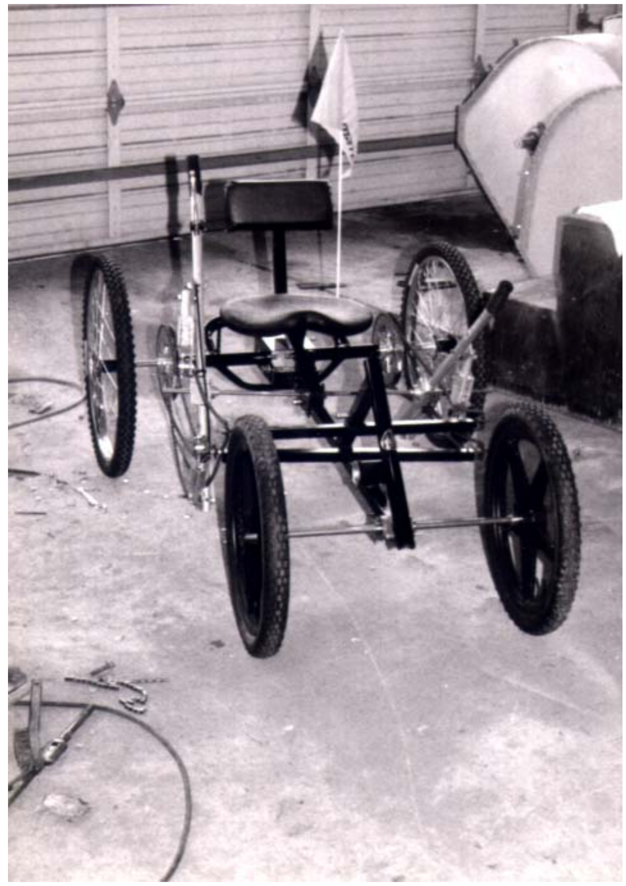

Figure 8.4. Chain-Drive Mechanism for an Off-Road Wheelchair.

The front axle consists of a 9/16-inch diameter rod with a length of 26 inch, two 20-inch diameter tires, and one disk rotor brake. A set of two Browning bearing casings is bolted to the frame to house the axle. Since the front two tires were originally the back tires, they already had a collar with a pinhole. Because of this, a hole was drilled through the axle corresponding to the pinhole. The pin was then inserted to secure the wheel to the axle.

The brake system was taken off the original recumbent bike and adjusted to this design. The brake is attached to the handle/lever at the top of the shaft. The difference in the brakes is how they are placed on the front axle. As previously stated, the wheels are attached to the axle by a pin. This pin is used in placing the rotor brake to the inner part of the right front wheel. Due to the fact that the brake's inner diameter was greater than the diameter of the collar attached to the wheel, a new collar was made out of steel with an inner diameter of 1 inch and an outer diameter of 1 3/8 inch. This collar holds the brake system to the front axle. The rotor of the brake also has a pinhole that attaches the brake to the new collar. The collar is attached to the wheel and axle by the pin.

Although this model had an estimated cost of $800, the cost would not be as great if manufactured commercially. This is due to the fact that a recumbent bicycle would not have to be purchased, but could be produced.

AUTOMATED GUIDANCE SYSTEM FOR A POWER WHEELCHAIR MANEUVERING IN A KNOWN ENVIRONMENT

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INTRODUCTION

An automated guidance system has been designed for use with a battery-powered wheelchair maneuvering in a known environment. It integrates with the Arrow Mark III Micro Computer Controls by Invacare via the attendant port of the Environmental Control Unit. The device consists of a wire pathway laid on the floor, infrared emitter modules at every reference point, and the input box and sensory circuits mounted on the wheelchair. Once the user maneuvers the wheelchair to one of the starting points located in every room, he or she inputs the room to which he or she wishes to go. The guidance system then takes control of the wheelchair, carrying the user to the desired room. The unit is easily mounted on the wheelchair, and requires no permanent changes to the wheelchair.

SUMMARY OF IMPACT

A great interest exists in developing a system to assist the transportation of a person from location x to location y. Battery powered wheelchairs help transport people with disabilities; however, there is a large population of people who have difficulty maneuvering these devices throughout environments with narrow hallways and doorways. Such people include people with Parkinson's disease and polio. A battery-powered wheelchair has been modified to eliminate this problem by carrying the user through the narrow pathways of a home. This device would improve the life of these individuals greatly by eliminating some of their reliance on others for mobility.

TECHNICAL DESCRIPTION

A guidance system for a battery-powered wheelchair was designed to aid the user in navigating through a specified environment. The main design requirements of the device were that it:

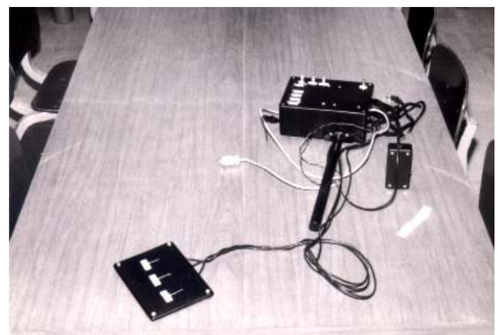

Figure. 8.5. Automated Guidance System for a Power Wheelchair.

- Work with the electronics of the Arrow Mark III Micro Computer Controls by Invacare;
- Enable the user to traverse narrow pathways without making contact with walls or door facings;
- Enable the user to use either the system controls or the joystick;
- Travel at a comfortable speed; and
- Not significantly modify the wheelchair.

The resulting prototype guidance system consists of five subsystems that include:

- The pathway sensor module (PSM),
- The infrared detection module (IRDM),
- The IR emitter module(s) (IREM),
- The microprocessor control module (MCM), and

- The wire path signal generator module (SGM).

The guidance system also has a provision for user input. The active wire sensors of the PSM are mounted on the posterior portion of the battery pack of the wheelchair. The IRDM is mounted on the right hand hold of the wheelchair. All of the subsystems are easily removed and do not result in any significant modifications of the wheelchair. The last component of the total guidance system is the pathway that the guidance system follows. It includes the wire to be followed, the device producing the alternating current carried by the wire, and the infrared emitting identification modules mounted on the ceiling. The control box is mounted on the right armrest of the wheelchair. Six momentary switches are mounted on the box, including an emergency stop button, a button used to ensure the acknowledgment of the feedback such as error and arrival, and a button for each room in the environment to which the user can be taken. The emergency stop button is used when the user wishes to abort the control system function. The acknowledgement button (AK) is used to notify the wheelchair guidance system that the user has recognized the feedback being returned and displayed by the MCM. The five buttons for rooms initiate travel when all of the necessary starting conditions have been met. These conditions include: sensing of an IR signal indicating a starting point, Maneuvering within two inches of the pathway, and receiving input from the user determining which room is the endpoint of the route. Three light emitting diodes (LEDs) mounted on the control box allow the device to communicate with the user. The LED labeled "vicinity" is illuminated when the guidance system senses an infrared signal and is within the correct distance of the pathway. This LED is turned off after the user depresses a switch to identify the correct room to which the user wishes to be transported. The LED labeled "destination" illuminates when the wheelchair has completed the route, at which point the user should be in the desired room. The LED labeled "error" illuminates when an error has occurred, such as the sensing of an unexpected infrared signal.

Standard Flat Ribbon Cable with twenty conductors is used to produce a path to be followed by the wheelchair. The cable is laid down to produce a central path from which single conductors are separated to produce pathways to different rooms.

Figure 8.6. Guidance System Installed on Wheelchair.

The pathway is placed throughout the environment in the center of passages the user might wish to traverse. The path following system consists of three sensors mounted in a straight line perpendicular to the pathway to be followed. Each of these sensors responds to the presence of a wire carrying alternating current. The sensors are placed two inches apart, allowing the wheelchair to vary a maximum of two inches from the specified wire path. IREMs are placed on the ceiling at every point along the pathway that a change in course could be made. These IREMs emit unique signals that are received by the IRDM mounted on the right hand hold of the wheelchair. The information received via the IRDM enables the mechanism to know where it is along the pathway and to determine what action must be made. After ensuring all subsystems worked individually, the systems were integrated with a MC68705U3 microprocessor and tested as a unit. At this point, passing different infrared reference points over the sensor and moving the wire sensors along a wire carrying alternating current simulated the use of the guidance system in an actual environment. The output sent to the motor control circuitry of the wheelchair was monitored to make certain the microprocessor functioned appropriately. The final cost of the guidance system was approximately $425.

SUSPENSION AND MONITORING SYSTEM FOR GAIT TRAINING USING A TREADMILL

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Project Proposed by: Dr. David H. Pearce, Dr. Dobrivoje S. Stokic
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Supervising Professor: Dr. Gary McFadyen
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INTRODUCTION

Weight unloading during gait training is an innovative approach used in restoring spinal locomotor activity in patients with paraplegia. Current gait training systems are cumbersome. The patient's weight is unloaded through a system of winches, weights, or pneumatic cylinders attached to a parachute harness by a gambrel and ropes. This system creates enough tension to provide weight relief that is (assumed) constant. Medical professionals at a rehabilitation center wanted to improve this suspension system. The new system provides independent unloading of each limb. It also has the capability of monitoring the force on each limb and the displacement of each side of the body. This information is sent to a data recorder, where it is recorded for analysis.

SUMMARY OF IMPACT

Interactive locomotor technology is used with people with loss of locomotion, due to spinal cord injury or stroke. The system designed here has been successful. Results show that patients with spinal cord injuries who undergo prolonged treadmill training have either gained the ability of locomotion, or enhanced their locomotor capabilities. Locomotion learned on a treadmill, with reduced body weight, can be transferred to locomotion on steady ground, with the full body weight being borne by the once-paralyzed limbs. All advantages of the new system are not yet apparent. More research must be conducted to fully evaluate this system. However, several advantages have been noted. The new system:

- Is more adjustable than the counterweight and winch systems;
- Provides a constant force (which is more effective because it prevents the patients from hanging in the harness); and
- Achieves a closer approximation of true weight unloading.

The ability of this system to monitor displacement and tension provides objective results for rehabilitation assessment.

TECHNICAL DESCRIPTION

The design uses two 36-inch stroke pneumatic cylinders. This ensures that stroke length is not a limiting factor. Two pressure regulators, each in conjunction with a 7-gallon air reservoir, regulate the cylinders. The reservoirs stabilize the force developed by the cylinders over the full range of the piston's travel. Two load cells are located above the rehabilitation harness to monitor the tension. A cable-drum potentiometer is connected to each piston to monitor displacement. Starting from an air compressor, air moves through hoses to the pressure regulators. It then travels to the reservoirs, which are connected in line with the pneumatic cylinders. The cylinders are mounted on a steel plate, which is bolted to the frame of a Woodway treadmill. The cylinder's pistons are connected to ropes, and the ropes are connected to the load cells. Data from the load cells and potentiometers are sent to data analysis equipment provided by the rehabilitation hospital.

The load cells are located above the harness to verify rope tension. Tension can be calculated from regulator pressure. However, regulator pressure includes cylinder and pulley friction. With this design, load cells attached to the harness allow monitoring of the true tension applied to the patient.

Each cable-drum potentiometer is connected, through a pulley, to the piston of one cylinder. The pulley allows the potentiometer to operate over the full stroke of the cylinder. Pulley placement dictates that the potentiometer cable is displaced half as much as the cylinder piston.

The air reservoir minimizes pressure change in the cylinder during and after a force was applied. The reservoir increases the volume of the system such that any volume change in the cylinder is negligible compared to the volume change in the system.

Each component of the system was tested and calibrated. Dynamics of the system were tested using three individuals: a person without paralysis, who served as the control, and two people with paralysis whose training required a medium to low level of therapist involvement.

Using two independent cylinders to unload patient weight during treadmill-gait training is a new concept. This concept, along with the addition of load cells and potentiometers, will enable researchers to collect objective data on the biomechanics of paraplegic gaits.

CLOSED CHAIN REHABILITATION DEVICE FOR THE KNEE

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INTRODUCTION

A closed chain rehabilitation device has been designed and constructed to aid in the rehabilitation of injured knees

There are currently several devices commercially available that provide open chain resistance for the knee. Open chain resistance causes tibial shear. Tibial shear results in pain and discomfort during exercise and may produce further injury. Existing devices are also rather large and expensive. The design is also much smaller and less expensive than existing devices.

The primary design requirements of the device were that it:

- Provide closed chain movement throughout exercise,
- Be more economical than existing devices,
- Be smaller than existing devices,
- Be portable,
- Provide bi-directional resistance,
- Reduce the amount of tibial shear experienced during exercise, and
- Fit the average American male.

SUMMARY OF IMPACT

This device was designed to fit the average American male. With further modifications, it could be made to accommodate people of all sizes. The overall goal of constructing a closed chain device has been met.

TECHNICAL DESCRIPTION

The device has in four major components: the footplate, the track and housing, the resistance mechanism, and the power supply. The footplate is constructed from a simple roller skate. One 3-inch piece of stainless steel is welded to the bottom of the footplate at a 45E angle from the vertical. The piece of steel has a ¼ inch hole drilled in it to allow the pulley cable to attach. Another 3-inch piece of stainless steel is welded to the bottom of the footplate at a 45E angle from the vertical. This piece of steel also has a ¼ inch hole drilled into it to allow a bungee cord to attach to aid in the return mechanism. Finally, two high-density polyethylene wheels are mounted to the bottom of the footplate, which rolls on the bottom of the track to reduce friction and wear.

The housing is constructed from two 3/16-inch 4 x 8 foot stainless steel sheets. From these sheets, two 3x 3-foot sheets were cut using a plasma torch. The edges of the 3 x 3 foot sheets were ground using a 2-inch stainless steel grinder. The track was then constructed by folding a 10.5-inch x 5-foot sheet of 3/16-inch stainless steel on a 3-cylinder flat sheet roller in a 90E curve. The track is cut to be 10.5 inches wide so that the device can properly house the machinery needed inside, and for stability purposes. A 90E arc was cut in each 3 x 3 foot stainless steel sheet so that the track can fit properly on the stainless steel sheet. The track is welded to the stainless steel sheet with the 90E curve by using a 3/16-inch stainless steel welding rod with a 1/8 inch diameter. Once the arc was welded properly on the sheets, a ½ inch slit was cut down the middle of the track to allow the footplate to travel the track.

The resistance mechanism consists of a mechanical cylinder with an 11-inch stroke, a 2-inch pulley, a ¼ -inch pulley cable, and a bungee cord. The resistance mechanism, however, could be improved dramatically by removing the air supply and replacing it with adjustable check valves. The cylinder is mounted to the floor of the steel housing by four 3/8-inch bolts, each with a ½-inch nut as a spacer. The cylinder is positioned 14 inches from the edge of the track where the footplate rests at a 60E angle to allow it to reach its maximum stroke length. Two 12-inch all-purpose threads with a 3/8-inch diameter hold the cylinder at this 60E angle. A ¼- inch pulley cable attaches to the front of the footplate and to the top of the cylinder to allow the footplate to pull the cylinder as it travels up the track. The bungee cord rolls over the pulley and attaches to the back of the skate to allow the footplate to return to the rest position.

The components controlling the power are a four-way solenoid valve, an industrial relay, and two limit switches. A simple parallel circuit was designed and implemented into the device to allow an outside power source to control the footplate. The cylinder, which controls the footplate, is powered by an air supply. When limit switch #1, which is mounted at the bottom of the track, is closed and in direct contact with the relay, air is supplied through a ¼ inch diameter inlet of the cylinder. This causes the cylinder to stroke until it reaches limit switch #2, which is mounted near the middle of the track. Once the footplate reaches limit switch #2, the 4 way solenoid valve reverses the airflow causing a discharge at limit switch #2 and suction at limit switch #1. This suction allows the cylinder to return to its rest position, causing the foot plate to travel down the track or flex ones leg.

The final cost of the total knee rehabilitation device is approximately $1,721.00 including parts and labor.

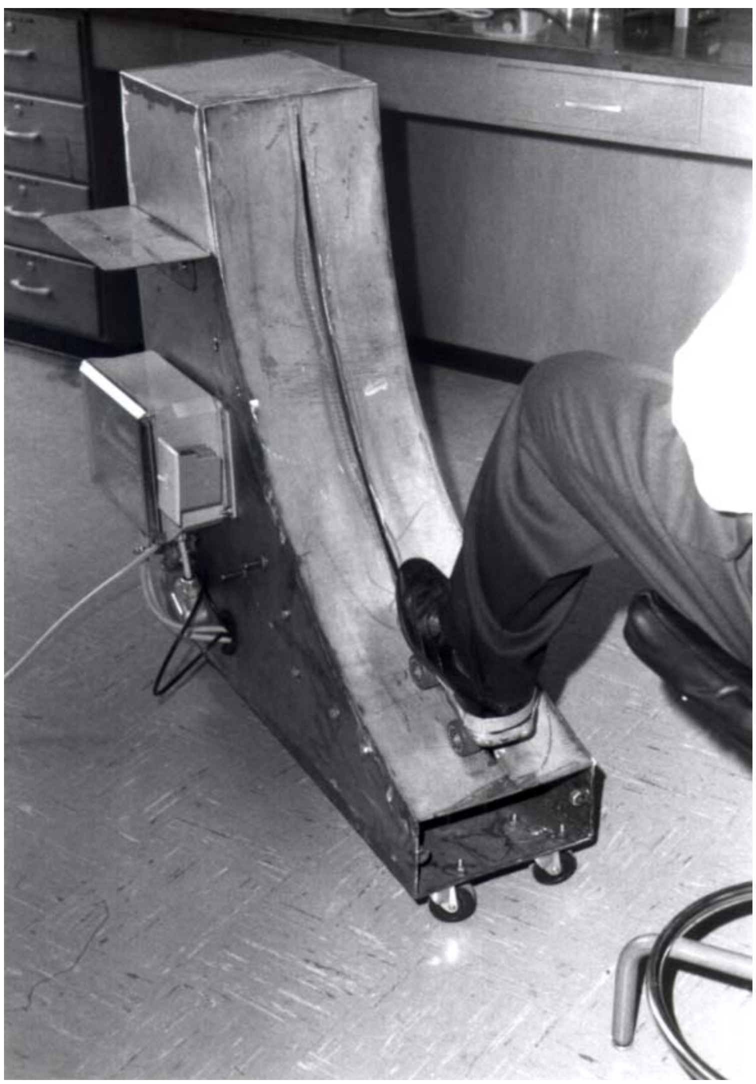

Figure 8.7. Closed Chain Rehabilitation Device for the Knee.

LEFT FIELD LOUNGE LIFT MECHANISM AND STRUCTURAL DESIGN

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Project Advisor: Dr. Gary McFadyen
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INTRODUCTION

A 22-year-old university student is ventilator dependent and has quadriplegia. Although this student requires constant nurse supervision, he strives to live a normal life. He, however, has never been able to enjoy the terrace of the university baseball stadium, where fans bring trailers, trucks, cars, and other vehicles to watch the game. A specific lot in the outfield terrace was given to the student. The lot is on the second row of the left field section and requires him to be elevated approximately 8 feet. A lift is needed as well as a structural design that will allow friends and family to enjoy the game with him.

SUMMARY OF IMPACT

The purpose of this project was to design a lift and surrounding structure that will allow a student to watch a baseball game in the outfield terrace of the baseball stadium. This project will give the student an opportunity to watch a sport that he enjoys as well as socialize with his friends and family. It will help him to lead a more normal college life.

TECHNICAL DESCRIPTION

Since the final design will be located in the outfield terrace, the design must be mounted on a trailer that can be transported to and from the field each season. The student rides a 10-foot ramp onto the trailer, which is approximately 1.5 feet off the ground. Next, the student transfers onto a 3x5 foot steel platform. The platform has wheels on each of the four sides that are placed in channels and used as tracts to guide the platform as it rises. A winch raises the platform. Cables from the winch that are attached to the platform travel through pulleys. The cables from the winch are in a double line configuration to reduce the load on the winch. Once at the top of the lift, the platform is secured, and the student has access to the top tier of the structure.

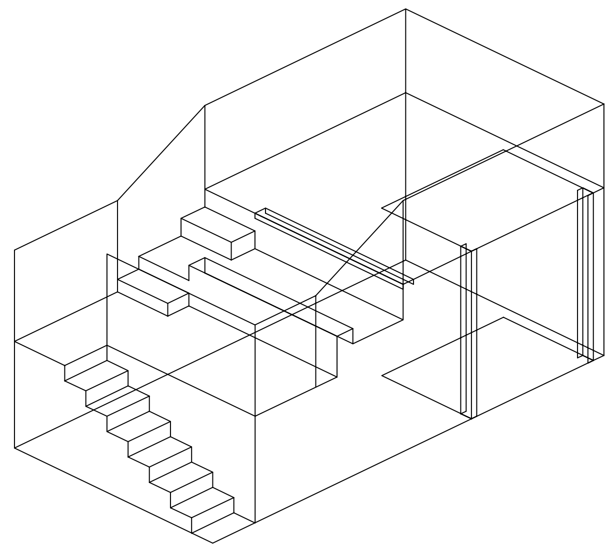

Figure 8.8. Structure and Lift.

Two 12-volt batteries in series power the winch. These batteries can be recharged by two solar panels. This configuration enables the lift to be free from an outside power source, which is integral, due to the distance of the trailer from an electrical outlet. The solar panels are estimated to recharge the batteries after one operation up and down in just over one day.

Although the winch is manufactured with an automatic brake, design plans were made for a manual brake in the unexpected case that some component of the design would fail. The manual brake is constructed of a metal shaft attached under the platform. As the platform travels up the shaft, it is dragged along a series of teeth. As the platform is lowered, the shaft must be lifted manually. If anything suddenly happens, the brake can be released, and the platform is blocked from moving by the teeth.

The structure of the lounge is made of angle iron. Ergonomic factors were taken into account when designing the structure. There is room on the lounge for ten people to sit comfortably. Figures 8.9 and 8.10 show the lounge during the construction phase.

The estimated cost of this project is $2000, including the trailer.

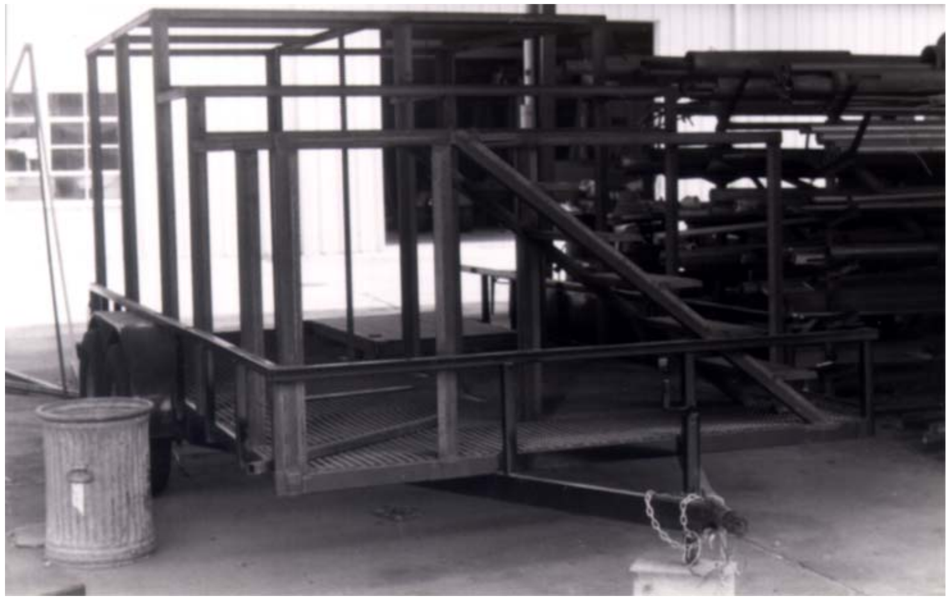

Figure 8.9. Support Structure for Left Field Lounge.

Figure 8.10. Wheelchair Lift Platform.

KENAF COMPOSITE SPORTS WHEELCHAIR

Designers: Monika Bhuta, H. Lee Hall III, John M. Zimmerman
Supervising Professors: Dr. Timothy N. Burcham, Eugene P. Columbus, Dr. Marty J. Fuller, Dr. G. M. McFadyen
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INTRODUCTION

Kenaf fibers embedded into an epoxy-resin matrix were used to construct the members of an athletic wheelchair, primarily used for tennis. With the use of flat and cylindrical stock composite members, a wheelchair, weighing 18.7 pounds, was constructed with the ability to withstand rigorous forces while providing maximum mobility to translate forward, backward, and with easy rotation. The tiny frame allows the user a wide range of arm motion and a minimum amount of energy spent to push him or her around. The wheelchair is made of 14 cylindrical members and three flat stock members. Fiberglass joins and reinforces each joint. A cotton-kenaf cloth was used to provide a seat and seatback. Metal housings enable the attachment of wheels to the composite frame and provide a smooth surface for the rotation of their components. Kenaf fibers used to reinforce the composite matrix help minimize the chair's weight, decrease the cost of production, and make it environmentally friendly from a production aspect.

SUMMARY OF IMPACT

This sports wheelchair has only kenaf-epoxy composite material in all of its structural members. This material, made primarily from the fibers of the kenaf plant, is a renewable resource, unlike metal alloys. It performs comparably to commercial counterparts without the use of metal members, as it and uses only composite reinforcements. This chair demonstrates that biological composites have a future in the manufacturing industry.

TECHNICAL DESCRIPTION

The chair was designed to emulate many of the features that are popular on the commercially manufactured chairs. For example, its advantages include that it is:

- Lightweight,
- Easily maneuvered,
- Strong, and
- Equipped with single front and back wheels and cambered main wheels.

The kenaf sports wheelchair design differs from conventional sport wheelchair designs in order to meet the criteria necessary when constructing with composite materials. This design has:

- Fewer joints,
- Most joint angles at less than 90 degrees,
- Larger surface area contact between members, and
- Longer members to maximize fiber length.

The chair has four wheels, two main wheels on each side of the seat, and two small caster wheels, one in front and one in back. The chair superstructure consists of an axle-seat complex, from which extend front and back wheel members. The chair was constructed in phases. All the members that were needed were fabricated using kenaf fibers and Epolite epoxy resin (2410 A + 2184 B) by the hand lay-up method. The superstructure of the chair is composed of kenaf-epoxy composites in the form of fourteen hollow-cylindrical members (OD approximately 1.6" inches and ID approximately 1 inch) and 11 flat-stock members approximately 0.1-0.3 inch thick, joined and reinforced with fiberglass fabric and epoxy.

The axle-seat complex can be divided into two main components: the axle-arch and the seat. Two cylindrical and one flat stock member make up the axle-arch component. The axle is composed of two cylindrical members each 15.9 inches long and joined at an angle of 150 degrees. Two aluminum metal housings (OD = 1.0 inch, ID = 0.5 inch, 2.5 inches long) allow attachment and smooth articulation of the two main wheels. These are fitted inside the ends of the hollow cylindrical axle members.

A catenary-arch shaped flat-stocked member is fitted to the ends of the axle just interior to the aluminum wheel attachment pieces. This provides a gentle curved surface that is 10.6 inches wide, 25.6 inches long, and approximately 0.3 inch thick to allow a large area for the attachment of the seat components. Together the arch and axle create a strong yet flexible double-wishbone suspension, which is the base of support for the chair. This three-member component shares the total load with only the front and back caster-wheel members.

The seat complex is composed of two identical seat halves joined together by two seat-strut members. The distance between the two seat halves is 15 inches. Each seat half is made of three members. The bottom member, approximately 12.9 inches long, is joined directly to the catenary arch piece via fiberglass and epoxy. Attached to this trans-arch member are the two members on which the kenaf-cotton fabric seats are suspended. The bottom seat member is perpendicular to the horizontal. All three of these members attach via fiberglass to an outside seat panel. Struts running from panel to panel join the two seat halves. These 18.2-inch struts each resist the compressive load that results from the user sitting on the fabric suspended between the two seat halves.

Attached to this central axle-seat complex are two members that connect to the front caster wheel, and two members that connect to the back caster wheel. Both the front and back wheel members attach to the axle-seat complex at the terminal ends of the trans-arch members near the base of the seat. These joints are reinforced with fiberglass. The front wheel members are each 21 inches long, slope downward at a 25-degree angle to the horizontal, and slope inward, meeting at the center of the chair to form a 50-degree angle.

The back wheel members are shorter and longer and slope inward. All four wheels contact the ground during use, meeting to form a 96-degree angle.

The front and back wheels are attached to these members in a similar fashion to the main wheels. Two aluminum housings (OD = 1.2 inch, ID = 1.1 inches, 1.75 inches long) fit inside two 2.4-inch

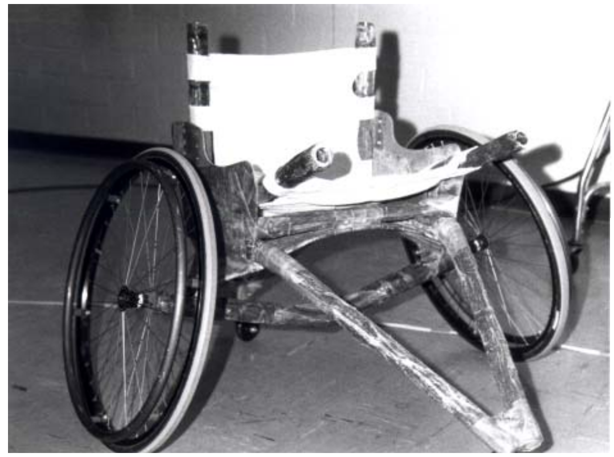

Figure 8.11. Kenaf Composite Sports Wheelchair.

composite cylinders. These housings were press-fitted onto bearings that articulate with the caster wheel hardware. The housing-bearing assemblies were then press fitted inside the two composite cylinders. These cylinders were then joined in between the respective wheel members using fiberglass and epoxy.

Solid wooden dowels (OD = 1 inch, approximately 4 inches long) were used as guides during construction to ensure that the structural members were fixed together at the appropriate angle. Two dowels were fixed together at the specified angle using wood glue, and were then epoxied into one of the two members to be joined. The 1-inch ID of each of the cylinders ensures member a snug fit and proper alignment after the second member was slid over the dowel during construction. These dowels are not intended to add strength, and added a negligible weight to the frame. For additional strength, kenaf composite gussets were added to most joints. The gussets are cut from kenaf composite flat stock (approx. 0.1 inch thick) and fixed to the joints using fiberglass and epoxy. These gussets are fixed in the direction of stress to be in either tension or compression as the joint was loaded.

The final cost of the chair is approximately $844.00.

A REMOTE CONTROLLED DOOR FOR PEOPLE IN WHEELCHAIRS

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INTRODUCTION

A system to open and close a residential door by remote control has been designed and built to assist people who use wheelchairs. The door opening system consists of a 12 volt, DC motor, a linear actuator, an AC-to-DC converter, and a remote control system. The door opening system uses a signal sent by a wireless remote control to open and close the door. The system not only opens and closes the door, but also latches the door using the same remote control unit. A linear actuator is as a door latch and operates with the remote control.

SUMMARY OF IMPACT

To someone living in a wheelchair, a simple task of such as opening and closing a door can be tedious and awkward. The person has to wheel up to the door or be wheeled up to the door, turn the handle, and push or pull the door open while maneuvering the wheelchair through the doorway. These tasks can become tiring and frustrating to someone in a wheelchair who is just trying to enter or exit their house. With the remote controlled door, getting in and out of the house is no longer an inconvenience. The unit can be installed in a few hours with minor work done to the existing door structure. The remote control door unit was designed with people in wheelchairs in mind, but it can be used by anyone needing or wanting their doors opened by a remote control.

TECHNICAL DESCRIPTION

The remote control door unit is designed to be used on a residential door. Main design requirements of the remote control unit were:

- The remote unit itself had to be installed inside the walls;
- The motor used to open and close the door needed to be as small as possible but still have enough torque to easily move the door; and
- The latch used needed to be installed inside the walls.

Figure 8.12. Remote Controlled Door.

The motor used to open and close the door is a 12-volt, DC, reversible motor. An AC-to-DC converter that can be plugged into a wall powers the motor. The shaft of the motor is attached to an arm that folds in the middle. The arm also has an adjustable length to allow for maximum torque. Using the folding arm, the motor can open and close any door as needed. The height of the motor including the shaft is no greater than eight inches and the width is more than four inches in the widest part. The motor can be mounted on the wall directly above the door.

The latch is a linear actuator similar to one found in a car door that operates power locks. The latch is being used as a dead bolt to add extra security to the door. The linear actuator is no longer than six inches and three inches wide. The actuator is four inches high at its highest point. These small dimensions make for an easy installment behind a wall. The actuator is powered using a 12-volt, DC source, the same as the motor. The shaft of the actuator extends out one and a half inches into the door to help make sure the door will not be opened without use of the remote control. The shaft of the actuator operates in and out with the remote control unit.

The remote control unit is a CMD-8000 from Dakota Digital. It is designed to be installed on vehicles to make the power options on cars remote controllable. The CMD-8000 is powered by a 12-volt, DC source. This is the same source being used on the motor and the actuator. The CMD-8000 comes with a receiver/controller, two relays, and a key chain remote control. The receiver is connected to the relays, and the relays are connected to the door. By holding one button down on the remote control, the door will open until the button is released. Holding the same button down again can close the door. Pressing down two buttons at once operates the actuator. Pressing the other two buttons reverses the operation of the actuator.

The remote control was tested thoroughly and found to be fully operational. The motor has enough power to open and close a residential door but not so much as to crush or harm anyone behind the door. The door can be stopped from opening by pressing against the door. This will help prevent accidents from happening in case anyone or anything is ever behind the door when someone else engages the system. With the entire unit being powered using 12-volts, DC, the unit may be backed up with a small battery in case of power failure.

The overall cost of the CMD-8000, the motor, the AC-to-DC converter, and the linear actuator is approximately $300.

Figure 8.13. 12-volt DC Motor for Door Opener.

THE GUARDIAN 2000: FORKLIFT DETECTING SYSTEM FOR PEOPLE WITH HEARING IMPAIRMENTS

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Client Coordinators: T. K. Martin Center
Supervising Professors: Dr. Gary McFadyen, Dr. Randolph Follett, Dr. Joseph Picone
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INTRODUCTION

The Forklift Detecting System (Guardian 2000) is a system designed to provide assistive technology for an employee with hearing-impairments. In order to enhance the employee's overall safety, this system was designed to alert the employee of an approaching forklift. The design will includes a system utilizing infrared transmitters and sensors, transmitters, receivers, and a vibrating pager unit. The solution will allow the employee to be warned of the presence of forklift despite his auditory impairment.

SUMMARY OF IMPACT

This client is unable to hear an approaching forklift due to his auditory impairment. As a result, this employee is subject to an unsafe working environment since he is unable to hear standard warning signs such as a horn and backup alarm. This system notifies the employee of the approaching forklift by means of a vibrating pager. The Guardian 2000 was designed for a particular client with a specific need, but could be beneficial to many other clients with similar needs.

TECHNICAL DESCRIPTION

The design requirements of the Guardian 2000 are described below.

Safety: The client will be relying on this system to detect and warn him of an approaching forklift. Thus, safety is the primary objective.

Monitoring System: The monitoring system consists of an infrared transmitting device and an infrared receiving sensor.

Power Specification: The Guardian 2000 is a battery-operated system utilizing voltages of 9 volts and 12 volts.

Durability: The Guardian 2000 is designed to withstand the stress and strain of operating in an industrial environment.

Physical Packaging: The vibrating pager unit is small enough to be worn on the belt or in a pocket. The infrared transmitter and the infrared receiving sensor are moveable and able to withstand the industrial environments (dust, smoke, etc).

The Guardian 2000 has three parts: the transmitter, the receiver, and the vibrating pager.

The infrared transmitter consists of 12-volt battery indicator, 555-timer chip, resistors, capacitors, and LED. The transmitter is a 555 oscillator with a frequency of approximately 38000 Hertz. The frequency insures that the receiver will not receiver interference from changing environmental light conditions, for example the 50 Hertz flickering light that is given off by a fluorescent light. The 555 oscillator output is taken to an infrared emitting diode that emits infrared pulses.

The active indicator indicates that the receiver is detecting infrared pulses from the transmitter. Once an approaching forklift or other object breaks the beam, or the transmitter is no longer operational, the active indicator will cease to operate. This will cause the receiver to activate the belt-worn vibrating pager.

The final cost of the Guardian 2000 was estimated to be $300 per unit.

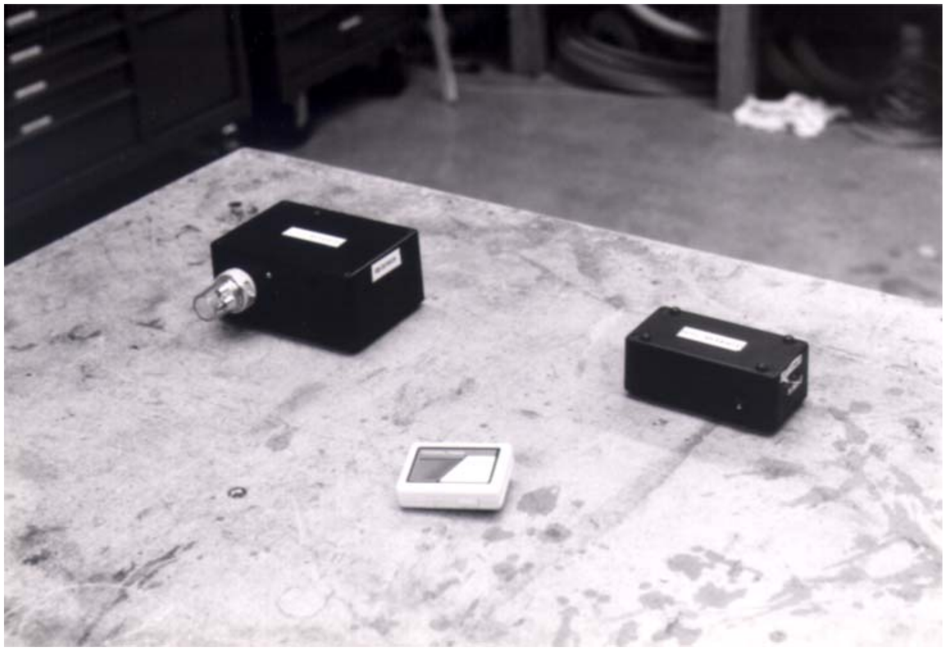

Figure 8.14. Forklift Detecting System for People with Hearing Impairments.