CHAPTER 17
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MULTI-DIRECTIONAL SCOOTER

Designers: Peter Anderson, Ben Ausdenmoore and Jason Monnin
Client Coordinator: Carol Steinsick, Montgomery County MRDD
Supervising Professor: Dr. Ping He
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INTRODUCTION

The client coordinator expressed a need for a scooter that is usable by children with disabilities. All of the students have at least one disability that has an effect on their motor control and/or mental capability. The overall goal is to provide a means of allowing the student develop their hand-eye coordination and short-term memory. The students also gain a body-in-space relationship through the movement of this scooter. Some commercial

Fig. 17.1. Client using the multi-directional scooter.

manufacturers have marketed motorized scooters for students with disabilities. These scooters lack two desired features. The client requires the seat to be roughly two feet above the ground and for the scooter to be controlled by a remote device, as well as the local joystick. The market price for commercial devices is also cost-prohibitive for the client.

The final product is a scooter, controlled both locally and remotely as desired. The seat is able to recline and legs are stretched out over the front of the scooter. The product has a top speed just above a normal walking pace of 3 mph, but is easily adjusted to the desired speed. The product is also safe to use.

SUMMARY OF IMPACT

The final design met and exceeded all required and desired design specifications. The client coordinator and the users expressed satisfaction and excitement over the scooter. While using the product, the supervisors remarked that it was the calmest that they had ever seen some of their students. The client coordinator didn't have any recommendations for further work, as the scooter it met and exceeded their requirements.

TECHNICAL DESCRIPTION

The multi-directional scooter is primarily based on the controls of an electric wheelchair. There are two basic controls for which the scooter is operated. The first control is a local joystick located in front of the user. Pushing the joystick forward and backward powers the product forward and backward, respectively. And similarly, left or right the joystick causes left or right movement. There is a sliding switch on the transmitter for switching between local and RC control. On the transmitter is a single stick that is able to move in the forward/backward and left/right directions, with corresponding movement of the scooter. Speed control is achieved based on the amount of deflection of the transmitter stick or local joystick. However, a master speed control is located on the back right side of the scooter. This is a rotary knob, which can vary the master speed from a crawl to roughly 4.5 ft./s. Located directly next to the speed control is the master power switch. The switch, when in the off position, cuts all power to scooter, preventing power to drain from the batteries.

Another switch on this control panel turns the sensors on and off. Four infrared proximity sensors,

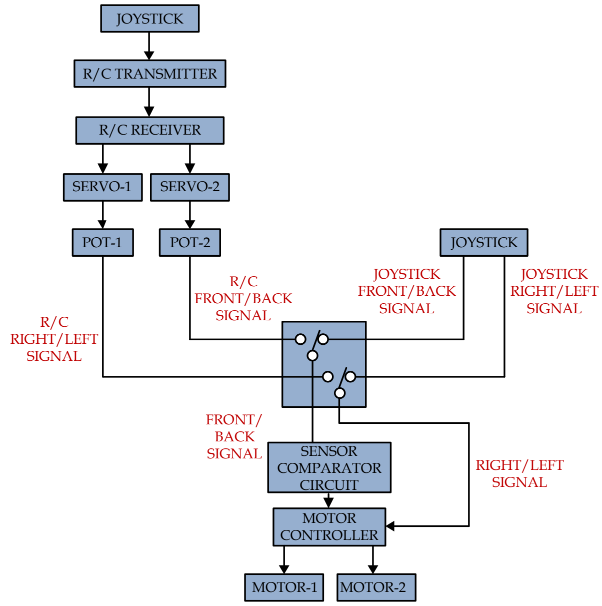

Fig. 17.2. Control diagram.

two on the front and two on the back, sense if the scooter is too close to an object. When an object is within five feet of the front or back of the scooter, the sensors do not allow the scooter to move in the direction of the object, only in the other three directions. Once the object is out of the five feet range, the scooter is allowed to once again move in that direction. There is also a three pin connector locater next to the previously mentioned switches and knobs, which is the battery charger plug. An external battery charger plugs directly into this plug and also into a wall socket, charging the batteries. Charge of the batteries from near half power takes about an hour. With full battery power, the scooter has an operating period of 4 hours, until the batteries need recharged. Operation after 4 hours may cause irregular operation and malfunction.

When a child is ready to use the product, they are placed into the seat of the scooter. The seat is able to recline to both adjust and allow the user to lie back, while the scooter is being used (primarily when the R/C transmitter is in use). The child is held in the seat with a 5 point harness. Two straps come across the top of the shoulders to the waist, two other straps come across the side of the user to the waist, and a final strap comes up between the legs to the waist. All five straps connect together through a buckle and lock into place. These straps are adjustable to accommodate for children of different heights and sizes. The joystick box is attached to a rod that is also adjustable, allowing for the local joystick to slide closer to the user or farther away, depending on the user.

The scooter sits 5 feet long by 2 feet in width, with the back tires extending out from the sides an additional 3 inches. The top of the frame sits 2 feet off the ground and the chair itself is 2 feet tall. The frame itself is constructed from steel and a sheet of plywood, lays in front of the chair on the top section of the frame. The frame is based on a truss design from which a force analysis, bending stress and safety factor are determined. Black vinyl covers the top and side sections of the frame, leaving the bottom open. A 2 foot by 1 foot section of plywood lies inside the frame behind the chair for circuit boxes and batteries.

There are many safety considerations taken into account when creating the product. The user needs to be safely secured in the scooter. An important safety consideration is to not allow the user to grab loose wires and increase the potential of electrocution. Driving the scooter into another object or person is also taken into consideration.

The scooter also needs to be reliable. The same performance from the product has to be obtained each for each use. Considerations relating to reliability include the ability for the batteries to withstand frequent recharging and not cause a decrease in performance. The frame is designed to be reliable after many uses at different weights and uses. The joystick and R/C transmitter are selected to endure the predicted stresses placed on them.

The total cost of parts and labor is $1,245.

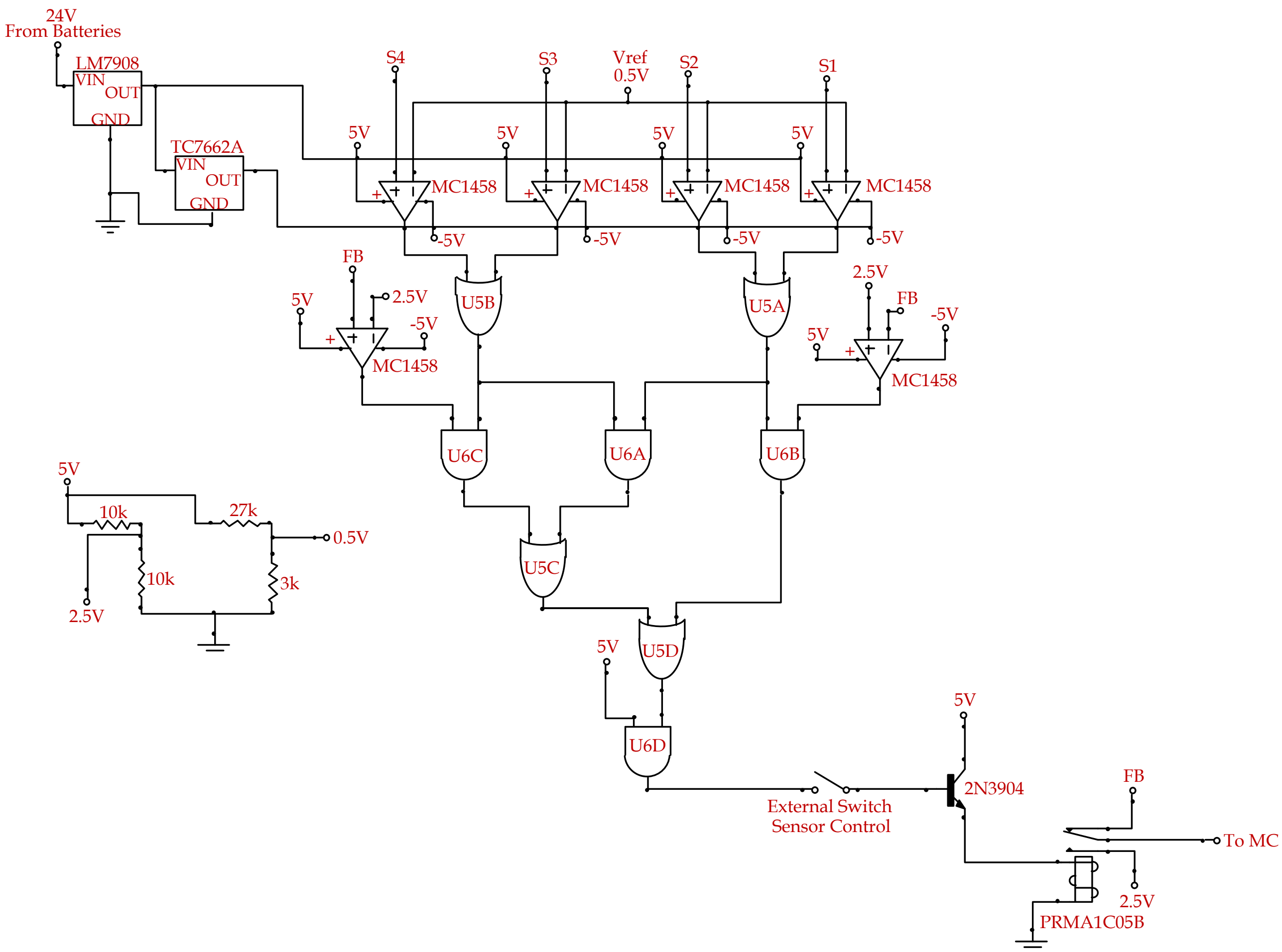

Fig. 17.3. Sensor control circuit.

ADAPTIVE CAN CRUSHER

Designers: Amit Saini and Jason Seidler
Client Coordinator: Tim Jones, United Rehabilitation Services
Supervising Professor: Dr. Thomas Hangartner
Biomedical, Industrial and Human Factors Engineering Department
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INTRODUCTION

At United Rehabilitation Services, many of the residents are able to earn money by crushing collected empty cans. They are assisted by a social worker and paid per crushed can. Currently, the can crusher being used is a commercial, wall-mounted, hand-operated, single-can crusher. It is very difficult and time-consuming for the residents to make money because they are not able to operate it themselves. United Rehabilitation Services requested an automatic can crusher that makes it easier for the residents with mental and physical disabilities to crush cans.

The final product is an adaptive can crusher that is completely automated, able to be operated by a person in a wheelchair, hold and crush approximately 50 cans per session, safe for people with varied disabilities, simple to use, and counts the crushed cans as they fell through the crusher. All these constraints are met in one enclosed apparatus that consists of two 15-inch tractor tires, a 0.5 hp motor connected to the tires by a chain pulley system, and a funnel hopper complete with a sorter to allow approximately one can at a time to fall through the system.

SUMMARY OF IMPACT

All design goals are achieved with the final product design. The hopper holds more than 50 cans, the crusher sufficiently crushes cans in a timely and safely manner, the photoelectric sensor counter counts each can as it passes through the chamber, and the entire device is operated by a single plug and single switch. The client coordinators are very impressed with the machine and its function. The demonstration they witnessed was "exactly what they were looking for."

TECHNICAL DESCRIPTION

The Adaptive Can Crusher is set on a 5-foot by 3-foot table with the crushing system mounted on top of it. The table has a 1-foot by 1-foot hole in the middle to allow crushed cans to pass through and fall into a recycling bin below.

Fig. 17.4. The adaptive can crusher.

The crushing system consists of a 2-foot by 2-foot welded steel frame that provides a mount for two 15-inch tractor tires that spin in opposite directions to crush the cans. The two wheels are attached to the frame with a steel rod that is welded to the middle axis of the wheel and runs through a sleeve that is welded onto the top of the frame. The sleeve and rod are lubricated with grease to reduce friction and heat. This entire crushing system is set into motion with a single motor (0.5 horsepower, 1725 revolutions per minute, single phase power and runs at 115 volts, 7.8 amperes at 60 hertz) connected to a chain pulley system that runs from a sprocket on the shaft of the motor to 20% larger sprocket on the end of the steel rod on the wheel. The larger sprocket on the top steel wheel rod reduces the revolutions per minute by 20%, from 1725 revolutions per minute on the motor end to 1380 revolutions per minute on the wheel end. It is entirely enclosed in a wooden box to hide all the moving parts and reduce noise as much as possible.

On top of the wooden box is the hopper cradle, which holds the hopper funnel. The cone-shaped hopper funnel is 25 inches tall with a top opening diameter of 39 inches and bottom opening diameter of 3.5 inches. The material used to make the hopper funnel is aluminum flashing. Mounted on top of the hopper funnel is the sorting mechanism that consists of a windshield wiper motor from a 1997 Jeep Grand Cherokee Laredo. The motor shaft has a 2-foot steel rod welded to it end-to-end with a 1-foot piece of angle iron welded perpendicularly to the end of the steel rod. This mechanism mixes the cans and feeds them through a hole nearly on at a time to the crushing chamber.

A photoelectric sensor and counter are mounted near the top of the back side of the wooden box. The sensor is placed directly over the space between the bottom of the hopper funnel and the top of the crushing chamber. Opposite of the sensor is a 60-watt light bulb. When the light from the bulb is blocked by a passing can, the sensor sends a signal to the circuit to a counter, which is recorded cumulatively on a three-digit digital display. The count can be reset by either pressing the red reset button or turning off the device.

All electrical devices, such as the motors and the sensor/counting system, are plugged into a four-way outlet mounted under the table. The power outlet is regulated by a single switch mounted on the side of the table. Figure 17.5 shows the circuit diagram for the electrical components and the wiring.

The total cost of parts and labor is $1,121.

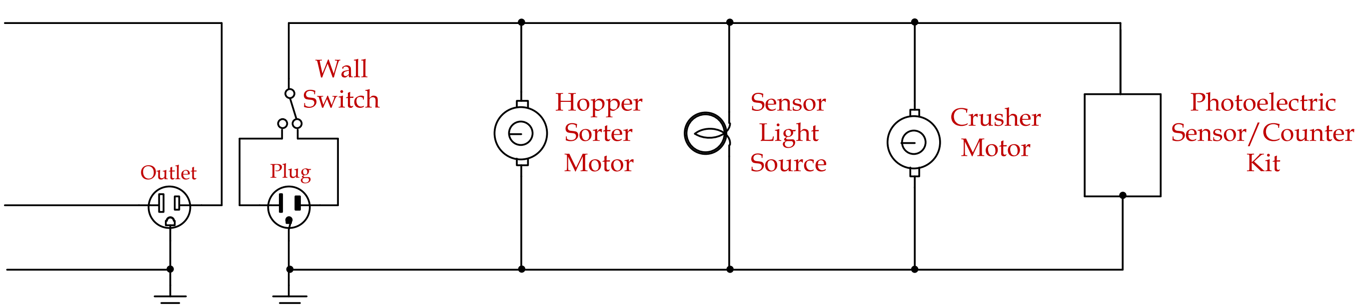

Fig. 17.5. Circuit diagram of electrical components.

LIGHT EFFECTIVE DISPLAY

Designers: Susan Schweitzer and Jennifer Wright
Client Coordinator: Brenda Anderson, Ankeney Middle School
Supervising Professor: Dr. Julie Skipper
Biomedical, Industrial and Human Factors Engineering Department
Wright State University
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INTRODUCTION

The client coordinator is a teacher at Ankeney Middle School and heads the special education resource room. The school has a special lighting room that is located between two of the special education rooms. This room provides a place for the teachers to change student's soiled clothing, and it also has a designated 8′ x 8′ area that has numerous lighting displays. With all of these lighting displays being in one concentrated area, the need to circulate air is greatly desired. The current means of providing air flow is a basic oscillating fan. The fan does not match fit in with all the other lighting décor. The client coordinator requested a fan device that integrates a lighting display.

The final product, the Light Effective Device, is a modification to a basic oscillating fan. The addition of light emitting diodes (LED's) to the fan blades creates an array of lighting effects to attract the attention of those children in the room. This device is best used by those students who have Sensory Integration Dysfunctions, often present with children who have autism or cerebral palsy.

SUMMARY OF IMPACT

All the design goals are achieved. The client coordinator is satisfied with the final product. Users enjoy the colorful lights and breeze generated by the fan. Recommendations for future work include a way to make it quieter and to revise the slip ring design so that there isn't metal on metal contact.

TECHNICAL DESCRIPTION

The final product includes a 12″ oscillating table fan and a project box (which is below the fan). The total height of the final product is about 24.75″ tall. The total width of the final product is about 14.5″. The total depth of the final product is about 11.625″. The project box is made of wood, assembled using wood screws. There are a few layers of white paint on the box. Circuitry for the project is in the project box.

Fig. 17.6. User interacting with the light effective display.

The fan is mostly made of plastic, excluding the motor parts and the bolts that hold it all together. On the fan blades are LED lights. Behind the fan blades is the slip ring that is made out of PVC pipe, with desoldering braid in the grooves. The actuators are micro switches that have wire heat shrunk to them which goes through the base shaft into the project box. Also behind the fan are bolts, nuts, and washers these are to act as spacers and to hold the cage in place.

The total cost of parts and labor is $556.

Fig. 17.7. Close up view of the slip ring and actuators.

PORTABLE CHANGING TABLE

Designers: Mathew Thomas and Nishant Vyas
Client Coordinator: Joanne Crowson, United Rehabilitation Services
Supervising Professor: Dr. David Reynolds
Biomedical, Industrial and Human Factors Engineering Department
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INTRODUCTION

The clients are outpatients who come to use the therapy rooms at the United Rehabilitation Services (URS). They have mild to severe cognitive disorders and physical disabilities. They need help from caretakers, usually their parents, to change themselves. The changing is presently done on a bed. This bed has an adverse effect on the backs of the caretakers, because the bed is either too high or too low. The client supervisor requested a changing table that is height adjustable. The adjustability makes the changing and transferring process much more efficient and less painful, as well as less time consuming. It should also be portable so that it can be moved from one part of the facility to another, instead of having to bring the patients to one room in the facility. The final goal of the project is to create a table which can accommodate an adult.

The final product is a portable changing table capable of adjusting from a height of 32 inches to 48 inches using a hydraulic scissor lift. It is capable of supporting an adult weighing up to 250 pounds. The table has a padded, cleanable surface and a safety strap.

SUMMARY OF IMPACT

The specifications requested by the client

Fig. 17.8. User on the portable changing table.

coordinator were met. Additional changes are also made to ensure more comfort and safety, such as the mattress/bed sheet, as well as the safety belt. The device has been tested by the students and performed as expected. The client coordinator is satisfied with the design and commended the design team on their work.

TECHNICAL DESCRIPTION

The top of the table is 6 feet in length and 2.5 feet in width. It has a thickness of half an inch. The table top is made of a composite material. Below the table top is a platform made of plywood. The dimensions of the platform are 32 inches in length and 19.5 inches in width. It has a height of 7 inches. These are the dimensions of the surface areas of the platform on the top and bottom. The thickness of the sides is three quarters of an inch. Below the platform is the main body of the hydraulic cart. The cart is made of steel. The hydraulic cart has a variable height range from 11 inches to 34.5 inches with a hydraulic ram as the method of adjustment. The hydraulic ram is operated using a manually operated foot pedal. The table has a lever that lowers the height in a controlled fashion. This lever is positioned on the top of the cart handle.

When the table top is placed on top of the hydraulic cart, there is approximately an overhang of 19 inches from the cart handle. The cart handle thus had to be extended by 19 inches to accommodate for the overhang. This is done by placing an extension on the rear of the cart, which extended the cart handle by 19 inches. There is a memory foam mattress on top of the table top, a mattress pad and a bed sheet on top of the table top. A safety strap is attached to the middle of the platform to provide additional safety. An accordion guard made of rubber has also been bolted to the table to prevent injuries originating from the hydraulic scissor arms.

The total cost of parts and labor is $1,097.

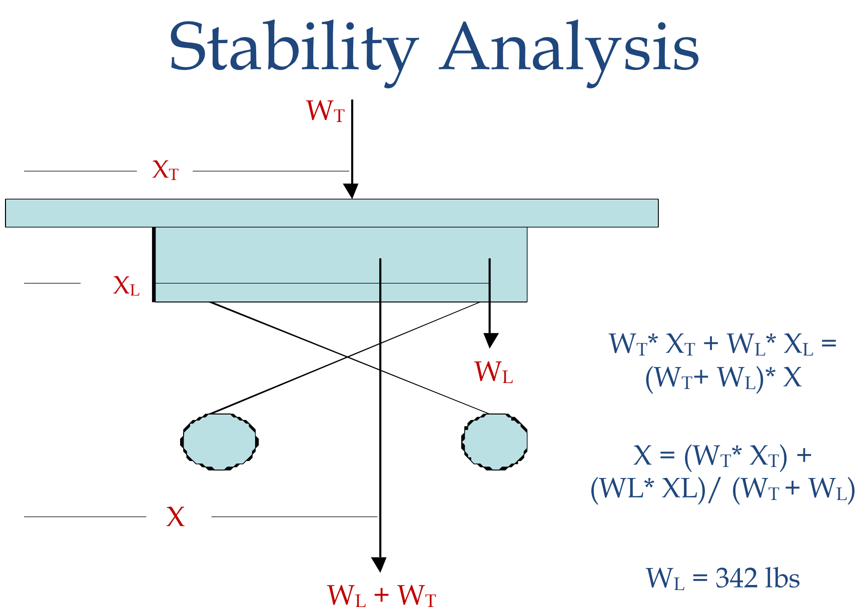

Fig. 17.9. Stability analysis model.

SENSORY MOUTH OBJECT

Designers: Abdul-rahman Abu-taleb and Akou Dossa
Client Coordinator: Carol Steinsick, Montgomery County MRDD (Southview Special School)
Supervising Professor: Dr. Chandler Phillips
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INTRODUCTION

The client coordinator requested a toy that a child could bite when stressed, which then plays a sound. The playing of music is thought to be beneficial for children with physical and/or mental disabilities that experience stress. While many soothers exist to stimulate the mouth and pacify children, the facility did not have a device that would also play soothing musical sounds to complement the calming process. The client coordinator required a device with the following characteristics: hygienic, chewing parts detachable from hand part to allow cleaning, free motion for the handle (the child must be able to swing it around freely), varied texture for stimulation.

The final product consists of a pacifier-like object that has a momentary grasp switch attached to a grip handle. The pacifier object is multi-textured. A project box emits the sounds triggered by the depression of the switch. The system runs on rechargeable batteries.

SUMMARY OF IMPACT

The final product met most of the required specifications. Upon review by the client coordinator, the designers determined that the project accomplished its objectives. Trials with two children [age 3 and 6] gave very positive results, with each child expressing satisfaction with the functioning of the toy. A recommendation for future work is the inclusion of a light display to further aid in the calming process for the child.

TECHNICAL DESCRIPTION

The mouth simulation system consists of the following components: one momentary grip switch, one battery charger, elastic band, one black plastic sound box with a three position toggle switch, two Raz-Berry® teethers, and a carrying case. The teethers are made of medical grade silicone, with multi-textured surfaces. The triggering of the momentary grip switch activates the musical sounds. Voltage divider equations are used to determine the value of R and the potential current draws from the batteries. Figure 17.11 shows the electrical circuit that controls the system.

Fig. 17.10. Child using sensory mouth object.

The batteries have a maximum continuous charging time of six hours. The charger delivers a 1000 mA current draw and each battery has a capacity of 2 Ah. The calculation for the charging time for the eight batteries in the system comes to 2 hours per battery. But charging the batteries generates heat within the sound box. Safety considerations include: making sure that the charger is never plugged in the box while the system is in use, charging the system under supervision to avoid overheating and damage to the batteries, keeping the teethers hygienic by cleaning them up before and after each use.

The total cost of parts and labor is $622.

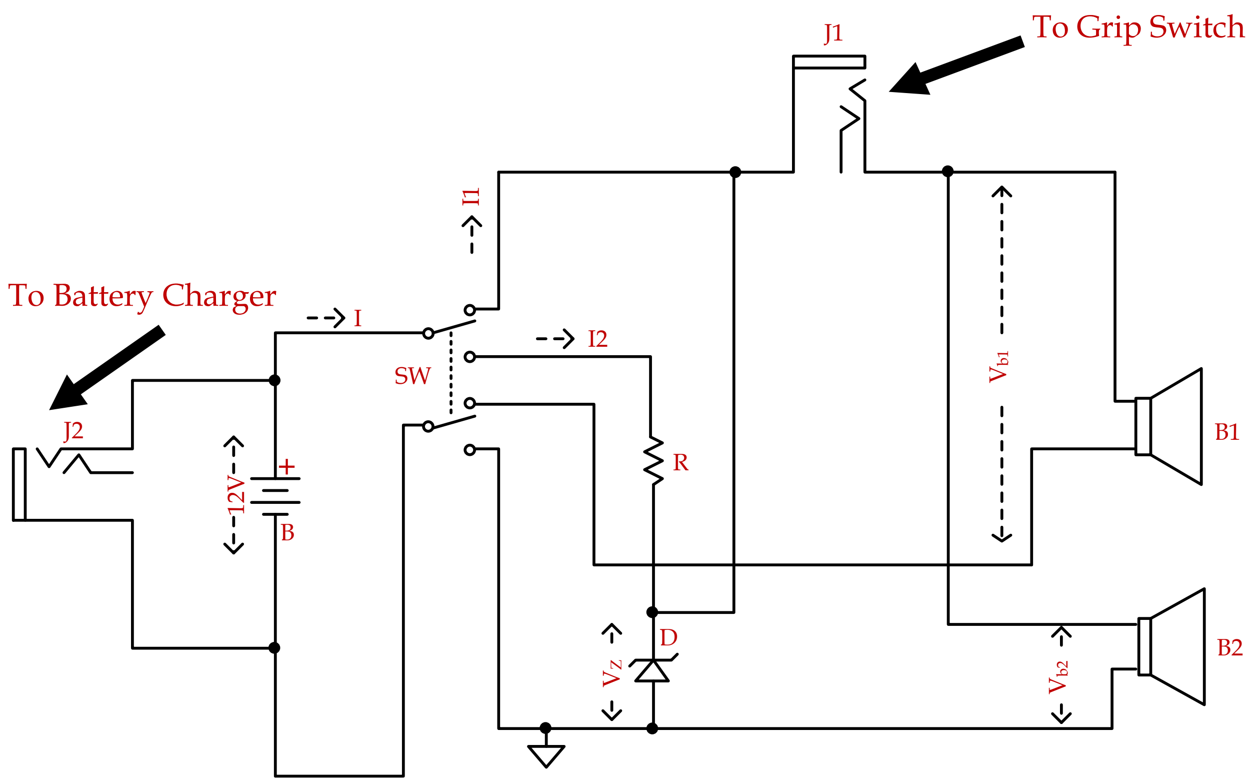

Fig. 17.11. Circuit schematic for sound box.

SUPERVISION ADAPTIVE READING STATION

Designers: Bridget Cassidy and Alex Revelos
Client Coordinator: Katherine Myers, Wright State University Office of Disability Services
Supervising Professor: Dr. Julie Skipper
Biomedical, Industrial and Human Factors Engineering Department
Wright State University
Dayton, OH 45435-0001

INTRODUCTION

The Office of Disability Services at Wright State University reports approximately five to six students on campus during a given academic year whose vision is significantly impaired. Low vision reading aids are often the only alternative for those with significantly impaired vision. The products commercially available do not meet the need of these students because of their associated high cost. Many offer low portability and are not even capable of enlarging figures. The client coordinator requested that the design team develop a vision enhancement station at a fraction of the cost of the present commercialized low vision readers with the possible capabilities of being portable and enlarging figures. A characteristic of the targeted client group is that their fine motor skills are often limited. A track ball type control, with large buttons, should thus be implemented to control the variable text speed.

The final product is a device is that scans text into a document and displays the text in a more clear and readable format. The program, written and implemented by the design team, formats the text into large black and white text that can be seen by the student. The users are able to set the speed of the scrolling text, the contrast options, the direction of the scrolling, and the size and zoom of the font.

SUMMARY OF IMPACT

The design goals are completely achieved – the program scrolls clear and large text in order to ease reading for those with low vision. One user said he was truly impressed with what the design team had accomplished. He remarked that he would use this program every day because it seems much better than other options that are currently available. The user liked that it showed only one row of text at the time so it was easy to focus on the words on the screen. The client coordinator also expressed satisfaction with the final product design.

Fig. 17.12. Client using the supervision adaptive reading station.

Recommendations for further work include: more exact text processing, perfecting figure detection, improving the graphical user interface.

TECHNICAL DESCRIPTION

The SuperVision system consists of a computer, scanner, DVD drive, keyboard, and mouse. The most critical component of the design is the user interface program, which is written using MATLAB. MATLAB is a high-level computing language and interactive environment for algorithm development, data visualization, data analysis, and numeric computation. The interface uses the image processing capabilities of MATLAB to display the text as an image onto the screen, while prompting the user for its choices for the various display options.

A scanner is used so that the text can be entered into the computer system. The document with the scanned text is used as an input into the interface so the text and figures within the document can be displayed. After the document is scanned into the computer operating system, MATLAB is used to analyze the text using many different functions and techniques. The flow chart (Figure 17.13) describes the exact test processing that occurs.

The user controls the program using a track ball mouse. The mouse allows the user to choose the zoom settings, move the ball in one direction to zoom out and the opposite for zooming in. The control is located in the front of the system so that users with limited range of motion are able to employ the system with ease. The trackball mouse was chosen because it allows users with limited dexterity to be able to control the system. The text displays on a screen, either a computer monitor or projection screen, depending on the use of the program.

A key feature of the design is the scrolling text capabilities of the program. The text is able to scroll, line by line, from the right side or the bottom of the screen. To ensure that the text is clear and readable, the font size is 24 point or larger, which should be sufficiently large for all users to read. The contrast and boldness of the font is variable. For some people reading a black font on a white background strains the eyes, therefore, there is an option within the program for white font on a black background. The font becomes unclear if the font size is too big, 32 size font is the maximum font size option within the program. The Arial font style is typically the easiest font to read because of its lack of serifs, so the text is converted to Arial within the MATLAB interface.

The total cost of parts and labor is $563.

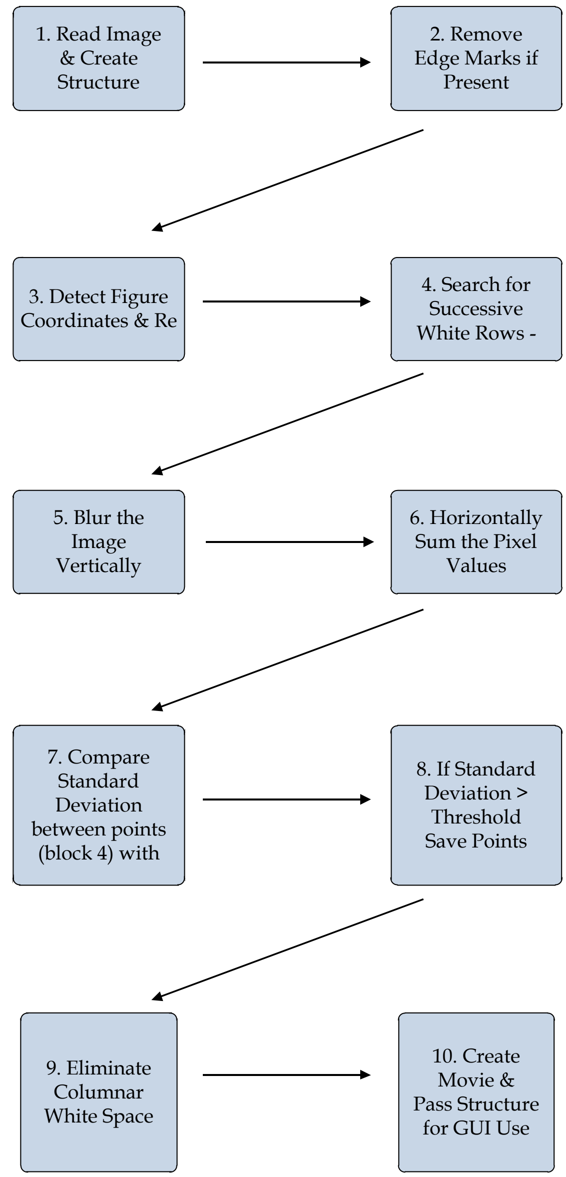

Fig. 17.13. Text processing flow chart.

VIBRATING MAT DESIGN

Designers: Danielle Borrero and Mohammed Redha
Client Coordinator: Carol Steinsick, Montgomery County MRDD
Supervising Professor: Dr. David Reynolds
Biomedical, Industrial and Human Factors Engineering Department
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INTRODUCTION

The client coordinator requested a device to help children with special needs improve their ability to process sensory information. They requested a mat that vibrates in nine different areas, under the control of the wireless remote, as the user moves from one section of the mat to another to feel the vibration. This kind of physical therapy gradually helps the user establish a better sensory system, with the hope of improving independent movement.

The final product is a mat that is divided into nine sections with all nine sections vibrating. Three sections of the mat vibrate under the control of one switch allowing for three switches total. The vibrating sections of the mat are 4 feet by 4 feet and contain nine motors spread out per square foot. The sections are all built separately are laid down side by side in order to make the final product. Each section is powered by rechargeable D batteries, which is able to be removed from the mat, recharged and reinserted by opening the bottom flap of each section. The battery power for each section vibrates strongly for approximately three hours, with its power decreasing over an additional three hours until it finally runs our out of power.

SUMMARY OF IMPACT

The product functions well, with all parts are operating as they should. The client is very pleased with the performance of the final product. The users are pleased with the vibrating mat, appearing delighted with the mat's functions. Figure 17.14 shows several children using the mat.

TECHNICAL DESCRIPTION

The vibrating mat is 12 foot by 12 foot when all pieces are assembled in a square pattern on the floor. Each mat piece is 4 foot by 4 foot and has thickness of 2 inches. Each mat contains 9 Motorola pager vibrators (model MXV4302). The vibrators operate from 1.5 V to 6.5 V. Three 1.5 D batteries are used in each mat for the vibrators. Receivers and transmitters from remote control cars are used for

Fig. 17.14. Clients using the vibrating mat.

the wireless communications components. As the transmitters operate on two frequencies, and each frequency has two signals, three separate signals are used to operate the mats as three sections are controlled. Each receiver needs 4.5 V to function correctly, which necessitated the use of 1.5V D batteries.

Each mat contains six sheets of cardboard, 4 foot by 4 foot. Four Cardboard pieces are attached by duct tape and nine holes, 2 inches in diameter, are cut proportionally into the cardboard stack. The vibrators are placed into these holes, to prevent them from ceasing vibration if they are stepped on. The circuitry is concealed in another cardboard piece, which is placed under the stack. The sixth piece of cardboard is used as a cover. To ensure softness 80 pound carpet padding is used for the sub-surface of the mat. This is a quality carpet padding that feels as soft as expensive Ethofoam (a material that was originally considered for the mat cushioning). In each mat, a 4 foot by 4 foot, 8 pound carpet padding is used. To keep the mats flat, level and in place, hard board is used. Each mat contains one section of 3/16 inch hardboard.

The entire mat is covered with a washable vinyl fabric. The vinyl is the marine-rade vinyl which is used mostly in boat seat covers. It can be washed with water and soap. Each mat used 3 yards of Marine Vinyl. The vinyl opens and closes for an easy access to change the batteries.

The total cost of parts and labor is $1,175.

GREAT TOE CAPSTONE PROJECT

Designers: Alexander Sheets and Allison Van Horn
Client Coordinator: Orthopedic Services, Miami Valley Hospital
Supervising Professor: Dr. Tarun Goswami
Biomedical, Industrial and Human Factors Engineering Department
Wright State University
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INTRODUCTION

Approximately 43 million Americans today experience painful foot problems. Some of the conditions causing the pain are hammertoes, calluses, bunions, or hallux valgus. There are many different solutions to these conditions, including nonsurgical treatments such as changing footwear and braces. Unfortunately immobilizing the great toe only causes increased stiffness. There are surgical solutions available that include toe joint replacement implants. These implants also have drawbacks, which include mechanical failure, grinding against healthy bone, and inflammation. The supervising professor asked the team to create a new brace design and a new implant design to decrease discomfort for individuals with severe hallux valgus deformities.

The designers presented several new designs for braces and surgical implants. Two brace designs were presented, depending on the severity of the great toe deformity. Each brace was designed for inexpensive materials and more expensive materials, for a total of four brace designs. Using a two component base model, four different designs for surgical implants were also presented.

SUMMARY OF IMPACT

The final designs met the design requirements defined by the supervising professor. The project as a whole includes many different aspects of joint treatment options. The splint helps to maintain and correct the outward angulation of the Hallux Valgus. The brace design has a metatarsal pad added to help runners along with people with MTP joint problems. The MTP total joint designs are all 3-D modeled and prototyped. The possible materials were all analyzed using finite element analysis to ensure they were durable enough for a patient. After the prototyping stage, a review showed the need to redesign a MTP joint replacement. In the slide design, the articulating surface appears a little too small after looking at the prototypes. Nevertheless, the articulating surface can't be enlarged because there would be no structure to support the wider surface area. These issues may be addressed during future work.

Fig. 17.15. Short reinforced brace.

TECHNICAL DESCRIPTION

For the non-surgical solutions, two different braces were designed. The first brace is very durable and cushions the toe lessening the pain. The brace also corrects the hallux valgus angle of the toe. It can be worn with most shoe types and is visually attractive. A second brace design was created for slightly more severe cases. The base of the first design is taken and the part that covers the great toe extends to the end of the toe. Therefore, the brace does interfere with the joint mechanics of the foot, yet the great toe is completely enclosed providing support for the entire toe. These two braces were then designed to fit into two different price ranges, a relatively inexpensive price range and a slightly more expensive price range. The more expensive braces are reinforced at the MTP joint with a different material that allows for extra cushioning and support.

For the surgical treatments, a two component design was deemed the most successful. Therefore, the design options are all two component implants. The first design consists of a total of four parts. The metatarsal component contains a tapered metal insert and a UHMWPE insert as well as the phalange component. The UHMWPE part is designed to snap to the inside of each of the metal parts using an O-ring method. The metal parts have wedges on the outside for a non-cemented press fit. To give a surgeon options when picking the perfect implant for a patient, several varieties have been introduced. The metal component options are to have the tapered implant without the wedges, for cementing or to have no tapering or wedges, also a cemented design.

In addition to the snap design, a slide design was also proposed. This design has more metal, which absorbs the forces better than a plastic would. The plastic articulating surfaces contain a circle that slides into a depression on the metal components, allowing for easy assembly by the surgeon. This design also has the three options for the metal components. There is a tapered and wedged version, a tapered and not wedged version, and a not tapered and no wedges version.

There are also two more implant designs to help correct the hallux valgus condition. There is a double hemi design that contains two metal components that are symmetrical and each can screw into the intramedullary canal of the metatarsal and phalange. The last set of designs is revision designs. Since there are so many difficulties with currently available solutions, many of the previous surgeries need to be redone. The revision designs allow for either one or both parts of the metatarsophalangeal joint to be replaced again. The revision designs consist of a metal insert that holds a screw. When the screw is inserted, the metal component expands and is press fit into the intramedullary canal. The articulating surface is either snap onto the metal insert and screw assembly or it can screw on to the assembly.

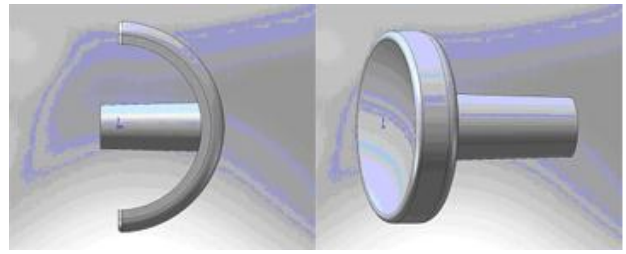

Fig. 17.16. Pyrocarbon MTP.

The final design uses a new material called Pyrocarbon that has very similar prosperities to human bone. The design is a non-constraining, two component design. The articulating surface of the phalange component is modeled after the human phalange bone. The articulating surface for the metatarsal component is also modeled after the human metatarsal bone. The components are designed so they would restore normal joint function. Pyrocarbon has shown great results as a joint replacement, but does not offer a good history of fixation. This problem is resolved by coating the pyrocarbon implant design with a thin layer of hydroxyapatite on the seams to insure proper fixation.

The problem of an implant slipping out is solved by either cementing or non-cementing the implant. The decision can be made individually for each patient by the surgeon. The materials are strong and durable enough to prevent fracturing, breaking, and wear. The designs for both the braces and the implants are the proper size. Each of the designs has different sizes to account for the differences in body types. The materials chosen are all FDA approved, and therefore are biocompatible and safe for the patient long-term. Given the constraints, the designs provide an optimal solution to the hallux valgus condition.

The total cost of parts and labor is $425.