CHAPTER 15
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THE HANSS WITH BIOFEEDBACK AND MULTI-FUNCTION TABLE: ENCOURAGING CORRECT ANATOMICAL SEATED POSITIONING FOR A CHILD WITH CEREBRAL PALSY

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INTRODUCTION

The client is a 10 year old girl with cerebral palsy. She spends most of her time throughout the day in a power wheelchair that she is able to operate and control. Due to weak neck and back muscles, the client's head is almost constantly in a downward flexed position. She is able to raise her head for a few seconds at a time but cannot maintain the position. A head and neck support device (HANSS) has been designed to help position the client with shoulders and head in a correct anatomical position. This will limit strain and discomfort that the client currently experiences. The HANSS features a biofeedback system, which encourages the client to assume correct anatomical position without the instruction of her parents or teachers. Schoolwork and extracurricular activities are very important to the client. The limitations of her power wheelchair include the inability to allow her access to certain desks and small areas. An ideal space for the client to do her school work, computer work, and crafts would be right in front of her on an easily adjustable and accessible desk top. One main function of this multi-function table is to raise her papers and books to eye level through the use of a linear actuator and tilt table. This will limit the strain on the client's neck and eyes, as she usually peers down to her lap to read or do homework.

SUMMARY OF IMPACT

Many devices currently available on the market are very restrictive in nature. The client is free-spirited and encouraged to express herself by her parents and teachers. A head and neck support device is designed to allow movement, but to encourage the client to remain in the correct position. Within the pillow cushioning of the HANSS are three light-touch sensors. When activated, these switches complete a circuit that outputs music through an iPod. This positive feedback will remind the client of the benefits of maintaining correct posture. Repeated use of the HANSS will begin to reprogram incorrect muscle memories and lead to a healthier and more relaxed neck and spine. Using the multi-function table to read materials at eye level will further improve the posture and muscles involved in correct positioning. Aside from the practical applications of these devices, the health rewards are numerous and very important to a young and growing child.

TECHNICAL DESCRIPTION

The HANSS is constructed using a stainless steel frame and covered in soft high density neoprene foam. The dimensions are custom fit to the contours of the client's neck and shoulders. The result is a comfortable neck pillow with side flanges that pull the shoulders backward and encourage a tucked chin position. An adjustable gooseneck can increase or decrease the resistance and support provided by the device. An optional Snap-On chin support further encourages correct positioning. The HANSS features a biofeedback system that uses positive and negative rewards. Through a series of three switches embedded in the cushion of the HANSS, the client is able to activate a circuit with iPod capabilities. Music will play through headphones connected to an RF transmitter box attached to the back seat of the wheelchair. This encourages the client to keep her head in an upright position and make contact with the switches. When the circuit is deactivated, a

signal is sent to an RF receiver, which activates a vibrating coin motor. This motor and PCB board are compactly designed to fit on a wrist band that can be attached to the client's wrist, arm, wheelchair, or placed on a table. This vibration reminds the client that she must reposition her neck in order to make contact with the switches. This feature is optional and can be turned off at any time. The positive and negative reminders, along with the durable and soft strength of the HANSS support physically and mentally allows the client to begin reprogramming muscle groups to favor the correct undistorted seated position.

The second device is the multi-function table. This table is constructed from a welded aluminum frame and Plexiglass table top. The frame sits on a lightweight aluminum telescoping support that connects to the base and frame of the wheelchair. A linear actuator is in place within this frame to allow easy raising and lowering of the table through the use of a toggle switch. The table also has tilt capabilities and a flip-up book ledge on which to rest papers. The table features a storage space within the frame for keeping personal belongings. The vertical support shaft is securely fastened to the base and frame of the wheelchair with three positioning adjustment brackets, one aluminum securing clamp, and two strap clamps. This limits any unwanted horizontal movement of the desk. The desk raises materials to the client's eye level, tilts materials to the desired angle for reading, and also serves as a support for the client. The client will be able to push off of, or lean on the desk in order to reposition or adjust herself in the wheelchair. The table has been designed to fit the client's current wheelchair model. The support arms feature adjustable lengths in the horizontal direction accommodating for the client's growth. The table can be removed from the support shaft, or the entire device can be removed from the wheelchair.

The combination of the HANSS and multi-function table will promote healthier living habits for the client. Fig. 15.1 shows the combined use of these products on the wheelchair. Equally as important, the HANSS will improve communication skill between the client and friends, and the multi-function table will provide a place for the client to perform all of the daily activities that she loves. The recreational use and health benefits of these devices, along with the custom dimensions and biofeedback system, set this design apart from any devices available on the market.

Fig. 15.1. HANSS and multi-function table.

Fig. 15.2. HANSS and multi-function table attached to power wheel chair.

The cost of materials is approximately $750.

THE ATPC-X42 ALL-TERRAIN POWER CHAIR

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INTRODUCTION

The all-terrain power chair (ATPC) is designed to have a low center of gravity so that it can allow for the operation on uneven terrain without the fear of the chair tipping over. After the all-terrain power chair was completely built and fully operational, it was presented to the client in Tolland, Connecticut. The client has cerebral palsy which affects her ability to sit up straight and limits her motor skills. She enjoys exploring the outdoors, and therefore it is necessary for her to have a safe wheelchair to operate in her rugged backyard. The ultimate intention of the ATPC is to enable the client to explore the outdoors where there is uneven terrain without tipping over and righting herself, as has occurred in the past.

SUMMARY OF IMPACT

The client, her parents, and her physical therapist contributed to the design criteria. The device needs a low center of gravity with a wider base to maintain stability, but still be high enough to have clearance from the ground. The wheels also need to be large enough to function on rough terrain. These features allow greater chair stability and prevent it from tipping. For safety purposes, the constraints necessary are a seat belt and a harness that attach to the frame of the device. These constraints keep the client upright and help her maintain the proper posture while operating the chair. A right-handed joystick is necessary, as the client still has control of her right arm and hand, as was a kill switch for safety purposes. There is also a sensor with an alarm that warns the client of slopes that are too steep and an auto-actuation mechanism, which keeps the client level. The auto-actuator also helps the client maintain proper posture by actuating the seat upwards while she goes down a hill and vice versa. Finally, since portability is necessary, the device can be taken to different locations including inside the house or transporting it by van or SUV by limiting the width of the chair to less than 32 inches.

Fig. 15.3. The ATPC-X42 All-Terrain Power Chair.

TECHNICAL DESCRIPTION

The ATPC is made from a number of smaller subunits that operate together. Mechanical parts include the seat, which is made of a jelly cushion for comfort. The size of the seat is 16 inches deep, 18 inches of wide and a height of 19 inches. The chassis is used from an existing power chair. The frame is modified from a Quickie S626. The seat mount was widened to accommodate the client, with one-inch spacers to increase the width to 16 inches (see Fig. 15.3). The tires used are two larger (4.5 inches wide), off-road tires in the rear which are individually powered by two electric motors. The size of the tires accounts for increased stability and traction. Two smaller (3.5 inches wide), off-road tires in the front are used to prevent compromising the chair stability. The front tires are placed into custom-made front casters that extend from the chassis.

Fig. 15.4. Autodesk Inventor 2009 model of the ATPC-X42.

The electrical and software components control the actions of the mechanical parts. The power module is the main control center, and the controller used is the Penny and Giles Pilot+. The batteries that are used are two PowerSonic 12 Volt batteries connected in series. The joystick is used as the controlling mechanism. There is also manual and automatic actuation control. The automatic actuation circuit uses two ADXL335 accelerometers, to control the tilt of the seat. The accelerometers are programmed using a microcontroller. Therefore, the actuator will automatically adjust the seat relative to the incline of the terrain. The accelerometers also are connected to a buzzer that will inform the user when they are approaching hills that are too steep for the device.

The total cost of the ATPC project is $1085, which was under the allotted budget of $1300. However, certain parts were donated for this project. If the full price of each part was paid, the total cost of the ATPC would be approximately $4000. This is still much cheaper than other similar devices currently on the market, which are sold for prices ranging from $12,000 to $18,000.

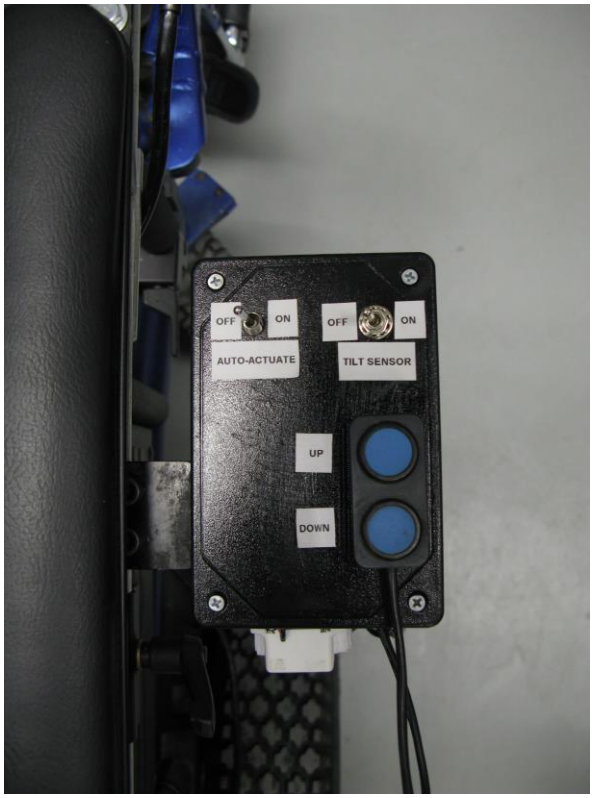

Fig. 15.5. Control mechanisms, incl. joystick (L) and actuation (R).

ASSISTIVE WALKING DEVICE

A Gait Trainer for Individuals with Cerebral Palsy
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INTRODUCTION

Many individuals with cerebral palsy (CP) have difficulty learning to walk. Often, irregular leg muscle control can make the learning process very difficult, or impossible. Currently available solutions are often too expensive or not supportive enough. There is a need for a low-cost, highly adjustable gait training device for children with cerebral palsy.

The Assisted Walking Device (Fig. 15.6) fills this need. It is designed to provide gait training for children with cerebral palsy. With practice, the child can climb into the device from the rear and pull herself into the arm and chest rests. A button press closes the leg braces, securing the child. For additional support, a broad four-point strap can be attached by an assistant. Depending on the child's abilities and needs, components such as the arm rests, leg closing mechanisms, and leg braces can be removed by the end user. Also, the device incorporates a piston-spring mechanism so that it will challenge the user to improve her abilities, rather than simply suspend her.

By providing a gateway to self-sufficient mobility, the Assisted Walking Device will substantially increase the independence and quality of life for children living with cerebral palsy. The completed device will be delivered to a local client.

SUMMARY OF IMPACT

The device will have a substantial positive impact on the client's life. She has significant internal rotation in her legs, especially in a standing position. This involuntary motion prevents her from learning to walk. In addition, she has difficulty supporting herself with her legs for more than a few seconds at a time due to low muscle strength.

By incorporating strong yet lightweight padded leg bracing and ankle-foot orthoses fixed to the braces (Fig. 15.7), the device provides lateral and rotational support for the client. This design works well in retaining her legs in a standing position, and the allowed range of motion facilitates a walking gait.

Fig. 15.6. The Assistive Walking Device.

However, she can use it initially as a simple standing device in order to strengthen and acclimate her muscles. This design enables the client to independently lift herself into the device from the rear and press a button to lock the motorized leg braces. A hydraulic piston provides mild spring force, so that she must work in order to remain upright. The client's physical trainer helped in the planning and troubleshooting stages of the project. Her comments directed the positioning and range of motion of the legs, as well as the positioning of the

arm and chest supports. Her help was invaluable in designing and fine-tuning the device. We feel that this design will provide our client with a platform for developing muscular tone and gait.

TECHNICAL DESCRIPTION

The device is fabricated from a wide variety of materials. The base, primary stalks, arm, hip, and chest rests are repurposed parts from salvaged walkers and wheelchairs. All other structural metal pieces are fabricated from 6061 aluminum bar stock. A 50 pound gas spring is used to gently suspend the entire structure. Therefore, our client must exert some effort to remain in the standing position. The spring will not allow her to fall completely, but will sag several inches under the client's weight, acting as a feedback mechanism for strong posture. The device uses rear-entry ankle-foot orthoses to reduce the client's tendency to scissor and rotate her legs. The calf and leg braces are curved to fit the client's legs, and are upholstered in soft neoprene foam. A motor and actuator assembly at the rear of each brace allows the client to enter the braces and close them by pressing a button.

The circuitry is based around a PIC16F877 microcontroller, which drives an H-bridge to control the opening and closing of the motors and actuators. The motors first swing the leg mechanism shut, and then the actuators extend to lock the device. Motor activation is controlled by timing. Power is supplied by two 9V batteries. One powers the microcontroller, and a second powers the H-bridge and all of the moving elements.

Fig. 15.7. Leg braces.

The cost of all parts and materials is approximately $1000. If new parts are purchased rather than salvaged, the total cost would be approximately $1500.

THE PORTABLE COMPACTABLE POWER WHEELCHAIR

Designer: Kristie Astoria and Nathan Storie
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INTRODUCTION

The portable compactable power wheelchair is designed to provide a patient with cerebral palsy with independent and easy transportation. Cerebral palsy can affect an individual's balance, movement, and posture. Typically, it causes loss of muscle control and motor activities, and most patients who suffer from the disease are permanently confined to a wheelchair. Powered wheelchairs are inconvenient for long distance travel because they are heavy, bulky, and usually not portable. The portable wheelchairs that are currently available are not powered, and therefore, our client needs assistance to move around. The powered wheelchair, presented in this design, has the ability to separate into three parts so that portability is as easy as possible. The chair also gives the patient control of their motion through a joystick. Upon completion of the power wheelchair, it will be donated to a family located in Storrs, CT with a 10 year-old daughter who has Cerebral Palsy.

SUMMARY OF IMPACT

The wheelchair design is based on the needs of the client's family to have a portable wheelchair that allows for the client to be independent. The family has difficulty transporting the current wheelchair in their minivan, and the client quickly outgrows portable chairs that have been used in the past. The designed wheelchair takes into consideration the client's medical needs and provides easy portability by separating into three lightweight pieces. Since the client has slightly more control of the right side of her body, an easily controlled joystick is mounted on the right side of the chair. The chair also provides supportive straps to prevent the client from constantly leaning forward. Additionally, foot straps are placed on the foot rests to keep the client's feet in the appropriate position.

Fig. 15.8. Portable compactable power wheelchair.

TECHNICAL DESCRIPTION

The overall structure of the portable compactable power wheel chair is based on the Invacare At'm Travel Power Wheelchair. This power wheelchair also separates into three parts: the base frame, the chair assembly, and the battery. The electrical system contains a joystick, speed control, and two motors. The motor has a friction attachment that drives the wheelchair by rubbing against the outer edges of the wheels. A modified frame of the Invacare wheelchair is used in this design. The chair frame and base frame are made of aluminum Pipe Schedule 80 (nominal 0.75", OD 1.05", ID 0.824"). The chair frame is modified to better suit the client by reducing the width from 18 inches to 15 inches. Also, the chair frame folds for easy travel. The frame is also modified by moving the central cross bar

forward 6 inches to mount a motor plate to the two transmissions and two motors.

The entire electrical system of the At'm Wheelchair is used in this design. The main alteration in the design was changing the motors from the friction drive system into direct-drive motors. This was done by creating two transmissions that reduce the RPMs of the motor. Each transmission has a gear reduction of 7.2. These two transmissions are designed to be of two different lengths so that when they are mounted, the motors will be offset. The motors are arranged in a tiered manner in order to reduce the width of the chair as much as possible.

Supportive restraints are also placed on the footrest. Lastly, two seat belt straps are bolted to the seat frame—one around the waist and the other crossed over the front of the patient from the shoulder to the waist. These prevent the patient from leaning too far forward or falling out of the chair.

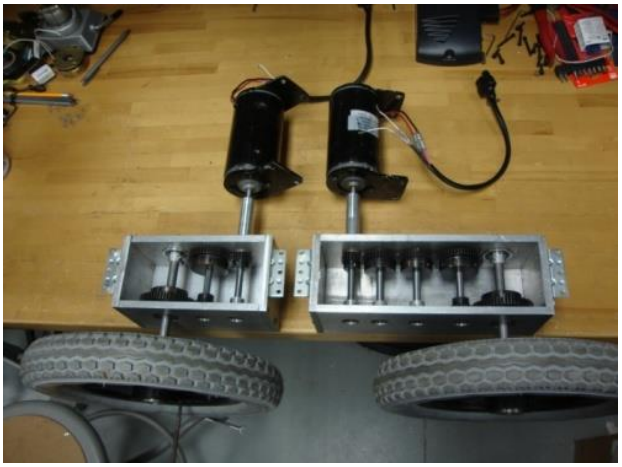

Fig. 15.9. Transmission Designs

The total cost of the parts and materials is approximately $806.

Fig. 15.10. Portable chair frame; unfolded and folded.

THE JOE-KART

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INTRODUCTION

This project is to design and fabricate a specialized go-kart for a child with Cerebral Palsy. The client has limited coordination and limb dexterity which prevents him from properly operating pedals and steering devices found on commercially available recreational go-karts. In order to solve this problem, the client has a remote control that will be operated by the parents. The remote control allows use of the go-kart immediately.

In order to ensure the maximum amount of safety, it was requested, by the client, that the go-kart be battery powered. Additionally, a multitude of other safety features were implemented in order to ensure maximum comfort and security. The seating area is designed to be adjustable to accommodate future growth as well as supportive to compensate for certain muscle weakness. The go-kart is designed and fabricated to meet the needs and requests of the client. The final product is a go-kart that is more user-friendly to the client than any commercially made product available.

SUMMARY OF IMPACT

The client is a 6 year old with Mixed type Quadriplegic Cerebral Palsy (CP) and a second diagnosis of Global Apraxia. He has severe motor planning issues and requires many repetitions to learn simple patterned movements. His CP restricts his movement, his balance and proprioception, and he is unable to walk, stand or sit-up without assistance. The Joe-Kart is specifically designed around these limitations, giving him full use of the go-kart. He and one other person will be able to comfortably sit in the go-kart. The go-kart is also remote controlled so that he will be able to ride in the go-kart while a parent operates it from outside the kart. The Joe-Kart gives the client a full sense of mobility and freedom, while also allowing him to spend quality time with his parents.

TECHNICAL DESCRIPTION

The chassis option selected for the design is the prefabricated Stingray complete go kart chassis kit from Northern Tool. This option, though at first seemingly expensive, ultimately saved money on labor and potential raw material cost. This option is chosen mostly to save time on welding and machining a chassis, allowing for more time to design higher quality subunits. The secondary benefit, as stated, is in the event of mistakes (welding or machining), money will not be lost re-purchasing damaged, unusable materials. This complete chassis kit comes with tires, wheels, brakes, cables, and 60-tooth sprocket.

This chassis has dimensions of 72 x 43.5 x 47.25 in (l x w x h) and is functional for two people. This double seat model is chosen because it allows for the client's parents to ride along. The remote control will allow for the parent to operate the kart from a distance as well as from within the kart itself. By selecting a two seat model the client's parents can sit in the kart with the client coaching him to learn the controls. This will increase time spent bonding as well as providing constant positive feedback to increase our client's pattern movements, eventually leading to complete individual control.

The chassis is equipped with a seat and seatbelts. These do not meet the required specifications for the kart and are therefore not used in the project. Instead of a single bench seat, this project implemented two separate seats; one specialized for the client, the other for the passenger. The passenger seat is a standard bucket seat on the left side of the go-kart. This seat is equipped with the seatbelt provided to ensure passenger safety. The specialized seat for the client is based on his existing wheelchair seat, providing all the similar adjustable supports such as head and neck, trunk, waist and groin. The specialized seat also has foot rests and foot straps to safely keep the client seated and protected. A seat from an old wheelchair is used.

This seat is very similar to the client's current wheelchair. It has the appropriate supports that are needed and also comes with a harness. The seat is modified so that it can be attached to the chassis. The client's seat is on the right side of the go-kart. This allows the left handed controls to be in the center of the go-kart.

The steering mechanism for the go-kart is designed to be quick and responsive to handle optimum maneuverability while also being able to withstand the forces exerted on the system while it executes turns while in motion. Since the client lacks the motor control to be able to steer the go-kart manually, the steering system is powered and controlled by a gear motor which powers a rack and pinion. The rack and pinion is connected to the wheel brackets via tie rods. The linear displacement of the rack, due to the rotation of the pinion, will result in a translational movement of the wheels which steer the car left and right.

The go kart is powered by a C40-300 MagMotor. Since the drive motor draws a much higher current, the speed controller for the drive motor must be much more robust and durable to handle the high current load. A 4QD-300 speed controller designed by SLT Technology, Inc drives the main motor. A transmission box to transfer torque from the motor was included in this design as well. This is accomplished through a specific gear ratio to increase the torque applied to the axle.

The client does not possess the capability to push down a brake pedal which means that this process also needs to be done mechanically. This system implements gear motor and motor drivers that are controlled by the receiver in order to safely and effectively apply brakes to the moving go kart.

The go-kart uses three deep cycle batteries. These batteries have an output voltage of 12V. Two batteries are put in series to create 24 V which powers the drive motor. These batteries are 500 CCA each. The third battery powers the steering, braking, and all other systems. This battery is larger and has 665 CCA. Any battery that satisfies these needs can be used.

Fig. 15.11. The Joe-Kart.

The go-kart consists of two different methods of control. This first is a remote control with two single axis joysticks. One controls steering, and the other controls speed, and braking. A switch is used to drive the go-kart in reverse. When in reverse, all of the functions will work the same; however, when the accelerator is pushed, it goes backwards.

The remote can also be mounted into the chassis to create a second method of control. This dashboard is mounted to the chassis via a mounting arm. The mounting arm can move side to side and front to back. This allows the parents to use the controls or point them to the client. It also allows the controls to be out of the clients reach so that he does not accidentally hit something.

The cost of the Joe-Kart iss approximately $5,000.

THE AUTOMATED RETRACTING COASTER SLIDE

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INTRODUCTION

The Automated Retracting Coaster (ARC) Slide is designed for a child diagnosed with cerebral palsy. This condition affects the client's motor control and inhibits his ability to fully control his posture and limbs. The six year old client enjoys playing outdoors and is in need of recreational equipment to accommodate his needs.

The concept of ARC Slide was based on the "Extreme Coaster" manufactured by the Step2 Company on which the client has previously ridden. The Extreme Coaster, however, does not account for the client's additional requirements. The car for the "Extreme Coaster" has no support or restraints to help maintain trunk posture and also requires the supervisor to manually push the rider and car up the slide to allow for additional descents down the ramp. This strain on the supervisor inspired the need for a recreational device that would help maintain the client's posture and eliminate the supervisor's need to manually push the car back up the slide. These two constraints are the foundation on which the ARC Slide design was based. The ARC Slide (Fig. 15.12) is a recreational device equipped with a car (Fig. 15.13) that supports the client's trunk and hips, a lift motor with an actuator that automates slide descent of the car down the ramp, and a winch with nylon rope that hooks to the car and retracts it back to the platform. The hook automatically releases using a spring loaded mechanism (Fig. 15.14) such that the car can descend down the track again without help from the supervisor. This device thereby eliminates the need for the car to be manually pushed up the ramp and eliminates the need for a manual push to begin descent. Currently, there are no devices on the market that possess these functions.

SUMMARY OF IMPACT

This device has improved the quality of life for the client in numerous ways. Primarily, the client is now able to experience the outdoors and enjoy recreation in a safe and fun manner. The device also promotes a sense of independence because the supervisor needs only to hook the rope to the rear of the car. The strain on the supervisor is greatly decreased as the need to push the car up the ramp or push the car to begin descent is eliminated. The supervisor only needs secure the rider in the car with three nylon restraints. This device can be modified to fit a wide range of riders and provide multiple users with a safe outdoor recreational experience.

Fig. 15.12.The ARC Slide ramp and platform.

Fig. 15.13. The ARC Slide car.

TECHNICAL DESCRIPTION

The structure of the ARC Slide is composed of both pressure treated and composite lumber. These wood types can endure extreme weather conditions year round. The pressure treated lumber is coated with a UV protection stain that will increase the lifetime of the device. The ARC Slide has a 10 foot ramp made of pressure treated wood and a 45 inch long platform track made of composite wood. The platform, however, is composed of both composite and pressure treated decking. With a height of 36 inches from the ground, the ramp has a 17° angle of elevation that allows for moderate acceleration down the ramp. The ramp track and platform are attached together using two ¾" diameter by 5 inch long pins. These pins insert into the top of the platform through steel plates that attach to each side of the ramp. The ramp and platform attachment allow for the platform track and ramp track to coincide; ensuring a smooth ride. The winch motor is attached to the rear of the platform while the lift motor is mounted on the rear underside of the platform. A 12V battery powers the motors as well as a photoelectric sensor, a wireless module, motor controllers, and a three color status tower light. Fig. 15.15 depicts the rear of the platform with the retraction, lift, and release systems. The ARC slide motors are wirelessly controlled using a four channel RF transmitter and receiver powered using the 12V DC battery. A 40 pin PIC16F874A is used as the controlling unit, with safety features programmed into the PIC such that the motors can only turn on at designated times. Two motor drivers power the winch and lift motors on and off upon input signals from microcontroller. A limit switch is used to stop the track lift when it reaches the starting position on the platform. A photoelectric sensor detects the car wheels as the car retracts and signals the microcontroller to stop the winch motor from retracting the car.

The microcontroller has 6 inputs; four inputs from the wireless receiver, an input from the photoelectric sensor, and also an input from the position switch. The different outputs from the microcontroller change the color of the LED tower light and power on and off the motors. A12-24V DC boost converter supplies sufficient power to the 24V LED tower light while using a 12V DC battery.

When the photoelectric sensor is not triggered, the winch motor can be powered in both the forward and reverse direction. When the motor is not being powered, the LED tower light illuminates green. However, when the winch motor turns on, the tower light illuminates red to indicate a change in status of the system. When the photoelectric sensor's beam is blocked by the car, the microcontroller does not allow any signals to be sent to the winch motor, and therefore the winch remains off. After the car is completely retracted, the LED tower light emits green again; indicating that the lift motor can be powered in the forward direction only. The lift motor will elevate the rear of the platform track until the car begins descent and the photoelectric beam is unbroken. When the photoelectric sensor is no longer triggered, the lift motor can only be powered in the reverse direction until platform track contacts the limit switch. The microcontroller also inhibits the winch from retracting if the platform track is elevated and the limit switch is not triggered. These components and safety measures ensure a safe ride for the user while riding the ARC Slide. The final cost of the parts and materials is approximately $1,800.

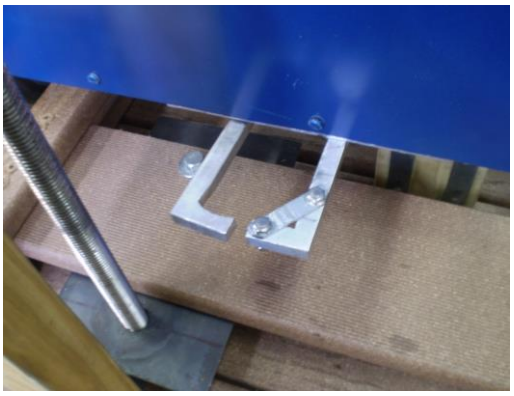

Fig. 15.14. Spring Loaded Hook Release.

Fig. 15.15. The winch, lift, and release systems.

CONTROL PANEL FOR CHILD WITH CEREBRAL PALSY

Designers: Robert Blake, Craig Goliber, and Alanna Ocampo
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INTRODUCTION

The remote setup is composed of a battery-powered control panel, which turns an Emerson CD player and Coby DVD player ON and OFF, using an RF signal. Fig. 15.17 describes this setup. The control panel runs on a single 9V battery, which may be replaced by unscrewing the battery compartment located in the base of the panel. The CD player and DVD player must each be run on the adapter supplied by the manufacturer, as the new wiring associated with the remote control does not allow for the use of the batteries. Instructions for running the CD and DVD players may be found in the manufacturer's manuals and any problems associated with those devices, outside of those related to remote control, may be addressed to the manufacturer.

SUMMARY OF IMPACT

The purpose of this device is to increase the client's independence and to enable greater interaction with his environment. This device will help the client feel a greater sense of independence and also provide a stimulating and fun way to control his DVD and CD players.

TECHNICAL DESCRIPTION

The transmitting end of the setup includes a Basic Stamp 2 (BS2) microcontroller and takes input from the four jelly bean buttons for the functions PLAY and STOP for both the CD and DVD players. The output of the BS2 goes to the transmitter which sends out the corresponding RF Signal to the receiving end, depending on which button is pressed on the panel. The 9V battery is connected to the rest of the circuit, via the toggle switch, and regulated to 5V.

Fig. 15.16 Control Panel.

The receiving end of the setup includes a BS2 which takes in the RF signal from the transmitter. The whole circuit receives its power from the CD or DVD player's own power source, which is then regulated to 5V. The BS2 outputs to two 5 VDC 0.5 amp DPST mini relays (R56-7D.5-6), one for PLAY and one for STOP. Each relay has one end of its coil attached to the output from a microcontroller pin and the other end of the coil is grounded. The two other pins of the relay (the switch) are connected across either the PLAY or STOP switch within the CD or DVD player.

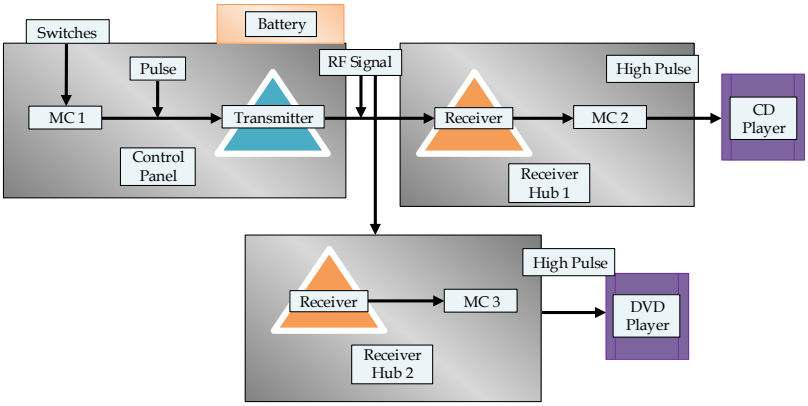

Fig. 15.17. Control panel setup

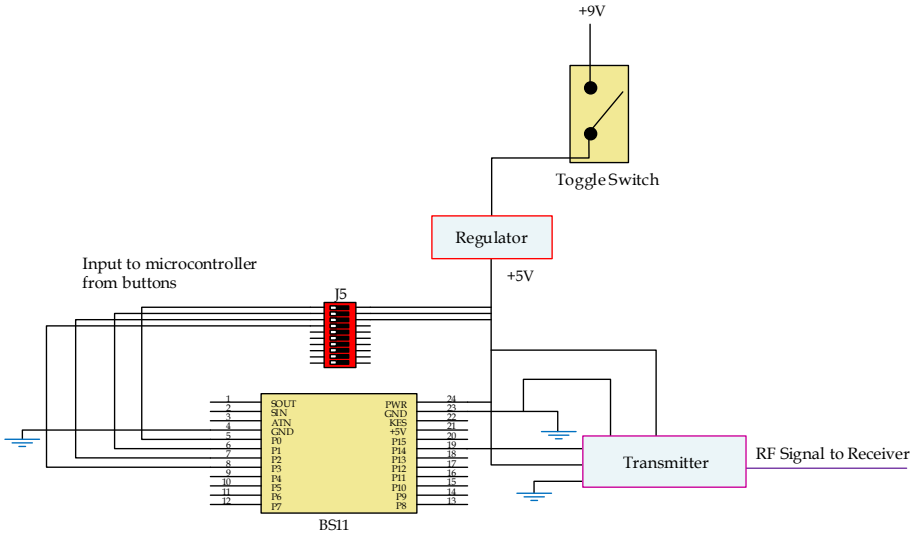

Fig. 15.18. Transmitting end in control panel

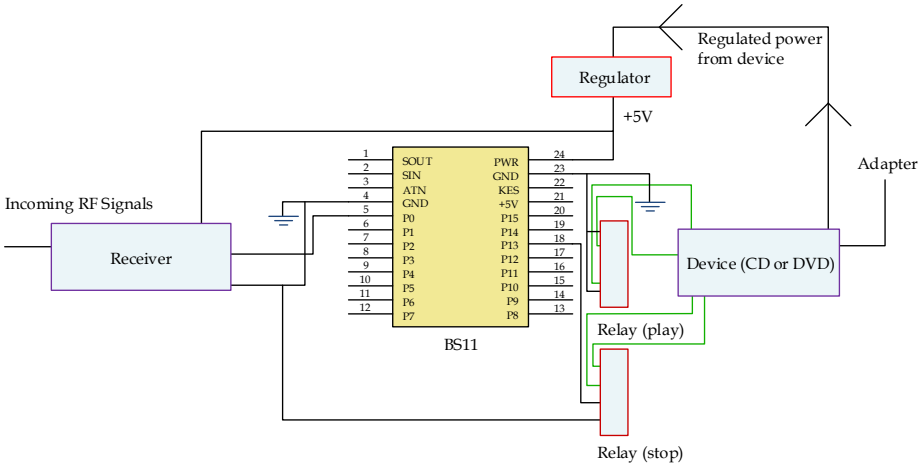

Fig. 15.19. Receiving end

ADAPTED HUNGRY, HUNGRY HIPPOS BOARD GAME

Designers: Robert Blake, Craig Goliber, and Alanna Ocampo
Client Coordinator: Katrina Toce, Southington, CT
Supervising Professor: Dr. John Enderle
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INTRODUCTION

The Adapted Hungry, Hungry Hippos Board Game is designed to provide a client with cerebral palsy the ability to independently operate and play the game Hungry, Hungry Hippos. The assistive device utilizes an electrical and mechanical operating system, which when activated, supplies all the necessary movements and forces required to play the game. This device was designed for a client with poor muscle tone, and as a result cannot exert the needed force to play the game independently. A commercially available product is on the market to address this issue; however it utilizes a pulley and lever system which still requires sufficient force. The approach taken when designing the assistive device is to completely eliminate the need for a force to be applied, while at the same time maintaining a level of physical involvement for the client.

SUMMARY OF IMPACT

The design of the Adapted Hungry Hippos device is built around the capabilities of the client. By creating this assistive device which allows for full operation of the board game, an independence which is rewarding to the client is achieved. By utilizing this device the client has gained a new level of involvement that was previously unachievable, and is now able to independently interact with others while playing this game.

TECHNICAL DESCRIPTION

The housing unit of the assistive device is fabricated from galvanized aluminum sheet metal. The characteristic high strength and low weight of aluminum made this material ideal for providing the necessary support throughout the design, while at the same time minimizing the weight of construction. The housing unit's base is constructed using a series of folds from a single piece of sheet metal along with the use of spot welds and rivets.

Fig. 15.20. The Completed Assistive Device.

Fig. 15.21. Joey enjoying his new game.

The cover pieces are fabricated in a similar manner and attached to the housing unit with sheet metal screws.

The assistive device operates the board game's levers by using two electrical DC geared motors that

run off of six volts, and rotate at 70 revolutions per minute. A DC geared motor was chosen because it supplies the needed torque required to operate the levers while at the same time maintaining a small profile. Also a motor with 70 revolutions per minute was chosen because that is considered the average operating speed when manually using the levers while playing the board game.

Attached to the electrical motors are two swing arms which are the actual mechanisms that interact with the board game. Each swing arm is attached to the motors output shaft, and when activated rotates about the motor axis, and repeatedly hits the board game levers thus activating the game. The primary swing arm is fabricated out of aluminum and provides the needed force to the main board game lever which is responsible for obtaining the marbles during play of the game. The secondary swing arm was fabricated out of ultra-high molecular weight polyethylene which is chosen because the force required is not extremely high, while the material can still take repeated wear without breaking. The function of this secondary swing arm is to interface with the marble release mechanism on the board game, and supply marbles to the playing field.

The mechanical components, that the assistive device utilizes, are connected together in a simple electrical circuit which runs off of a battery compartment that supplies six volts from four "AA" batteries. The device is operated by a large push button. When the button is pressed and held, the electrical circuit is closed and the motor swing arm setup is activated. The push button used is removable from the actual assistive device, which makes storage easy. The way this is accomplished is through a 3.5mm mono electrical jack. The push button contains a similar 3.5mm mono prong which can then be plugged directly into the jack which is located on the housing unit. The cost of parts and material needed to complete this project is approximately $90.

Fig. 15.22. Primary Motor and Swing Arm

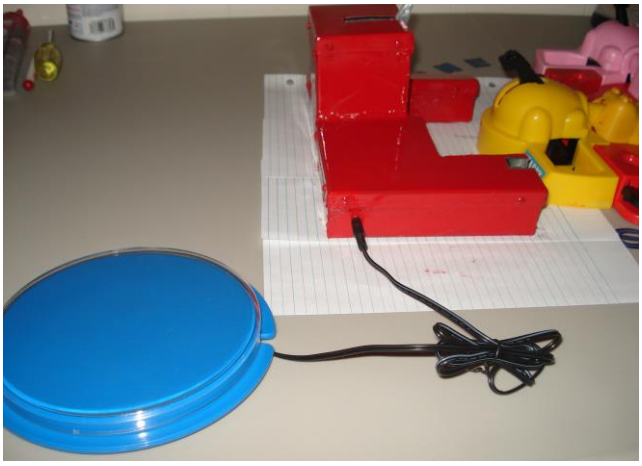

Fig. 15.23. Push Button and Housing Unit Interface

MEMORY RECALL GAME

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INTRODUCTION

This Memory Game application is written in C# using the .NET framework libraries. The Microsoft Windows Visual Studio 5.0 environment is used to code the game. The intent of this game is to improve memory recall in patients with Alzheimer's, dementia, or short-term memory loss, through the use of images and repetition. The game allows the user to upload personal pictures, create lists of persons (names and photos), called scenarios, and then run these lists within the game space. As each picture in the selected scenario appears, the user says the name of that person into the microphone and the game discerns if this is the correct response or not and then gives feedback. The game times the length of the scenario and the score for each run, and then these statistics may be viewed in both table and graph form. All data is saved by the game. There are other memory games on the market; however, they do not offer the flexibility and tailored scenarios that this software game allows.

SUMMARY OF IMPACT

This design of a memory game application to enhance memory recall in people with Alzheimer's or other short-term memory impairments will have a societal impact on those who make use of the software. A human being's ability to interact with those around them is an irreplaceable aspect to life, which, if impaired by cognitive disabilities, can have heart-breaking consequences for those affected by the disability and their loved ones. Being able to recognize the faces of people they love, say their names, and engage them on a level similar to that before their memory impairment began can greatly increase quality of life for those with memory impairments

TECHNICAL DESCRIPTION

The application consists of several subsystems. An intuitive user interface allows the user to access the full functionality of the application through a menu system. Additionally, a profile database keeps track of the users of the program, their associated persons, scenarios, and photos. A handler class is used to create files containing information on a scenario or load a scenario file. A speech handler class is used to enable speech input for names during a user's scenario session.

Upon entering the application, the user is prompted to create or select a profile. The list of current profiles is loaded from the profile database. Creating, editing or switching profiles can be accessed at any time from the top menu bar of the program window. The default interface upon admittance shows a list of recent scenarios, a button to run those scenarios, and an option to create new scenarios. Creating or editing a scenario brings the user to a list of persons attached to that user's profile. Persons may be added to the scenario list in a one-to-many relationship so a person can be used more than once in a single scenario. Additional persons may be added from within the Administrator role user interface. A panel containing various fields pertaining to a person are available from the edit/create person menu option. A person and photo library are maintained within each user profile database.

The User session is automatically initialized when a scenario is run. The application window then switches to full screen mode and the first round commences. A round consists of a photo being displayed to the User and the User speaking the correct phonemic pattern into the microphone. The round is then scored for correctness and a new round is shown until all rounds in the scenario are exhausted. The user interface then reverts to the Administrator role and display statistics.

The back end of the memory game application consists of a profile database. The profile database is stored and encrypted in save files and handled

through a Data Access Object. A specially designed class is used to create encrypted scenario files. These files consist of the person list associated with the scenario and any other settings needed to run the scenario. This enables exporting and importing files between workstations or directories.

Speech recognition is an essential characteristic of the memory game application. The program achieves this by using the system.speech reference of the .NET libraries. This reference imports Speechlib SDK 5.3 for Windows Vista operating systems and SDK 5.1 for Windows XP operating systems. A speech handler class handles all speech interaction containing methods to start and stop listening, identify and compare phonemes, and store phonemes for comparison.

A properly installed microphone is necessary for the speech components of the memory game application to work. Using the Windows speech training wizard increases the accuracy with which the speech libraries can recognize the User's voice. The memory game application requires Windows XP or Windows Vista. A CD-Rom drive is required for installation. .Net 3.5 libraries must be installed on the system for the application to run voice components properly.

Fig. 15.24. Screen image of the memory recall game.

ADAPTED SNOW SLED

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INTRODUCTION

The purpose of this device is to provide a safe and secure way for the client to enjoy playing in the snow. The client suffers from cerebral palsy that inhibits his motor function. Therefore, the sled must keep him secure while riding around. The key features required by the client include that the device offer full support for his head and trunk, an adductor between his legs, and a full harness. Currently, no devices exists that meet the client's specific needs. The adapted sled is designed and built by attaching a full harness swing seat to a sled.

SUMMARY OF IMPACT

The client loves the outdoors, especially the snow in winter. Prior to the adapted sled, there was no safe way for the client to play in the icy conditions. Since receiving his new sled, the client enjoys going outside in the snow even more than before and loves riding around in his new sled. His parents are very pleased as they know he is safe when using this device.

TECHNICAL DESCRIPTION

The plastic swing seat with full harness is attached to the sled via one inch high density polyethylene. Three stainless steel bolts, fender washers, nuts, and split lock washers are used on each side to secure the seat to the sled. Two PVC tubes are bolted with four stainless steel bolts and nuts from the back corners of the sled to the back of the seat to provide support. The last part of assembly involved replacing the existing rope with a new one. The holes in the front of the sled, where the previous rope was attached, were drilled out to fit the larger diameter of the new rope. Since the rope is made of nylon, the ends were burned to prevent fraying after being tied to the front of the sled. The design was very simple but effective as it met all of the client's specifications. The final cost of parts is less than $100.

Fig. 15.25. Adapted Sled.