CHAPTER 6

RENSSELAER POLYTECHNIC INSTITUTE
DEPARTMENT OF BIOMEDICAL ENGINEERING
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"Bar-Code Reader"
A Moving Bar-Code Reader for the
Functionally Impaired

Designers: Peter S. Donzelli, James Carollo, Tony Chan
Disabled Coordinator: Beverly Maszdzen, Albany CP Center for the Disabled
Supervising Professors: Dr. J. Lawrence Katz and Dr. Jonathan C. Newell
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INTRODUCTION

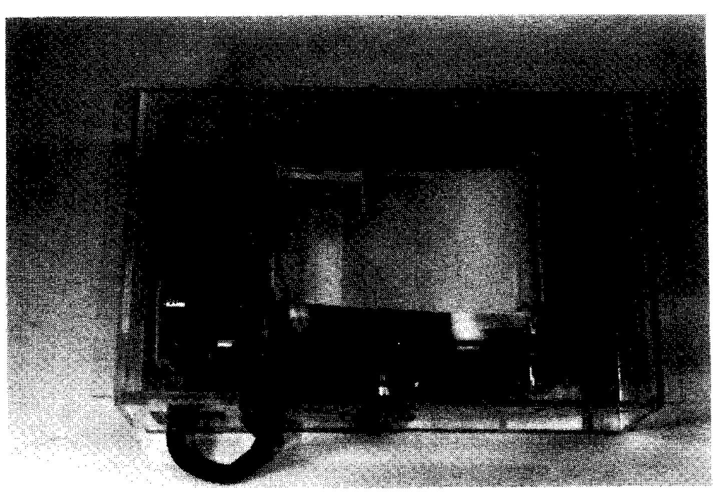
Many of the clients at the Albany Cerebral Palsy Center for the Disabled are non-verbal. Staff feel that a client would benefit from a communication system that provides audio feedback. The Texas Instruments Magic Wand Speaking Reader uses bar codes, a fiberoptic pen and an audio speaker to synthesize speech. However, the client does not have the muscle control to operate the Magic Wand. This device operates on the premise that the pen remains stationary and the bar codes are moved. The bar codes are on a sheet of continuous paper wound on wooden rollers. A toggle switch moves the codes left and right. While the toggle is active, no signal is sent to the speaker. A separate button is used to "speak" a code.

SUMMARY OF IMPACT

Many commercial devices exist which enable disabled people to communicate through synthesized speech. One such device is called the "Magic Wand". Ths device generates speech which is encoded in a series of bar-codes. To cause the device to say a word, the user must pass a bar-code wand over the appropriate bar-code. This device produces a high quality speech output and is used extensively to make talking language boards for non-speaking disabled people.

Many disabled people are physically unable to pass the wand over the appropriate bar-codes. A modification to the "Magic Wand" has been under development to enable a disabled person with diminished fine motor ability to use the Wand. The modification is designed to allow the user to move the bar-codes under a stationary wand. The user will increment the bar-codes with associated pictures and words by pressing a button. When the appropriate item is under the wand, the user will press another button to activate the wand and cause the device to speak.

The device is currently non-functional. The modification project was completed but was not tested by the time the school term ended, and the students involved in the design are no longer available. Further testing and work on the project has been given a low priority at this time due to a revised evaluation of client needs. Failure to complete the testing was due in part to a project change in the middle of the semester and the over-ambitious nature of the project.



TECHNICAL DESCRIPTION

This project entails adapting a Texas Instruments Magic Wand Speaking Reader. The device uses an optical bar-code scanner to convert bar codes to audible speech. The basis of the design is that the pen is fixed and the paper containing bar codes moves. This device was designed and constructed in three parts: the chassis, the mechanical systems and the control circuits. Plexiglas 1/4" thick was cut to make a box with inside dimensions 4" x 10" x 16". K-lax solvent for cementing was used for securing various Plexiglas components to one another. Bearings were cut from 3/8" Plexiglas and attached perpendicularly to the base with fine screws.

For paper take-up a spring-belt was used to provide both friction and slip. A 1.5" grooved Plexiglas wheel was attached to each of the paper rollers. A 3" Plexiglas wheel was placed between the two smaller wheels, and a spring-belt was looped around the three wheels. The larger wheel is driven by one of the 25 rpm reversible DC gear-motors, always in a single direction, whenever a switch on the device is activated. This motion of the large wheel drives the smaller wheels so that paper is always being wound onto the rollers. When the paper-drive system is activated and paper is being drawn off one roller, the spring-belt allows the wheel on this roller to slip while winding paper onto the other roll.

The 1/4" steel rods were cut to 9" lengths and fitted with ten rubber O-rings. These are the drive rollers. Paper is sandwiched between the drive rollers and 1/2" strips of 1/4" Plexiglas attached to the lid of the chassis. Attached to each drive roller is a 2" pulley; these pulleys are connected by a 16" long V-belt. A 1" pulley is placed on one of the drive rollers and connected via a 12" V-belt to a 2" pulley on the shaft of the gearmotor. Thus, the motor drives one roller, which in turn drives the opposite roller, both at a linear speed of 58.9 in. per minute.

A toggle switch is used to control the direction of paper advancement. A push switch is used to scan a particular code. Both of these are connected to the Scantech with 1/8" RCA jacks. The signal from the toggle is not ideal, so a dual JK flip-flop is used to debounce the signal. Whenever a switch is operated, a low signal is sent to a 555 timer.

For proper action on the paper-drive system, the motors run for six seconds in order that one bar code passes the pen. The 555 timer produces this time constant. High output from the timer has two functions. An inverter takes the high signal and feeds it to the clocks of the JK flip-flops, insuring no other inputs trigger the timer until the six-second period has elapsed. Secondly, the high signal turns on the motors. Relays reverse the polarity of the source voltage for the motor, reversing the direction of rotation.

When the toggle switch is pushed left or right, output from the flip-flop will be sent to prevent signals from reaching the speaker. Four D-cell batteries are needed to power the Magic Wand. Each of the motors runs on three volts.

Cost of parts and construction was two hundred one dollars ($201).

Further details can be obtained from the principal investigator.

"The Mechanical Rocking System"
A Motorized Rocking Chair for the
Functionally Impaired Child

Designers: Dawn Tramaglini, Miriam Lane, Marietta Malik
Disabled Coordinator: Beverly Maszdzen, Albany CP Center for the Disabled
Supervising Professors: Dr. J. Lawrence Katz and Dr. Jonathan C. Newell
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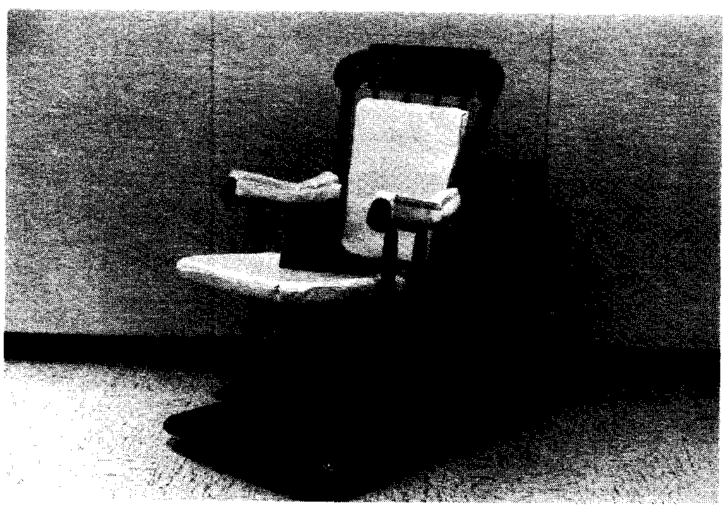
INTRODUCTION

This project entailed designing a mechanical system to set a rocking chair in motion. The system was designed to accommodate the needs of young children at the Cerebral Palsy Center for the Disabled in Albany, New York. These children exhibit poor trunk control, no lower extremity usage, and developmental delay. This system will allow the children to have a greater impact on their environment and aid in their understanding of cause and effect relationships.

The mechanical rocking system is powered by a low-horsepower motor and rocks at a speed of six rocks per minute. The chair is covered with cushions for comfort and is equipped with a seat belt for safety. The system is also easily mobile and requires little maintenance.

SUMMARY OF IMPACT

For many multi-handicapped children, the ability to control their environment is of prime importance in their educational programming. Many such children, due to their physical impairments, are unable to move themselves in space. Often this inability to move independently prevents full sensory integration. Most often, staff must attempt to provide those motor and sensory experiences for the child. While rocking in a rocking chair is a pleasant and motivating experience for normal children, multi-handicapped children may be unable to rock, due to orthopedic impairments and inadequate trunk control. These same children may be of a chronological age such that it is inappropriate for staff to hold and rock them in a chair. In addition, this type of activity would not provide the important aspect of independent control. Some of these children have not as yet acquired the cause-effect relationship through activation of simple toys. The motorized rocking chair allows for the positioning of a variety of children in a therapeutic manner. It also allows the child to activate the rocker for a pre-set amount of time, through the use of a commercial switch interface-timer box. This mechanical rocking system allows the children to have a greater impact on their environment and provides them with enjoyable recreational experiences. It remains a valuable educational tool.



TECHNICAL DESCRIPTION

A mechanical system to set a rocking chair in motion has been designed to accommodate the needs of young children at the Cerebral Palsy Center for the Disabled in Albany, New York.

The mechanical rocking system consists of five components: the rocking chair, the platform, the cushions, the motor, and the cam-follower system. The rocking chair is made from beechwood and is extremely large to accommodate the different tumble-form safety chairs that are used at the Cerebral Palsy Center. A seat extension was built from 3/8" plywood and attached to the chair with wood screws. It was shaped to cover the seat of the rocker and extends eight inches past the end of the chair. The seat extension is needed to accommodate children who have locked knees. For safety purposes a two-inch seat belt is attached to the side supports of the chair. Due to the odd shape of the chair, cushions for the seat, chair back and arm rests had to be custom-sewn. These cushions were made from heavy-duty vinyl because it was required that they be waterproof.

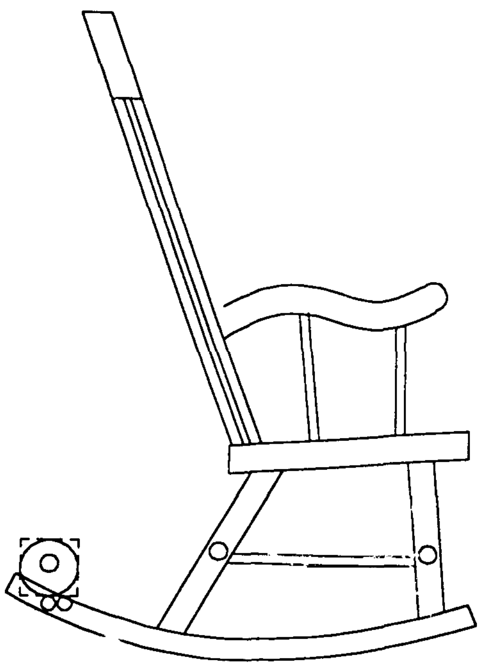
A platform for the chair and cam-follower system and an enclosure for the motor were constructed from 3/4" BC exterior pine plywood. The platform is 26" x 46" and has rounded corners for safety. To guard against side motion of the chair, a runner system is in place on both sides of the chair rocker arms. To permit easy mobility of the system, four caster-lock wheels are attached to the bottom of the platform.

The chair is powered by a constant torque, fan-cooled, shaded-pole, parallel shaft gearmotor (model #3M126). It produces a speed of six rpm, is safe for a torque of 113"-lb, has a horsepower of 1/20, runs with an amperage of 1.4, and has a 5/8" shaft diameter with a keyway. The motor is wired so that it can be powered from a standard wall outlet and a 2-amp sloblo fuse is in the system to compensate for the voltage surge that occurs when the motor is turned on.

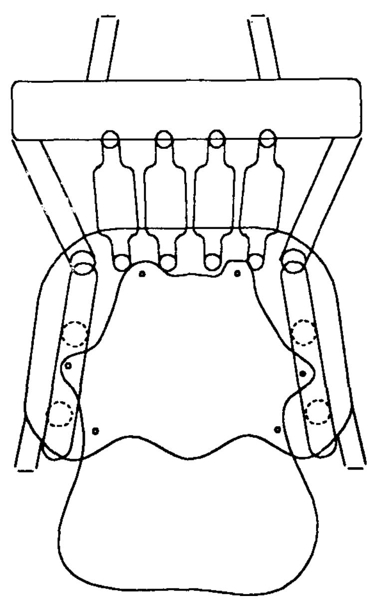
The cam system consists of a 5 1/2" pulley and a set-screw clamp welded together. The clamp was welded 1 3/4" from the center of the pulley. This offset gives a 2 1/2" displacement of the rocking chair. Two garage door rollers are used as the followers for the cam. The rollers are positioned on one of the rocker arms, one 1" from the end of the rocker arm and the other 3 1/4" from the end of the rocker arm. These distances provide a 1/4" space between the rollers. For added support, a block of 3/4" plywood is attached to the inside of the rocker arm. The motor was placed three inches above the platform and the cam rides over the 1/4" gap between the rollers. As the cam turns, it pushes the rollers with a vertical force that causes the chair to rock. To produce a positive-drive condition there is a spring connection from the pulley to the rollers. This spring prevents slippage and vibration between the cam and the followers.

The cost of parts and construction of this system was four hundred fifty five dollars ($455).

Further details can be obtained from the principal investigator.



Cam and Follower Design



Seat Extension Design

"Sit-n-Spin"
A Device to Provide Vestibular Stimulation
for the Developmentally Disabled

Designers: Michelle Gamble, Ray Chow, Mary Yoshimoto
Disabled Coordinator: Beverly Maszdzen, Albany CP Center for the Disabled
Supervising Professors: Dr. J. Lawrence Katz and Dr. Jonathan C. Newell
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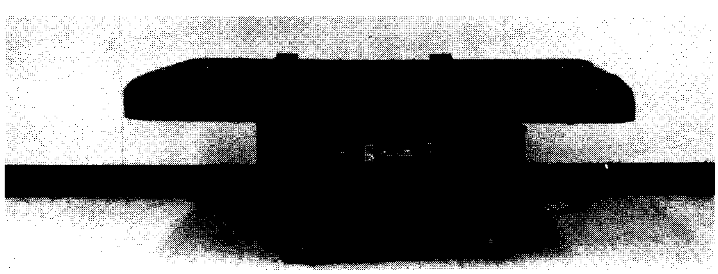
INTRODUCTION

The Sit-n-Spin design consists of a rectangular platform that is driven by a motor. A steel rod attached to its underside passes through a box which houses the motor mechanism and acts as a support system. The rotating platform rides on swivel casters that are attached to the top of the support box. The locking casters on the bottom of the box allow for transport of the device. The Sit-n-Spin was intended for use with the "Tumble-form Units" that are currently in use at the Center for the Disabled. The units are placed and held bv the VELCRO on the platform. These units, along with the safety belts attached to the platform, allow the client to be held securely and comfortably in various positions. The client can control the device by pressing the remote control switch.

SUMMARY OF IMPACT

Many children who are developmentally disabled are unable to interact with their environment appropriately. Many toys and play items are inaccessible to these children due to their demand for physical manipulation and control. These same children are often unable to engage in vestibular stimulation which is conducive to sensory integration. This type of rotational movement is provided by the popular commercial toy, the "Sit 'n Spin". This toy, however, is not accessible or practical for use with physically disabled children. The adapted sit-n-spin provides the same type of movement while accommodating the seating and positioning needs of cerebral palsied children. Its most important feature, however, is its ability to be controlled by the children themselves. By using the sit-n-spin with a commercial timing device, the child is able to activate the single switch which rotates the sit-n-spin for a pre-set amount of time. In this way, the device is not only an appropriate recreational and therapeutic tool but an educational one as well. Some of the children who use the sit-n-spin have not yet developed the understanding of cause and effect relationships. The exciting and immediate feedback of the rotational movement is a powerful new way to teach this cause-effect relationship.



TECHNICAL DESCRIPTION

The design of the Sit-n-Spin can be divided into three parts: the rectangular platform, the powertrain, and the support box. This section will provide a detailed plan of construction for the entire system.

PLATFORM:

The platform was constructed of a 2 1/2' x 4' x 3/4" sheet of plywood. An extra piece of 3/4" plywood was added as reinforcement to the underside perimeter of the platform. An additional piece of 3/4" plywood (8" x 10") was added to the underside of the platform in the center. These pieces were glued and screwed together. The top of the platform was then covered with 3" foam and naugahyde. Two safety belts were bolted to the underside of the platform to secure the client to the top of the platform. Velcro was glued to most of the surface area of the naugahyde (to allow for attachment of the "Tumbleform Units" already in use at the CPCD) and to the sides where the safety belts touch the platform (to keep belts from interfering with rotation of platform). A 1/8" thick piece of Plexiglas (24" x 24") was glued and screwed to the underside of the platform for smoother rotation. A piece of 1/4" thick sheet metal (8" x 10") was bolted to the 8" x 10" underside of the platform. A steel shaft (1/2" in diameter) was welded to the sheet metal at 90°. A 3/16" wide and 1/16" deep groove was milled into the shaft (in which a set screw can be tightened.)

POWERTRAIN:

The powertrain of the design consists of a 1/15 HP gear motor rotating an assumed load of 150 lbs. (required torque of 216 in. lbs.) at 6.7 rpm. The motor is wired to a cord which can then be plugged into a cordless wall outlet. This outlet operates the device in conjunction with the radio frequency remote control switch. Since the output shaft of the motor lies horizontally, a set of 1:1 ratio bevel gears with a 2" pitch (for better meshing of the gears) was used to rotate the vertical shaft (the steel rod attached to the platform).

Modifications were made to the gears. The gears' inner diameters as received were 3/4". However, both the motor shaft and the vertical shaft are 1/2" in diameter. Therefore bushings with inner diameters of 1/2" have been inserted into the gears. Two set screw holes (at 90°) were drilled and tapped in each gear (with bushing inserted). A collar (with three set screws at 120°) was attached to the vertical and motor shafts to stop vertical and horizontal motion of the gears.

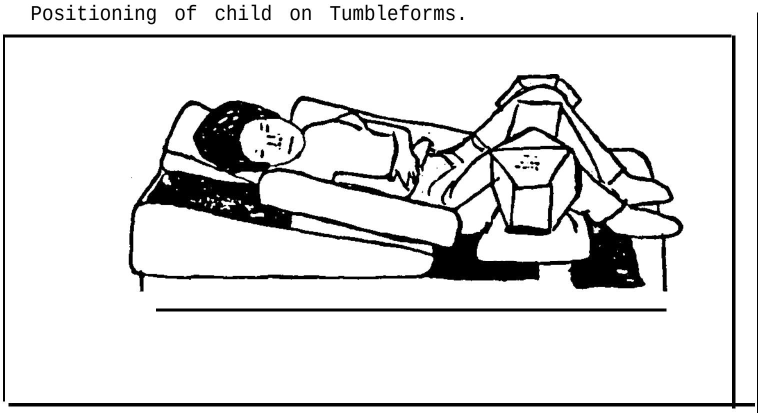
SUPPORT BOX:

A 24" x 10' box of 3/4" plywood encases the powertrain. Vertical beams were placed in the corners of the box for added support. A support block was glued to the bottom of the box to support the motor. A piece of 1/4" firm rubber was glued to the bottom of the box where the gear motor is attached. Eight swivel casters were placed on the top of the box to distribute the vertical load from the shaft to the box during rotation. An eccentrically locking bearing was attached to the ceiling and floor of the box. Four locking casters were attached to the bottom of the box to allow for transport of the device. A door consisting of a small piece of wood hinged to the side of the box (for easy access to the powertrain) with a handle for easy opening and barrel bolts to hold doors shut was made. The space in the support box surrounding the powertrain and vertical shaft was filled with poly-fil and foam rubber for sound insulation. An 18" x 18" piece of foam rubber was 'added to the underside of the box also for sound insulation. The outside of the support box and the added foam have been spray-painted for aesthetic purposes.

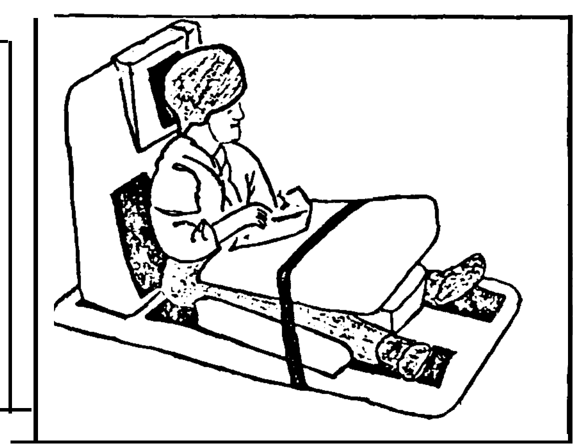
Costs for parts and construction amounted to five hundred sixty five dollars ($565).

Further details can be obtained from the principal investigator.

Positioning of child on Tumbleforms.



Lying Position



Sitting Position

"Electric Toy Jeep"
An Electric Powered Vehicle for
Cerebral Palsy Children

Designers: Carl Albuquerque, Martin Fichtner, D'Angela Griffin,
Leif Hagerup, Edward Li, Vince Livoti, Mario San Juan,
Kevin Uram, Brian Wojton, Sam Zaidspiner
Disabled Coordinators: Linda van Alstyne, Kelly Howatt, Francesca Storrs
Supervising Professor: Dr. Gary A. Gabriele
Department of Mechanical Engineering, Aeronautical Engineering and Mechanics
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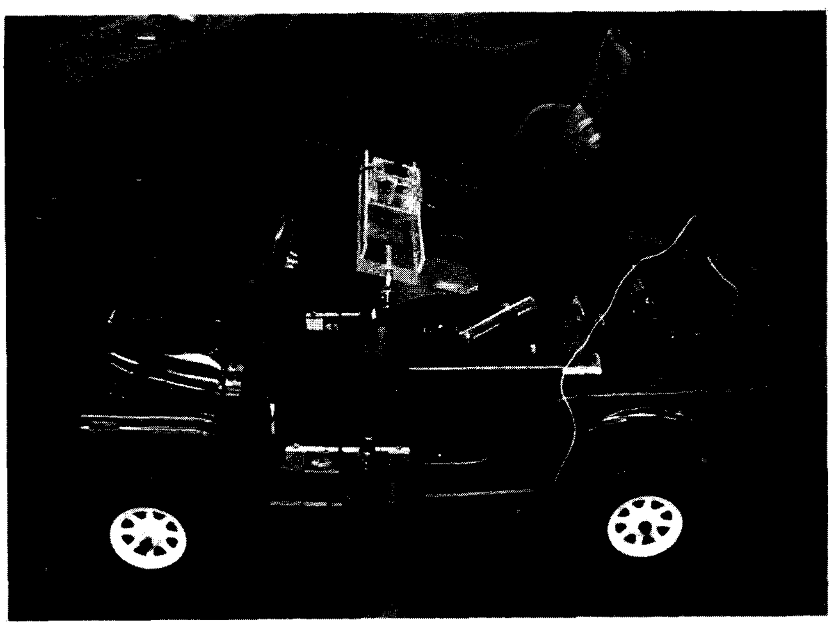
INTRODUCTION

An electric powered vehicle suitable for three-five year-old cerebral palsy children has been designed and constructed for the United Cerebral Palsy Association of Schenectady, NY. The vehicle is based on an electric toy jeep manufactured by Power Wheels. The steering wheel and seats have been replaced with a joystick and child's car seat, both of which are fully adjustable to allow for easy operation by cerebral palsy children. The vehicle is powered by a rechargeable, gel cel battery that gives the vehicle a minimum operating time of approximately two hours. Other features include smooth acceleration, top speed control, and a safety cord for a therapist to hold while the child is operating the vehicle.

SUMMARY OF IMPACT

Many clients are often confined to a manual wheelchair, as they are unable to develop and refine the prerequisite skills needed to demonstrate readiness for electric mobility. While some of these clients may be able to operate a joystick, many others will require an adaptive switch to control their environment. This presents an additional challenge in finding appropriate ways to provide pre-mobility experiences. While adapted toys such as cars and robots can provide some training in movement and space, they clearly do not provide the type of experience needed to move one's self in the environment. The motorized car meets this need for several clients. The car provides adjustability in its seating, so that clients are able to operate it in various sitting positions with appropriate positioning equipment. The motorized car represents an invaluable training tool for clients to develop wheelchair driving skills and allow for future acquisition of independent mobility.



TECHNICAL DESCRIPTION

An electric powered vehicle suitable for three-five-year-old cerebral palsy children has been designed and constructed for the United Cerebral Palsy Center of Schenectady, NY. The vehicle is to be used by the Center to study the effect of providing independent mobility on the cognitive development of young cerebral palsy children. The main requirements for the vehicle are the following: 1. The vehicle must be adaptable to children in the three-five-year-old ranger with a wide range of disabilities. It was assumed that a child would have enough ability, or could be trained, to operate a joystick. 2. The vehicle would be used in the Center, therefore it should fit through the doors in the Center and be very maneuverable. 3. The vehicle should use a readily available and rechargeable power source. 4. The vehicle should be appealing to children and should not look like a wheelchair. 5. The vehicle should be safe to operate.

The vehicle is based on a Power Wheels toy jeep that was donated by the Center to the project. The vehicle is driven by a pair of electric DC gear motors that are attached to the rear wheels and were part of the original toy jeep. The motors are controlled by a control system that determines which wheels will come on and in what direction. Using this arrangement allows the vehicle to be driven and steered by the rear wheels. The vehicle can move forward (both motors forward), backward (both motors backward), or rotate left or right (one motor on forward, the other off). The front of the vehicle is supported by two casters which are attached to the frame and raise the original front wheels off the ground. The motors are powered by a 12 volt gel cell rechargeable battery. Braking is accomplished by using the dynamic braking of the motors.

The control system of the vehicle accepts input from the joystick and controls power to the motors. The control system is made up of three major subsystems: the relay system, the speed control, and the joystick. The relay system is made up of six relays which control power and polarity to the motors. The speed control system is a pulse width modulation system that smoothly accelerates the motors and controls their top speed. The top speed can be adjusted by a knob under the hood of the vehicle. The joystick is a modification of a video game joystick known as the Ergo Stick. This joystick uses four micro switches which were easy for the children to operate and provided good tactile feel. A safety switch is provided at the back of the vehicle with a safety cord that the therapist holds. If the child is in danger, the therapist pulls on the cord to remove the switch and disable the joystick.

The seat of the vehicle is an adapted child's car seat that has a hinge between the back and seat bottom. The seat bottom is mounted to a six-way power seat adjustment adapted from an old Cadillac automobile. This provides the seat with height, fore and aft, and tilt motion, as well as allowing the seat back to recline. The joystick is mounted on a tray in front of the seat and is adjustable for height, left and right, and fore and aft positioning.

The final cost of the vehicle, not including the cost of the original vehicle, was approximately three hundred eighty two dollars ($382).

Further details can be obtained from the principal investigator.

"Wake-Up Alarm Clock"
A Self-Setting Alarm Clock for the
Functionally Impaired

Designers: Donald Dione, Kenneth Scioscia, Scott Bialik
Disabled Coordinator: Beverly Maszdzen, Albany CP Center for the Disabled
Supervising Professors: Dr. J. Lawrence Katz and Dr. Jonathan C. Newell
Department of Biomedical Engineering
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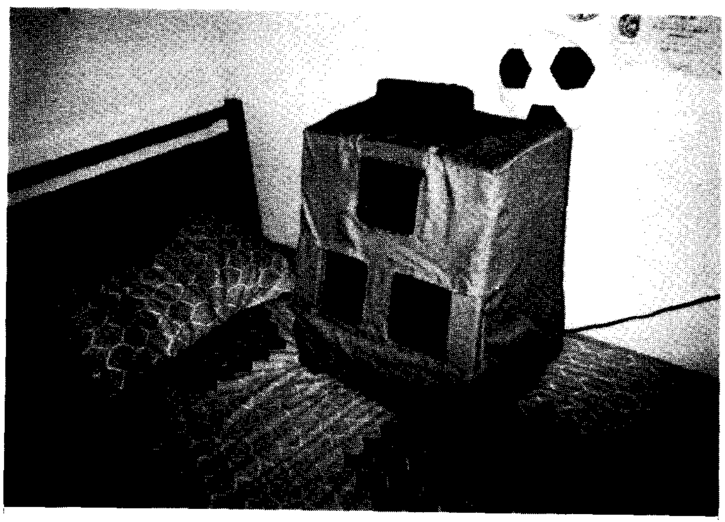
INTRODUCTION

A two-component alarm clock system for the functionally impaired has been developed. The system has two components: First, the mechanical sub-system. This includes a three-input switch system and the casing to hold these switches. The second sub-system is the electronics. These include the logic to control the alarm clock from any three-input system and the circuitry to control the feedback lights of the switch system.

SUMMARY OF IMPACT

One of the primary goals of programming for the developmentally disabled adult is the acquisition of skills necessary for independent living. While many clients may be unable to achieve independent living, they may be placed in a community residence. In such placements, the ability to independently control one's environment is of paramount importance. Such independence may include the responsibility of waking and preparing for work reliably. Setting an alarm clock presents a physical challenge beyond the capabilities of many clients who may at best possess gross hand movements. The adapted alarm clock allows for easy access by using three switches for operation. This implies that any three mechanical input systems can be interfaced with the electronics, making the clock appropriate for use by a variety of clients who may all activate different types of switches with different body parts. The alarm clock represents an important step in the process of acquiring control over one's environment and ultimately, toward independence.



TECHNICAL DESCRIPTION

A two-component alarm clock system for the functionally impaired has been developed. One major component of this device is the mechanical sub-system. This includes a three-input switch system and the casing to hold these switches. The switches are made of 3/4" Plexiglas squares with dimensions of 5.5" x 6". Each of these Plexiglas squares is held in place by three Plexiglas C-brackets. The C-brackets were made from Plexiglas strips with the dimensions of 6" x 0.5" x 1". These strips have a groove milled into them so that they hold the Plexiglas squares in place and also allow a clearance of 3/8". This distance was required for the clearance of a common pulse push switch. The switches are also spring-loaded so that the weight of the Plexiglas squares does not activate the switches. These components are attached to a large irregularly-shaped aluminum box. Padding and fabric have been added to give the apparatus the appearance of a large pillow.

The second sub-system is the electronics. These include the logic to control the alarm clock from any three-input system and the circuitry to control the feedback lights of the switch system. The master switch toggles among three states: ALARM OFF, ALARM SET, and ALARM ON. The other two switches are used to change the hours and minutes when setting the alarm. All the switches are lighted when pressed; this serves as a feedback system to the user. The main switch is either green, yellow, or off, depending on which mode the system is in. The other two switches illuminate red when they are activated. The circuit is a set of CMOS logic functions with two JK flip-flops that allow the switches to control the clock. A 555 timer is used as a clock to run the flip-flops. The logic has low as OV and high as +12V. This is interfaced with an existing Radio Shack alarm clock by adding the voltages in the clocks -12V to simulate the alarm clock switches. Also the clock's power was used for this purpose, so no batteries were needed.

Total cost for this system was two hundred sixty one dollars ($261).

Further details can be obtained from the principal investigator.

"Modified Toaster"
A Toaster Modified for Operation
by the Manually Impaired

Designers: Karen Bookman, Nelson Sanchez, Christopher Blum
Disabled Coordinator: Beverly Maszdzen, Albany CP Center for the Disabled
Supervising Professors: Dr. J. Lawrence Katz and Dr. Jonathan C. Newell
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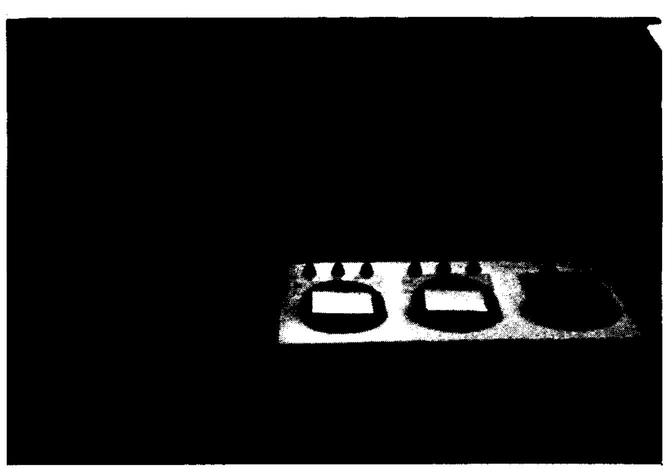
INTRODUCTION

The product is a toaster modified for use by people with limited dexterity and upper body motion. This toaster has a control panel from which functions can be controlled by the user. The control panel is a 10" x 17" x 2" aluminum box which contains three 4"-diameter control buttons. Each of these buttons has a set of lights that turn on when a function is activated. The bright colors of the lights and the large buttons make it easy to use in cases of visual impairment. The whole unit is encased in a moisture-proof covering convenient for cleaning. There are spaces on the control panel where labels can be placed. This feature is specifically for those client who require a different labeling system.

The control panel is portable and is attached to the toaster by a ten-foot cord. This enables the customer either to use the panel away from the heat of the toaster, or to place it on the lap tray of a wheelchair. The toaster itself is driven by motors that are controlled by the panel. The user can toast two or four pieces of bread at one time; one of three different degrees of darkness for the toast can also be selected.

SUMMARY OF IMPACT

For many developmentally disabled adults, the focus of their programming is on those activities of daily living such as grooming, cooking, and self-care. The kitchen environment presents multiple challenges to the physically disabled person. The levers, buttons, and settings on household appliances are physically inaccessible and cognitively demanding. Many of these clients do not have functional use of their upper extremities and can, at best, use a headpointer or a gross hand motion. Often the developmentally disabled adult is unable to independently use these appliances, and is forced to rely on co-active assistance. Food preparation remains a motivating activity as well as a functional task. The modified toaster allows the client to have control over the appliance's operation. This control entails being able to set the time of toasting, and activate the levers on the toaster's front panel to actually start toasting the bread. Adaptations include mechanical modifications to drive the toaster handles down, and a control panel that acts as an interface between the client and the appliance, thus providing the client with a degree of freedom and control they previously lacked in their environment.



TECHNICAL DESCRIPTION

The toaster, a four-slice unit owned by the Albany C.P. Center for the Disabled, could not be utilized by clients who participate in a training program. The toaster has been modified to allow the client to become more involved in the experience of independent living. The modification design takes into consideration the functional abilities of the client, e.g., muscle coordination, visual impairment and inadequacy of cognitive skills. A control panel housing three switches and electronic logic circuitry directs electronics that are housed in an extension. The extension is built as part of the toaster itself. The control panel and the toaster are connected via a ten-foot cable.

Electronic circuitry controls the entire operation of the toaster. This control, accomplished by three switches, includes the selection of heating elements, the duration of toasting cycle, and the start time. The choice of how many heating elements are activated was a requirement for the toaster to become a training aspect. Logic circuitry using NOR GATES, OR GATES, resistors, capacitors and a DECADE counter are employed for switch #1. Switch #1 governs whether two or four heating elements are to be used. A linear actuator, an A.C. reversible motor having a threaded shaft, receives an electrical signal from the logic circuitry and rotates CCW. Attached to the threaded shaft is a steel rod that forces the toaster handles down until they lock in place for toasting. At this point, the activation of a microswitch trips a relay which forces the current in the motor to reverse direction and thus reverse the motor rotation. The motor circuit uses a triac as a switch which passes an A.C. current.

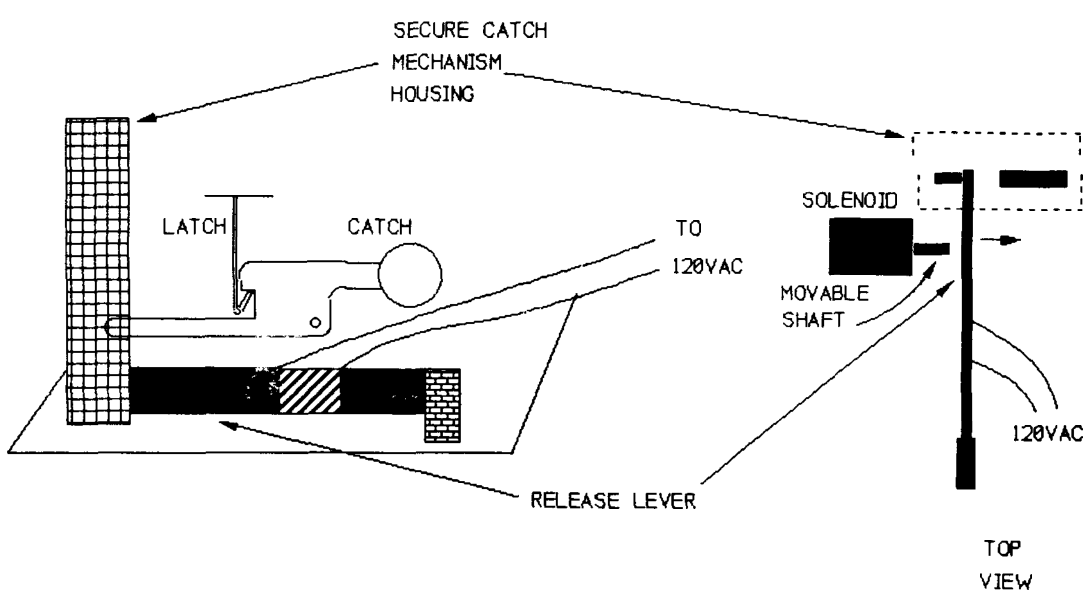
Switch #2 controls the time that the toast remains in the toast cycle. The circuitry consists of NOR GATES, AND GATES, resistors, capacitors and a DECADE counter. The AND GATES use an input from the OR GATES of switch #1 to decide what side of the toaster will be on. The client has three choices of toasting time which are accomplished by three different RC networks. The latch and catch mechanism that was initially used in the toaster was slightly modified to allow a solenoid plunger to release the mechanism. Depending on the time constant selected, two 555 TIMERS act as the time delay circuitry. The solenoid is activated for one second and forces the release mechanism, popping up the toast.

Switch #3 permits switches #1 and #2 to perform the operations selected by the client. All the outputs from switch #1 and switch #2 go to a relay that is normally open. When switch #3 is activated, the relay becomes energized and the selected signals are passed to perform the operation desired. Switch #3 also sends an inhibiting signal to both decade counters of switch #1 and switch #2. This inhibiting signal deactivates the first two switches during the operation. After the toast pops up, a microswitch is activated which resets switch #3. By resetting switch #3, the relay becomes de-energized and switches #1 and #2 are active to make another selection.

A power supply consisting of a transformer, a full wave rectifier and two voltage regulators provides the necessary current and voltages to the circuitry. The transformer is rated to provide a maximum of 2 amps of current. A fuse is provided for protection from shorts.

The cost of parts and construction was four hundred thirty dollars ($430).

Further details can be obtained from the principal investigator.



CATCH RELEASE MECHANISM

"Remote Control Dune Buggy"
A Toy Radio-Controlled Car
for Wheelchair Simulation

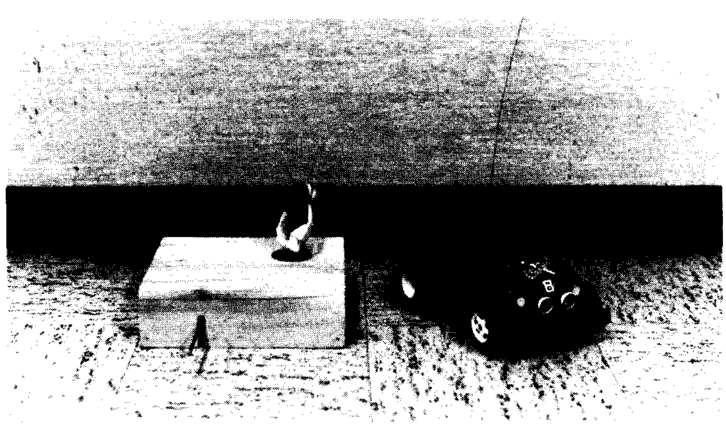
Designers: Brontie Benn, Yvette Richardson
Disabled Coordinator: Beverly Maszdzen, Albany CP Center for the Disabled
Supervising Professor: Dr. J. Lawrence Katz
Department of Biomedical Engineering
and
Department of Electrical, Computer, and Systems Engineering
Rensselaer Polytechnic Institute
Troy, NY 12180

INTRODUCTION

This project involves using a toy radio-controlled car as a wheelchair simulation to train a handicapped client to eventually be able to use a wheelchair. With the simulation, it is hoped that the client will be able to enhance his/her perception of space and motion. It also serves as a playtoy providing entertainment for the child.

SUMMARY OF IMPACT

For many young children with physical disabilities, the potential for independent mobility through an electric wheelchair is difficult to determine. Due to physical inability to move one's self, or to move toys in space, these children often do not develop the prerequisite skills necessary for the operation of a wheelchair. These skills include the perception of space, time, and speed concepts. These same children require adapted switches in order to control items in their environment. The various types of physical disabilities demonstrated by the cerebral palsied population imply that each child needs to be assessed for the particular switch and body site to be the activator. The remote control dune buggy accommodates a variety of interchangeable switches. The buggy is radio-controlled, motorized, steerable and has the directional mobility necessary for a wheelchair training device. It is large enough to fit a doll of approximately four inches in the front seat. Also, the buggy is large enough to be weighed down for speed control and is attractive to the children. This device provides indirect/observational experience of spatio-temporal concepts in a fashion that will have meaning and value to the children. It also provides a "normalizing" play experience for children who are unable to directly manipulate a doll.



TECMICAL DESCRIPTION

A toy radio-controlled car has been converted into a pre-wheelchair training device by transforming the controls of the transmitter into controls that could be performed by a joystick or other control mechanisms. The transmitter was rewired so that it could be controlled by the joystick. Since most control devices for the handicapped (waferboards, joysticks, etc., include a nine-pin port as the interface, the Turbo Beetle's radio control was modified so that it is now compatible to most control devices by the incorporation of a nine-pin port to its transmitter. The nine-pin port allows the wheelchair training device (Turbo Beetle) the versatility of using a multitude of possible control devices, thereby enabling its use by a vast range of clients. A velcro strip was attached to the joystick so that the client's hand could be held in place while he/she is learning to control the car.

An Atari joystick interface was attached to the system so that it could be used with other devices to train other clients to use this technology. Many clients cannot use the joystick; some must use a waferboard or head pointer. This interface can be used to plug these devices into the joystick.

Finally, a wooden case was built to enclose the design. This case includes the following: (1) Rounded corners to insure that there would be no injuries to any of the clients. (2) A hole for the joystick to insure its stability and to enable the client to have constant contact. (3) A place for the antenna of the transmitter so that it can be pulled in/out as needed. (4) Extra space on the box where a hole can be made for a new switching device that will be more suitable for the client. (5) A drop-out bottom to open the case, which is held together by rounded pegs.

The cost of parts and construction was approximately eighty two dollars ($82).

Further details can be obtained from the principal investigator.

"Motorized Scooter"
A Kinetic-Interaction Device for Disabled Students

Designers: Samie Niver, Angela Acito, Lawrence Vaughan
Disabled Coordinator: Beverly Maszdzen, Albany CP Center for the Disabed
Supervising Professors: Dr. J. Lawrence Katz and Dr. Jonathan C. Newell
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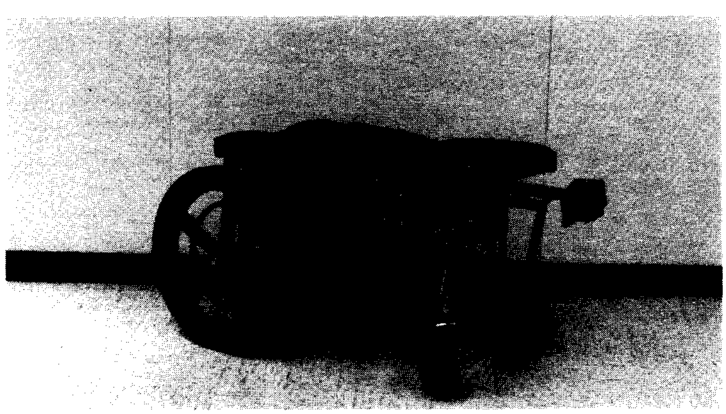
INTRODUCTION

A motorized scooter to be used by CP children has been designed and fabricated. There are three main purposes for this scooter: (1) To teach the concept of cause and effect. (2) To allow interaction with the environment. (3) To prepare the child for future wheelchair use.

When the client is in the sitting position, he/she will be secured in the seat with chest and lap belts, his/her feet will be secured in the leg rest, and the seat itself will be locked into the lowest position. By adjusting a leaning chair device, the client can recline at angles down to 30 degrees. To accommodate the client in the prone position, the chair device is released and the bottom of the seat is raised to the highest position. A triangular cushion is strapped to the bottom and the back of the seat, and the client is secured to this cushion by adjustable straps. The control arm can be adjusted for the client's comfort. The joystick can be detached so that the therapist can operate the scooter. There is also a safety kill switch on the back of the scooter so that the therapist can override the user.

SUMMARY OF IMPACT

Currently, there are many clients who have the potential to operate an electric wheelchair. These clients are often confined to a manual wheelchair, as they are unable to develop and refine the prerequisite skills needed to demonstrate readiness for electric mobility. These skills include perception and control of space, directionality, time, and speed. While some of these clients may be able to operate a joystick, many others will require an adaptive switch to control their environment. This presents an additional challenge in finding appropriate ways to provide pre-mobility experiences. While adapted toys such as cars and robots can provide some training in movement and space, they clearly do not provide the type of experience needed to move one's self in the environment. The motorized scooter meets this need for several clients. It provides a powerful evaluation tool for possible future electric wheelchair acquisition. The scooter provides adjustability in its seating, so that clients are able to operate it in prone and various sitting positions with appropriate positioning equipment. While its purpose is to allow for independent exploration, issues of safety remain so that a control switch is included for the therapist/teacher to override the mechanism. The motorized scooter represents an invaluable training tool for clients to develop wheelchair driving skills and allow for future acquisition of independent mobility.



TECHNICAL DESCRIPTION

The four-wheel rectangular frame was constructed of one-inch square steel beams welded together. The aluminum armrests were welded to the frame.

The vehicle is driven by two Klaxen l/S-horsepower DC motors. The vehicle was designed to travel at a maximum speed of 4.4 ft/sec. The two main wheels are driven by the motors by a three-to-one pulley ratio. To power the motors, one 12-volt gel-cell battery was used. In order to prevent overloading, three 35-amp circuit breakers and two 30-amp "slo-blo" fuses were attached to the positive terminal of the battery.

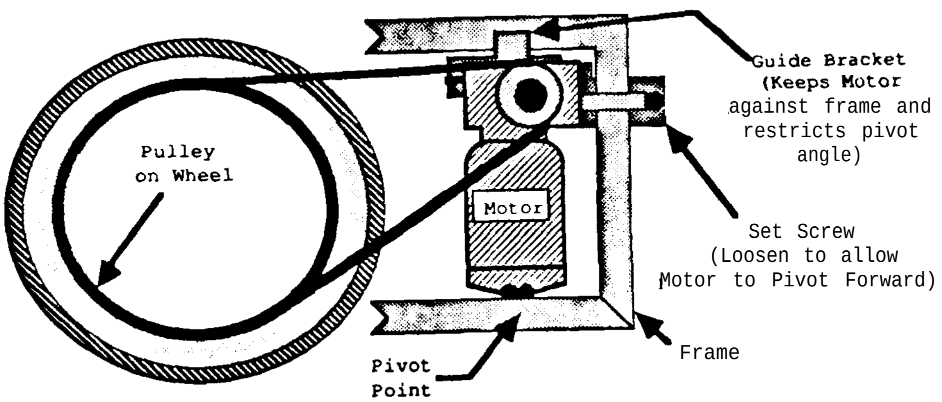
A Naugahyde upholstered seat with a headrest, legrest and a reclining feature was designed and constructed. The headrest was made an optional feature; the legrest can be adjusted angularly.

The reclining feature is from a Morse chair. The Morris chair mechanism allows the client to be accommodated at reclining angles as low as 30 degrees. The back of the seat can be released (down) to 180 degrees so that the client can be accommodated in the prone position.

The control system controls the flow of power from the battery to the motors by microswitches. The control arm is attached to the side of the armrest by a bolted steel housing. The L-shape of the control arm will meet the client's needs in both the sitting and the prone positions.

Parts and construction cost four hundred ninety dollars ($490); an additional four hundred dollars ($400) worth of parts was provided by the Albany CP Center for the Disabled.

Further details can be obtained from the principal investigator.



Motor & Clutch Assembly

"The Joystick Positioning Table"
A Device for Assessing Positioning of
Joystick Controls for the Functionally Impaired

Designers: Andrew Keegan, Marcia Holbrook, Ann Polanki
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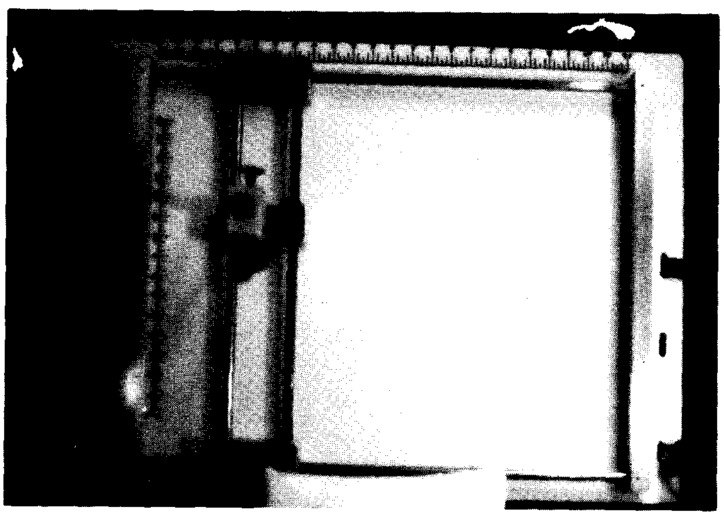
INTRODUCTION

Many individuals who can control an electric wheelchair do not have good motor control in the standard areas where joysticks are usually placed on the arms of an electric powered wheelchair. The Joystick Positioning Table is an assessment tool used by the occupational and physical therapists of disabled clients to help them determine where to place the joystick on the wheelchair. The device is attached to a Plexiglas tray that can be secured to the arms of a wheelchair, or situated on an adjustable table. A simulation of a joystick is moved around by the therapist and locked into place so the client can try it out. The positioning motion is carried out through the use of linear bearings that run on shafts in the front-to-back, side-to-side and vertical directions. Angular adjustments of the joystick position are also allowed by the motion of a ball-and-socket joint. Once the suitable placement of the joystick is determined, the therapist reads its location through the use of the inscribed measuring system. Several different joystick tops are also included with the device which allow the correct handle for the individual client to be determined at the same time.

SUMMARY OF IMPACT

Currently there are many clients who demonstrate the cognitive and spatial skills necessary to operate an electric wheelchair. Often these clients receive limited exposure to the trial use of an electric wheelchair due to limited joystick types and limited positioning available to use for assessment. In some cases, a wheelchair may be ordered without the proper joystick alignment being determined, delaying mobility training significantly. In addition, these clients may be able to operate computer software programs via a joystick, but receive limited exposure for similar reasons. The use of this device enables the client to gain independence through the use of a wheelchair or a computer in a much shorter period of time. Each client is able to test the various joystick positions and achieve the most optimum placement through trial and usage. The therapist has the ability to move the joystick in all directions until the best position is found where the client can control it efficiently, and in the best possible pattern. This type of assessment tool allows the client to have the most suitable joystick ordered at the same time as their wheelchair is ordered. Thus, electric wheelchair mobility training could begin immediately. Through the use of the joystick positioning table, the therapist is able to complete a normally time-consuming task much more quickly and efficiently.



TECHNICAL DESCRIPTION

For many disabled people, the ability to operate a joystick is an important means of obtaining a degree of independence and self-sufficiency. These joysticks can be adapted to run electric wheelchairs, computers, and many other pieces of equipment. Due to physical considerations, however, many disabled individuals are unable to operate the standard joystick in the standard positions. Consequently, an occupational therapist must work with the client in assessing the abilities of the client and in determining the optimal placement of a joystick.

To assist the occupational therapist in this task, a Joystick Positioning Table (JPT) has been designed. This device allows the occupational therapist to evaluate how well the client can use a joystick in various positions.

In order to accommodate the needs of the client, the JPT contains a joystick simulator which can be moved in three dimensions and can be adjusted at various angles. To accomplish these degrees of movement, a durable, smooth-rolling system has been developed.

This system begins at the base with a solid piece of Plexiglas. On top of this base are aluminum frame ends which serve as supports for two horizontal, 23" long 1/2" steel shafts. On each shaft, aluminum housings with linear bearings are allowed to slide side-to-side. The two housings are connected by two shorter (18") 1/2" steel shafts. These shafts are perpendicular to the first two shafts so that they can provide for front-to-back positioning.

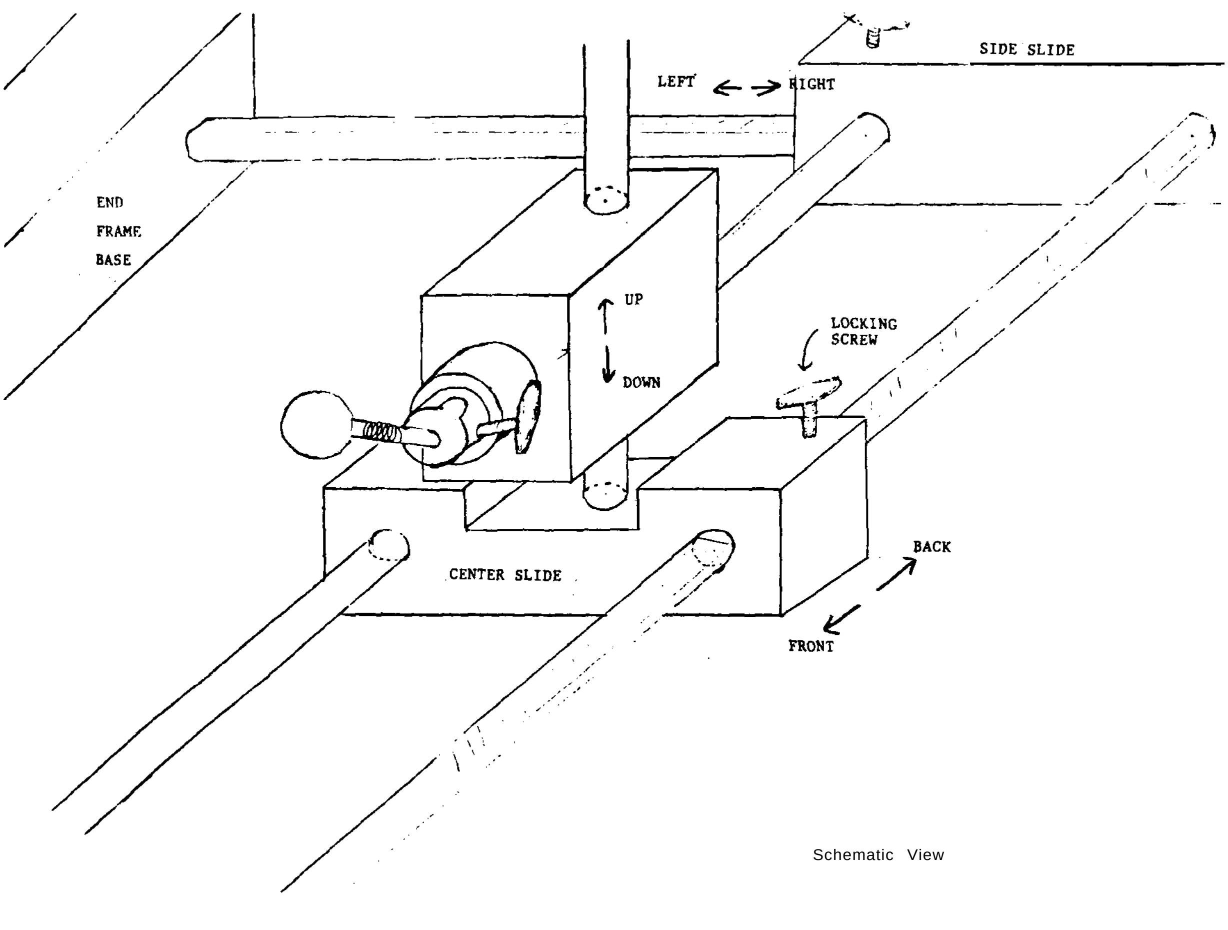
To allow for vertical positioning, another aluminum block which runs along the front-to-back shafts contains an 8"-tall, 1/2" vertical shaft. Surrounding this shaft is a small aluminum block which also holds a camera tripod top. This top contains a ball-and-socket type mechanism which acts as the angular adjustment for the joystick simulator. The actual simulator, which is connected to the tripod top, is comprised of a threaded rod, a spring for bending, and a coupler to attach various joystick tops.

Each direction of movement can be locked easily by tightening knobs which go through the aluminum housings and lock onto the shafts. For locking the side-to-side and front-to-back positions, a flat has been milled on the shafts so that marring does not inhibit the motion of the linear bearings. For locking the up-and-down position and also for preventing rotation, a keyway has been milled into the vertical shaft. A locking knob is also provided on the camera tripod top to lock the angular position.

Two parts which are specific to this design are the linear bearings, model LMB-3 from Winfred M. Berg, Inc., and the camera tripod top, model 3293 from Bogen.

The cost of parts was one hundred eighty dollars ($180); an additional four hundred fifty-two dollars ($452) was required for machining various parts. Thus the total cost was six hundred thirty-two dollars ($632).

Further details can be obtained from the principal investigator.



Schematic View

"Feedback Kneebrace"
A Feedback Device to Alert when
Hyperextension of the Knee Occurs

Designers: Robert Cargill, Shelly Petronis, Nelson Rosen
Disabled Coordinator: Beverly Maszdzen, Albany CP Center for the Disabled
Supervising Professors: Dr. J. Lawrence Katz and Dr. Jonathan C. Newell
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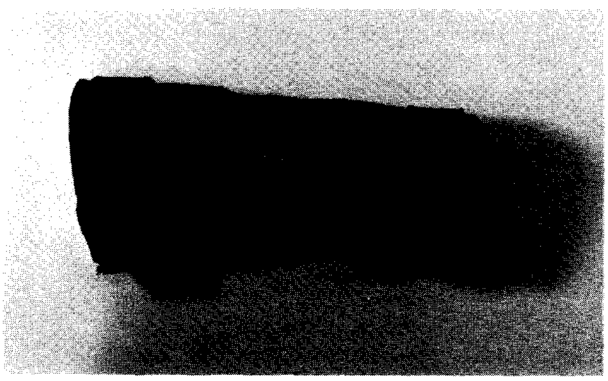
INTRODUCTION

The client is a five-year-old male who hyper-extends his right knee during upright activity (bends backwards, e.g., the lower leg bends too far forward). The client is unable to control this hyperextension because he usually is not aware that it is happening. If he knew when he was hyperextending his knee, he would be able to stop doing it. The task was to design and build a device which tells him when he is hyperextending. This device is called the HSU (Hyperextension Signaling Unit).

The HSU slides onto the client's leg like a sock. It is pulled up on the leg until the knee-cap is in line with a large hole in the center of the HSU. When it is in proper position on the leg, the client may proceed with any daily acti-vity (except water sports). Whon he hyperextends, the HSU will turn on an electric buzzer to tell him his knee is hyperextending. When he bends his knee back into the normal range of motion, the buzzer will turn off. The HSU is powered by a rechargeable AAA battery. The battery and hinge system can be removed for washing the sleeve.

SUMMARY OF IMPACT

A variety of gait deviations are demonstrated by the cerebral palsied client. Hyperextension of the knee can produce a slow and stressful gait pattern. Often the type of verbal and visual feed-back from the physical therapist may be insuffi-cient to correct the deviation. The Hyperexten-sion Signaling Unit (HSU) was designed to signal the client when his knee hyperextends so that eventually he can learn to control the degree of knee extension used while upright. The HSU was designed for comfort, convenience, aesthetic pur-poses, low cost and wear resistance. The HSU uses a neoprene sleeve to hold a Plexiglas hinge to the client's knee. This hinge actuates a rotary switch, turning on a buzzer while the knee hyperex-tends. The buzzer, battery and switch are attached to the hinge and contained on the sleeve. The HSU will signal the client while the angle between his tibia and femur exceeds a pre-set angle. As a result of this auditory signal, the client will learn to control the hyperextension of his knee, producing a less stressful and more functional gait.



TECHNICAL DESCRIPTION

The task was to design and construct a knee hyperextension signaling unit (HSU) for the right knee of a five-year-old male client. The device uses a buzzer to signal the client when he hyperextends his right knee.

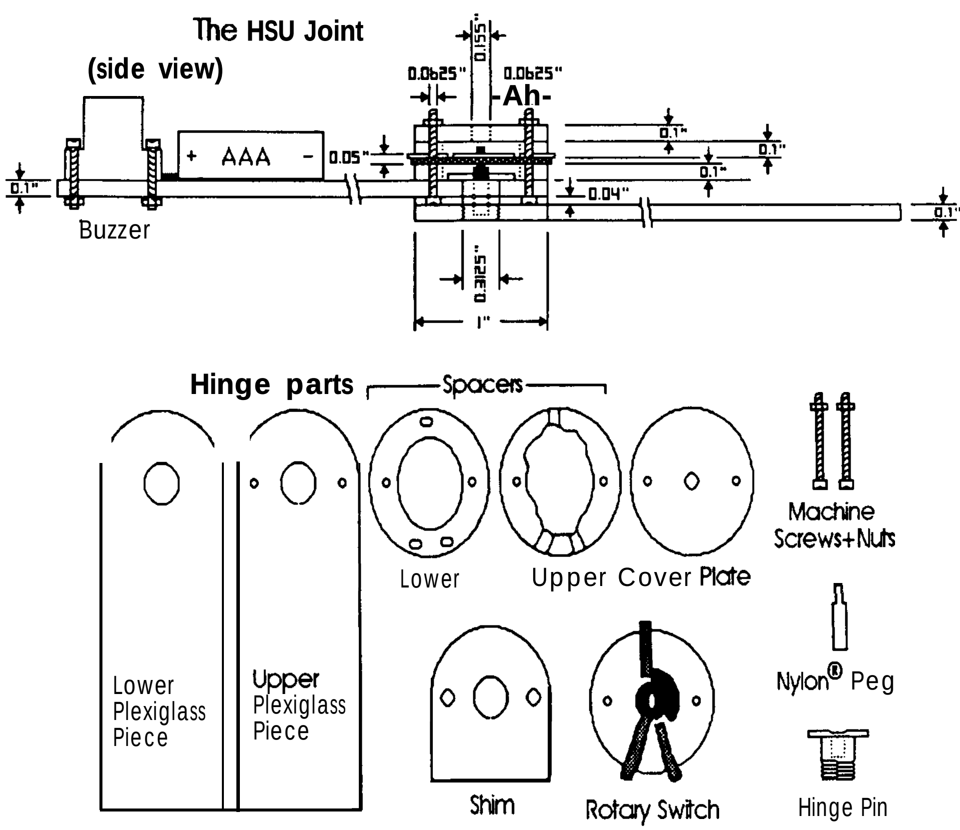
The HSU is made up of two major components: the sleeve (Fig. 1) which holds the device to the client's leg, and the hinge (Fig. 2) which actuates the buzzer.

The sleeve is a Donjoy #002 extra small dense sleeve, modified to hold the hinge system in place against the leg. This modification consists of two hand-made socks that hold the hinge system in place on the sleeve. The socks are sewn to the sleeve with nylon thread. The complete modified sleeve is made of neoprene with a nylon finish on the inside and outside (Fig. 1).

The hinge system is made of 1/10" Plexiglas, custom cut to the client's measurements (Fig. 2). It contains a rotary switch located at the pivot point, actuated by the hinge pin. The rotary switch is lifted off the hinge system with a spacer to allow for switch rotation. There is a spacer on top of the switch which supports a protective cover. The hinge pin is made of a 5/16" grade 1 steel bolt that was machined to fit the system (Fig. 3). The head thickness is 1/16". This is used for the flange that holds the two hinge pieces together. A nylon peg is pressed into a hole in the top of the hinge pin. This peg fits through a hole in the center of the rotary switch, and serves to actuate the switch. The purpose of the peg being press-fit into the hole in the hinge pin is to allow the peg to be adjusted rotationally, i.e., to vary the angular position of the peg with respect to the hinge pin. A calibration tool was constructed from a phillips-head screwdriver to angularly adjust the peg.

Parts and construction cost one hundred fifty two dollars ($152).

Further details can be obtained from the principal investigator.



"A Feedback Knee Brace"
A Feedback Device to Alert when
Hyperextension of the Knee Occurs

Designers: A. Toppses, T. Lenihan, T. Larkin
Disabled Coordinator: Beverly Maszdzen, Albany CP Center for the Disabled
Supervising Professors: Dr. J. Lawrence Katz and Dr. Jonathan C. Newell
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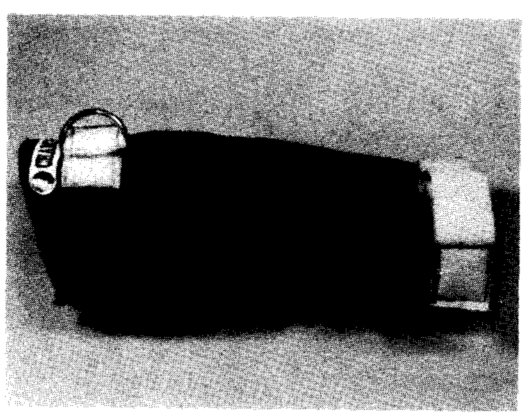
INTRODUCTION

The Feedback Kneebrace device was designed either to make a buzzing sound or to vibrate when the client extends his/her leg beyond the point of being perfectly straight, i.e., hyperextended. This is accomplished by a hinge that is sewn to the side of a kneebrace similar to those braces used by basketball players. The hinge moves with the movement of the client's leg. When the hinge extends just beyond the point of being perfectly straight, a "hump" on the upper band of the hinge presses against a switch mounted on the lower band. In this way, power is routed to either the buzzer or the vibrator in a pocket on the lower rear of the brace and produces a signal that can either be heard or felt. (A slide-switch located on a box which contains the buzzer and the vibrator is used to select the desired signal.) Thus, the brace can be used to help *train* the client not to hyperextend his/her leg and to walk more efficiently, thus reducing the potential of damage to calf muscles because of hyperextension.

SUMMARY OF IMPACT

A variety of gait deviations are demonstrated by the cerebral palsied client. Hyperextension of the knee can produce a slow and stressful gait pattern. Often, the type of verbal and visual feedback from the physical therapist may be insufficient to correct the deviation. The Hyperextension Signaling Unit (HSU) was designed to signal the client when his knee hyperextends, so that eventually he can learn to control the degree of knee extension used while upright. The HSU was designed for comfort, convenience, aesthetic purposes, low cost, and wear resistance. The HSU uses a Neoprene sleeve to hold a Plexiglas hinge to the client's knee. This hinge actuates a rotary switch, turning on a buzzer while the knee hyperextends. The buzzer, battery and switch are all attached to the hinge and contained on the sleeve. The HSU will signal him while the angle between his tibia and femur exceeds a pre-set angle. As a result of this auditory signal, the client will learn to control the hyperextension of his knee, producing a less stressful and more functional gait.



TECHNICAL DESCRIPTION

A hyperextension detection mechanism has been designed and constructed. It utilizes a machined plastic hinge approximately 30 cm long (when fully extended) attached to a knee brace. A screw at the hinge pivot goes through one leg of the hinge, then through a "cam" or "bumper", and through the other hinge leg. The cam is an elliptically-shaped piece of plastic whose purpose is to make contact with a micro-switch over a predetermined radial position range. The cam is held tight to the upper leg of the hinge by a thumbscrew. The flat end of the thrumscrew is recessed into an adjustment slot in the cam so that it will not rub on the lower hinge leg. Thus, when the thumbscrew is loosened, the rotational position of the cam relative to the upper hinge leg can be adjusted, allowing for the adjustment of the activation point of the hinge mechanism. This hinge is mounted on the brace via pockets that contain most of the length of the uper and lower hinge legs.

Once the cam on the hinge makes contact with the micro-switch, a circuit consisting of a selector switch in series with a three-volt power source (two "AAA" batteries) is completed. The selector switch routes current either to a buzzer (for the signaling option using sound) or to a motor with an off-center weight placed on its drive shaft (for the vibrational signaling option). The buzzer, motor and selector switch are all contained in a signal box 3.9 cm wide, 5.7 cm long, and 1.8 cm thick. This box, along with the two "AAA" batteries, is held in a tight pouch at the lower rear of the brace (on the client's upper calf).

The brace which serves as the mounting base for the detection-signaling mechanism consists of a tube with a hole and pad for the patella. This hole and pad insure consistent positioning of the brace on the client's leg (since any other position is made very uncomfortable). The brace material is rubber neoprene which stretches around the client's leg preventing slip and allowing for growth. Thus, the hinge as mounted on this brace will move as the client's leg moves and will activate either the buzzer or the vibrator when the micro-switch is contacted.

The total cost of the parts which comprise the prototype is $49.75. During the course of development, however, many components were purchased redundantly (to insure a working part) or for exploration of an alternate design option that was subsequently rejected. The total cost of these parts amounted to approximately $105. Thus, the total financial investment in this project on its completion is approximately one hundred fifty five dollars ($155).

Further details can be obtained from the principal investigator.


VALENTA