CHAPTER 20
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INTERACTIVE OBJECT MOBILE WITH LIGHT AND SOUND

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INTRODUCTION

A client coordinator desired a sensory device for a child with cerebral palsy. One aim of the project was to assist the child in muscle control and coordination by engaging multiple senses with a toy. The toy creates a feedback system that engages the child's interest and encourages further interaction. Another aim was to improve the child's optical tracking ability by engaging her with a moving light stimulus on the toys. The device had to be accessible to the child while lying down, and take into account the client's fine motor control abilities. The client coordinator desired that the device stand independently and have multiple toys, each emitting sound and light when struck. The height of the device had to be adjustable to enable use by other children in a classroom environment. The Interactive Object Mobile with Light and Sound met all the requirements defined by the client coordinator.

SUMMARY OF IMPACT

The client coordinator indicated that the device is simple to set up, and instructions are easy to follow. In the future, more toys can be added. Although songs can be selected by changing the address of the toys, additional songs may also be programmed at any time. Currently, the toys are set up to respond with lights, but any sort of device may be attached to the LED pin of the toys provided they draw less than 800 mA. All of these techniques may be used to increase the long term appeal of the device. The client showed interest in the device and was engaged by the various toys and stimuli (Fig. 20.1).

TECHNICAL DESCRIPTION

The design is a modified T-Frame seen in Fig. 20.2. The benefits of a simple T-Frame include that it is lightweight, simple, and compact. Modification of the T-Frame included adding an additional vertical and horizontal bar, and a top panel to house the electronics. This two-bar design allows the structure to achieve stability in both horizontal axes. Although stable, this design is subject to stresses at the joints. For example, the stability of the design to shearing forces, such as a force that moves the base and top in opposite directions, is dependent on the strength of the joints between the members. Strong joints were made using two 2.5″ screws to fasten each leg to its base. These types of forces are also reduced by the addition of a cross bar on each side of the legs. SolidWorks models were constructed and analyzed to determine weak points and maximum stresses.

Fig. 20.1. Client Using Interactive Object Mobile with Light and Sound.

To meet the demand of compact storage the device is divided into three parts: two legs and a top. The top features a collapsible structure that is three feet long when collapsed and can span a four-foot mat when expanded. The legs are foldable so they can be stored in the provided space. Height adjustability is implemented using a pin and sleeve system. The system consists of equidistant holes drilled into the legs into which 3/8″ steel pins are inserted. The top rests on the pins and is secured by inserting an additional pin.

To provide interaction, and demonstrate cause and effect relationships to the user, the device must generate sound and light responses that are tied to a specific action. The light control circuit is shown in Fig. 20.4. In order to meet these specifications a microcomputer-controlled system was implemented. Communication from the toys to the microprocessor is handled through auxiliary circuitry. The microcontroller used in this device is the Freescale MC9S08GB60, as part of the M68DEMO908GB60 Demonstration Board. It features 60KB Flash Memory, 4KB RAM, 56 Input or output (I/O) pins, hardware interrupt (IRQ), keyboard interrupt (KBI), real time interrupt (RTI), serial communication interface (SCI), and a preinstalled serial monitor program. Programming of this controller was done using CodeWarrior v3.1 by MetroWerks, primarily in C programming language.

Toys are mounted on the structure at four locations. They communicate with the microcontroller, which is responsible for each toy's response. This design required two lines for the power supply and ground connections because lights are mounted on the toys. However, since the light response is controlled centrally, there is an additional line to handle the light signal. Each toy also indicates whether it has been hit or pulled, requiring two additional lines. Finally, all of the toys send a unique identifier, in the form of a four-bit binary address, to the controller. Without this address, it is impossible to make each action unique to the toy. Due to the limitations of binary scale imposed by the number of bits, it was determined that four bit addressing was the most appropriate. This level of addressing enables development of up to 16 unique toys, providing a balance between flexibility and complexity. A total of nine lines connecting the toy to the central system were required. The pulling indicator is separate from the toy because the signaling mechanism is mounted in the structure.

To detect the address of each toy, digital comparison circuitry is used to compare the address of the toy to an address being broadcast by the microcontroller. When the two addresses match, a flag triggers and indicates the location at which the match occurs. This flag is read and stored by the microprocessor and is required in order to send responses to the

Fig. 20.2. Modified T-Frame Structure.

appropriate location. Initialization procurement occurs at power-up to detect all of the toys, and is not needed again unless the device is powered down, or toy locations are changed. A power reset circuit is used to send a short, low logic pulse to the microcontroller at power-up. Upon detecting this pulse, the microcontroller broadcasts addresses from one to 15, and then polls the input pins for locations one to four in order to detect response. When a response occurs, the microcontroller associates the toy address to the location that responds.

To detect a pulling response, a simple limit switch, tied to a spring mechanism, was used. When the toy is pulled, the shaft to which the spring is attached travels down. A protrusion, placed on the end of the shaft, is used to trigger a limit switch. When the toy is released, the spring simply causes the shaft to return to its original place, thus deactivating the limit switch.

To detect impact, a piezoelectric transducer was used. The impact detection circuit is shown if Fig. 20.3. The transducer responds to vibrations and deflections. It then generates a decaying, sinusoidal voltage in proportion to deflection, which can be caused by vibration or bending. These voltages range from less than 50 mV for a light vibration to almost 7 V for a severe deflection. Although sufficiently high voltages were generated, there was not enough current to allow signal processing from the transducer. It was determined that an analog comparator performs well with high impedance, an easily controlled threshold voltage, and a digital output. A voltage divider is used to set the reference voltage to the non-inverting input of the op-amp, and the transducer is connected to the inverting input. When this is tied into a monostable 555 timer, it creates a "high" voltage for approximately 300 ms.

All communication to and from the microprocessor is controlled through circuitry embedded in a custom- printed circuit board. Because of the complexity of the circuit it was decided that the auxiliary circuitry would best be implemented on a PCB. The circuitry uses 6 volts, and level conversion circuitry is used to convert the 6 volt logic into 3 volt logic. A zener diode is used to regulate the voltage at 3 volts. Also, because the KBI on the microcontroller is an active low input, the outputs from the pulling and hitting responses were inverted. To achieve both level conversion and inversion, a HEF4049 IC is used. The impact detection circuitry amplifies and cleans the output from the piezoelectric transducer. Once it reaches the 4049 inverter, the active high pulse is converted into an active low pulse, which is fed into the KBI port of the microcontroller. When the microprocessor detects this pulse, it enters into a service routine to determine which toy, and what type of input (hitting or pulling), has been activated.

Output for the lights is controlled by both the microcontroller and external circuitry. The microcontroller generates an enable or disable signal to control the status of the lights. Blink rate is determined by an external oscillator running at approximately two to three Hz. Light intensity control is implemented using a pulse width modulation (PWM) that varies duty cycle, and runs at approximately 60 Hz. Output from the three subsystems (microcontroller, light flasher, and PWM) is passed through a logical AND, resulting in the final output. To handle the current demands of the LEDs, this output is fed into a transistor to provide appropriate gain.

The total electrical system implemented on the printed circuit board consists of four impact detection blocks for digital comparators, light flashing circuitry, DB9 connectors for toys, a DB-25 connector for the microcontroller, level converters, and four transistors.

The device features a low battery indicator, designed to illuminate an LED when the battery voltage drops below a certain threshold. The circuit uses an op-amp as an analog comparator. The input to the non-inverting input of the op-amp is tied to the battery voltage through a voltage divider. A zener diode is used to set a reference voltage at the inverting input. Normally, the battery voltage is above the reference voltage, which causes the op-amp to saturate to +V. However, when the battery voltage drops below the reference voltage, the op-amp output goes to ground, triggering the LED. To

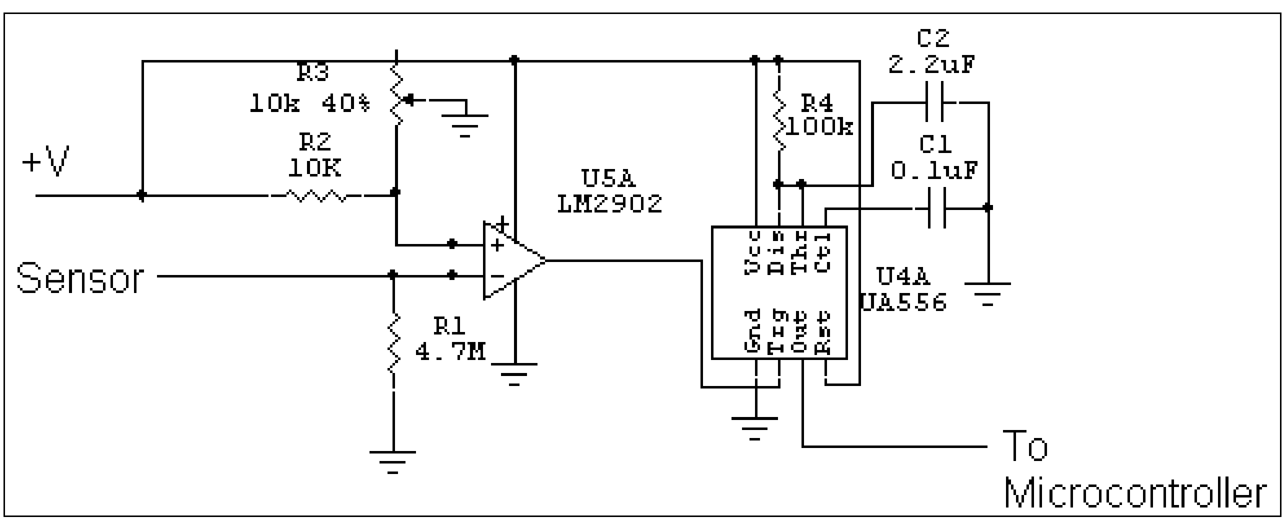

Fig. 20.3. Impact Detection Circuit.

determine the trigger voltage for the circuit, the different components of the PCB mentioned above were tested. It was determined that a voltage of 4.5V was ideal.

To address the need of volume control, a computer speaker was removed from its casing and was used for audio output. There is a volume control built on the speaker. The audio signal comes from 8 pins on the microcontroller as a digital signal and then runs through an 8-bit digital-to-analog converter that outputs to the computer speaker. Sound generation is done within the microprocessor using a variable frequency amplitude output. The output generates points on a sine wave through the digital to analog converter, resulting in an audio format similar to that of MIDI.

The total cost of parts and labor was $665.

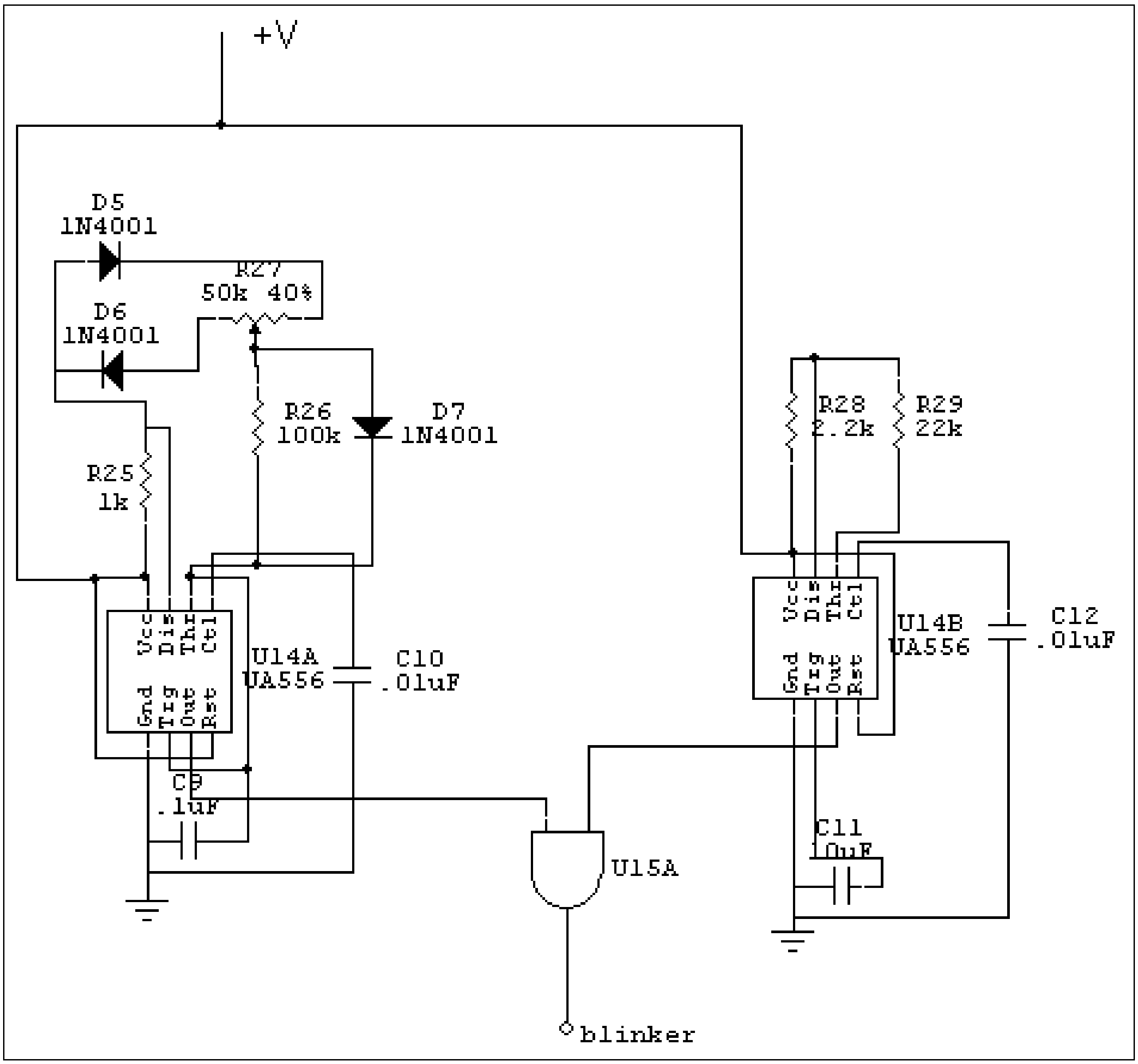

Fig. 20.4. Light Control Circuit.

ADAPTATION OF THE 7-LEVEL COMMUNICATION BUILDER

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INTRODUCTION

Augmentative communication devices promote independent use while also stimulating the cognitive thought process of a child. In a classroom setting it is desirable that they be inexpensive, durable, and lightweight. The 7-Level Communication Builder (7-LCB; Enabling Devices, Inc., Hastings-on-Hudson, NY), met all the required features of a classroom communicator, with the exception of promoting independent use. The 7-LCB was modified so that the client may use the device without any extraneous aid.

SUMMARY OF IMPACT

All of the required design specifications were met by the final prototype. The client supervisor indicated that the device could be successfully used by the intended clients during the upcoming school year. The design project gives clients the ability to use the communicator independently, thus promoting the advancement of their communication abilities.

TECHNICAL DESCRIPTION

The final design of the Adapted 7-Level Communication Builder has the same general physical configuration as the original model. The most noticeable outward change is the addition of sub-surface photoreflectors that lie below the top cover of the device. The central photoreflector is aligned with the center of the device; the two peripheral photoreflectors are separated from the central photoreflector at a distance of 6.5 cm. The axial line containing all three photoreflectors lies 1cm below the recessed edge of the top cover.

The mechanical knob on the back of the device that changes the level setting is no longer functional. To lessen the amount of mechanical modification that had to be made to the device casing, the knob itself was left in its original location.

Fig. 20.5. Client Using Adapted 7-Level Communication Builder.

The modified device uses a binary barcode system to indicate the setting level. A binary barcode system decreases the number of photoreflectors needed to implement the project when compared to a discrete barcode system. Three photoreflectors are used to read the barcodes corresponding to the 7 levels of the 7-LCB. Photoreflectors are a type of integrated circuit that detect reflection or absorption of infrared light to give either a high or a low output, respectively. Different combinations of three black and white surfaces can be used to represent a maximum of eight outcomes. These barcode configurations represent the corresponding seven levels. The first level is represented as the lowest logic of “0” and the seventh level is represented as the highest logic of “6”. For such a barcode system, the black surface represents logic low or 0, and the white surface represents logic high or 1. Experimentation was used to determine the optimal distance for placing a surface to reflect the IR back to the photoreflector. It was determined that an optimal range for the reflection of the IR would be 4mm to 6mm.

Fig. 20.6 shows the circuit design used in the project. The three photoreflector circuits on the top left read the barcode on the rear of the overlay and produce a corresponding high or low output. The output from the three photoreflector circuits is the binary input of the circuit. This binary input is fed to a binary-to-decimal decoder, CMOS 4028. The CMOS outputs 5V through the pin that corresponds to the level matching the binary input to the CMOS. Each output pin on the CMOS is connected to a relay circuit through an NPN transistor. The pin with the high output forward bias corresponding to the transistor and current starts flowing through the coil of the relay. This closes the switch connecting the corresponding level to the common. The common is a high output of 5V from the microprocessor board on the actual 7-LCB. The level leads are inputs to the microprocessor in the 7-LCB. Closing the switch through the relay and connecting the level to the common lead signals the appropriate level to the microprocessor. An outside DC power supply was used initially to supply the voltage to the circuit. The amount of current being drained by the circuit was 90mA. Assuming that AA batteries have 1200mAh, the device has a total of approximately 13 hours of continuous operation time. The adapted 7-LCB will operate according to the original operating parameters of the device. The final project is shown in Fig. 20.5.

The total cost of parts and labor was $855.

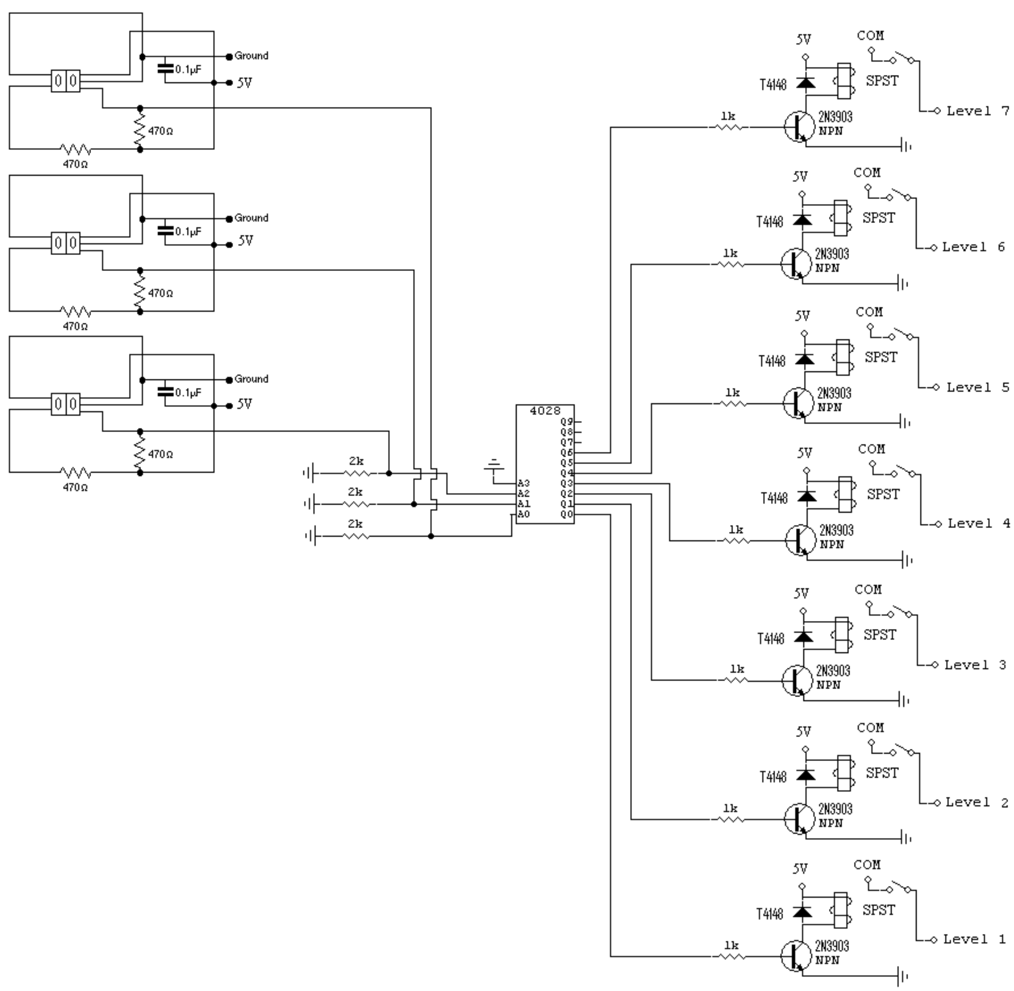

Fig. 20.6. Project Circuit Diagram.

SENSORY VEST

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INTRODUCTION

The Sensory Vest was designed to provide musical and tactile stimulation for a child with cerebral palsy and blindness. He is also nonverbal and therefore cannot effectively communicate his need for stimulation. The vest is a garment worn by the user, who is able to control the various stimuli. Currently, there are a variety of similar systems available for tactile stimulation. However, most of these devices are tabletop units that are not easily portable. The Sensory Vest is a battery-operated sensory stimulating system that can be worn by the user and is self-contained.

SUMMARY OF IMPACT

The Sensory Vest provides auditory and tactile stimulation. These stimuli can be altered by a caregiver in order to provide new stimuli for the client. The client expressed his satisfaction with the design with a big smile as he used the vest. He required only a brief amount of time to learn how to control the different types of stimulation.

TECHNICAL DESCRIPTION

The inside and outside layers of the vest are made of a durable lightweight denim. These layers encase up to one inch of easily compressible foam. Embedded in the foam are the circuit components, wiring, switches, and speakers. Three buckle closures are attached to the backside of the vest for easy donning and doffing as well as maintaining adjustability. Because the vest is intended for a young child, it measures only 16 inches wide by 17 inches tall. Lying flat, the thickness of the vest measures 1.5 inches. The arm hole circumference is 16 inches. The opening for the neck and head has a 25 inch circumference.

Raised rigid musical notes adorn each shoulder. The center of the chest holds a large circular foamy texture and is flanked on either side by two strips of Velcro. The Velcro strips allow for the interchanging

Fig. 20.7. Client Using Sensory Vest.

of four different textures: bumpy, soft and fuzzy, beaded, and hanging pom-poms. An oversized pocket near the bottom of the vest is lined with thick fur. At any time, the client can access any of the different textures. The interchangeable patches can be changed by a supervisor.

To hear music the client presses the switch located under the raised rigid musical note on the right shoulder. A 15 to 30 second children's melody plays after the button is pressed. The speakers for the sound element are located just above the music notes on each shoulder. If the switch is pressed a second time, while the first tune is playing the circuit will automatically switch to the next song on its play list. A total of 12 songs will cycle through after each pressing of the switch.

The motor generating the vibration is housed in the chest region of the vest, directly beneath the soft foam circle. To activate this stimulator, the user must press the switch located at the bottom of the foam circle. The control circuit is designed to create pulsing vibrations for each press of the switch. Each pulse is around 2.5 seconds followed by 2.5 seconds of no vibration. This process repeats four times before stopping.

One circuit used in the design is a 12-tone melody generator circuit (shown in Fig. 20.8). The output of the circuit required an impedance of 8 ohms, which was satisfied by using two 16 ohm speakers wired in parallel. A potentiometer incorporated into the circuit regulates the current flow through the speakers to control the volume. Two AA batteries produce the voltage and current necessary for operation. Because of their long life and cost effectiveness rechargeable batteries were selected. Two rechargeable AA batteries, wired in series, provide 2.8 volts and have a current capacity of 1800 milliamp hours.

A second circuit was designed to create a sequence for the vibration. This circuit is composed of a bi-stable 555 timer, a 555 clock timer and a 4017 decade counter as well as other basic circuit elements. The output from the 4017 controls a relay that operates a small DC motor spinning an unbalanced weight. This circuit is controlled by a lever switch and nine-volt battery. The clock pulse drives the 4017 decade counter. Every other output of the decade counter is connected through a diode to a transistor-controlled relay. Once the relay is turned on, 2.8 volts is sent to the motor, producing vibration.

The total cost of parts and labor was $660.

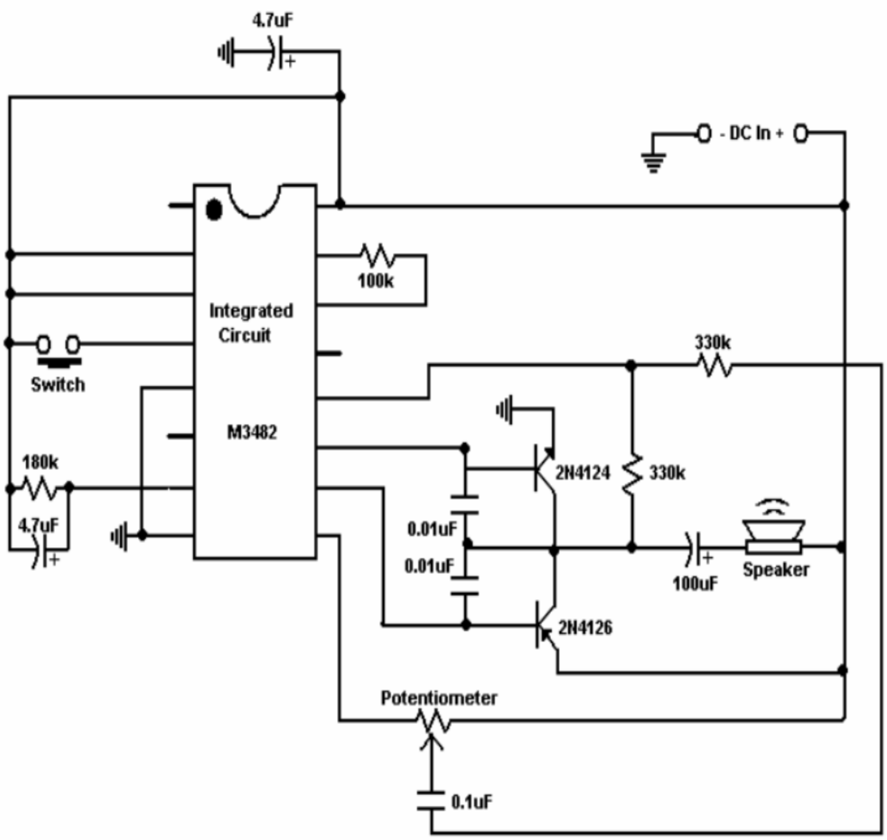

Fig. 20.8. Twelve-Tone Melody Generator Circuit.

CANDY SORTER

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INTRODUCTION

The Candy Sorter (Fig. 20.9) enables a user to sort individually wrapped pieces of candy by color. These pieces of candy are used to make wreaths, which are then sold. The client has limited fine motor skills with both hands, and uses an electric wheelchair. The Sorter assists the client in performing the sorting task, which allows him or her to earn an income.

This project is a redesign of a candy sorting system. The original design sorted gumballs of various colors into containers, under the supervision of the operator. The old design was unable to handle wrapped pieces of candy. The new Candy Sorter design is capable of sorting many different kinds of

Fig. 20.9. Candy Sorter.

piece of candy from a bag of mixed candy. The mechanical design accomplishes this. Using this device creates employment opportunities for the client. The new design is simpler than the original device, with fewer moving parts. This was accomplished by eliminating the conveyor belt system and by the use of potential and kinetic energies to move the candy. However, the design is not fully automated and is not controlled by single-button operation due to the constraints placed on the project. The available funds and time were insufficient to fully achieve an optimal solution. In this respect, the design is a compromised solution. Despite this complication the client supervisor was satisfied with the final design.

TECHNICAL DESCRIPTION

The hopper is a rotating drum with a spiral fin inside of the drum, similar to a cement truck. Candy that is to be sorted is placed into the hopper. The hopper sits approximately 5° upward from back to front. It rotates and dispenses a controlled amount of candy, one to five pieces, onto a slide. Using a momentary contact switch, the motor (controlled by the client) rotates the hopper.

The candy comes down the slide, aligned against the right edge. The slide is angled from left to right, facing the device, at 22.5°. There is a 20° downward angle from back to front on the slide. Two rollers at the end of the slide rotate to dispense a single piece of candy into a holding area. The holding area is also angled downward at 20°. The rollers are manually operated to dispense the candy into a holding area. The sorting slide rotates to the corresponding color bin for each different colored piece. The sorting slide is rotated by a motor using a toggle switch until the correct position is reached. The gate opens to release the candy down the sorting slide and into the bin. The release of the gate is manually controlled and the gate is held closed by magnets.

The supporting structure was made completely of wood. The motor mounts were constructed from PVC Expanded Foam Board and assembled using various length deck screws, machine screws and nuts, and Liquid Nails adhesive.

The structure was then coated with Krylon Semi-Flat Latex Paint. Its overall dimensions are 30″ length x 17″ width x 34″ height. The drum was constructed from Fiberglas. It is attached to the motor by bolts and the adapter is mounted to the motor. The drum is coated with shellac inside and outside. Its dimensions are 10″ diameter, with a 10 ¾″ depth. The slide pieces are made of PVC Expanded Foam Board. They were attached using PVC cement, Liquid Nails adhesive, and deck screws. Their dimensions are: 1) Slide: 9″ width under drum, 12″ length, 1 ¾″ width opening at end of slide, 2) Holding Area: 5 ¼″ length, 2 ½″ width, 3) Gate: 2″ width, 2″ height, and 4) Selector Slide: 7 ¼″ length, 3″ diameter semi-circle at top, 2 ½″ width opening at bottom. The rollers are 2 foam paint rollers, with a 1″ diameter and 4″ width.

A physics analysis of the slide system was performed to effectively design a gravity-fed system without having the candy stop sliding due to friction. At an angle of 20 degrees, the force of friction was overcome by the force of gravity exerted on the candy. This angle was then applied to all slide pieces to assure smooth motion of the candy through the system.

The device is powered by a 120V power source. The motor that rotates the drum had to be separately controlled through a DC to PWC. This was necessary to control the speed of the motor and allow for future adjustment. The current to the motor had to be reduced due to the power supply voltage being 13.77V. Using Ohm's Law, V=I*R, and power equations, P=V*I, the output voltage of the PWC was modified to obtain the necessary speed and torque from the motor.

The total cost of parts and labor was $725.

TACTILE BOARD

Designers: Lisa Griffith and Stephanie Salas
Client Coordinator: Ms. Christina Miller, Fairborn High School
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INTRODUCTION

The Tactile Board is a sensory-stimulating apparatus that is used in a classroom setting. It includes sounds, textures, and lights. The client is an eight-year-old girl with autism. She loves music and enjoys textures; the presence of such stimuli engages the client and reduces incidents of destructive behavior. The client coordinator attempted to stimulate the client's senses by gluing a piece of carpet and a string of beads to a desk in the classroom and playing music from time to time. The Tactile Board incorporates similar stimuli into a small board that can fit on a desk or tabletop, and is controlled by the client. By allowing the client to control the stimuli, cause and effect relationships are demonstrated.

SUMMARY OF IMPACT

The client coordinator was satisfied with the final design. The client was able to use each different part. Fig. 20.10 shows the client using the Tactile Board. She danced around to the music as it played and appeared fascinated by the other sensations the board created. By successfully engaging the client's senses, the Tactile Board may help to improve her motor skills and understanding of cause and effect relationships. It may also reduce incidents of self-harm and destructive behavior.

Fig. 20.10. Client Using Tactile Board.

TECHNICAL DESCRIPTION

There are six main stimuli areas on the board: 1) vibration area, 2) abacus, 3) noisy wheel, 4) lights, 5) texture slides, and 6) music. To use the vibrating area the client presses on the vibrating pillow and the pillow continues to vibrate until she releases it. The abacus acts as a touch and audio sense stimulating area. A client will be able to run her hand across the beads and knock them together, causing loud clicking noises. The noisy wheel is essentially an audio stimulating area. The lights portion of the board stimulates the visual sense. There are five LEDs inside of small domes arranged in a semi-circle. At the center of it is a switch that can be pressed to make the lights flash around the semi-circle until the switch is released. The texture slides stimulate the client's touch sense when she runs her hands across them. The client coordinator was given seven extra slides that may be swapped on the board periodically.

The last part of the board is the sound area. There are four different switches from which the client can choose to play four different nursery rhymes. Each of the buttons play a song for approximately 20 seconds and a new song cannot be chosen until the present song is finished.

The body of the board is constructed from royal blue PVC foam. The bottom of the board is 1.5′ by 2′. The vibrator is comprised of the components from a pressure-touch massager from a retail store. The materials for the pillow and the vibrator are held in black fleece and cotton or wool stuffing. The abacus is comprised of four rows of multicolored wooden balls on stainless steel rods. The noisy wheel is made up of a PVC pipe with small pieces of PVC foam glued randomly to the inside of the piping. Loose beads were placed inside this piping. The ends of the piping are sealed with two circular pieces of the same PVC foam used for the body of the board. The noisy wheel was spray-painted red. It spins on a rod of stainless steel. The light circuit comes from a chip, approximately ¾″ in diameter. The small LEDs that came on the chip were removed and replaced with brighter LEDs with longer leads. This allows the LEDs to reach each of the light holes. The switches for the lights and for the sound are normally-open momentary switches. The texture slides are made of carpet, fleece, noisy paper, and other random textures affixed by glue or staples to a 4″ by 5″ slide. These slides are held in place with 4 mm screws and wing nuts. To remove the texture slides the user simply removes the wing nuts and takes the current slide off. A new slide is placed on the board and affixed with the four screws and wing nuts.

The sound circuit that is connected to the four switches in the sound area is a Sound Pro Board from Blue Point Engineering. The board runs on rechargeable batteries. The batteries must be charged after approximately five hours of use. The user may simply connect the battery pack hook-up that is sticking out of the board to the wall charger that was provided and allow the batteries to charge overnight. A diagram of the on and off switch and the terminal board are shown in Fig. 20.11.

The total cost of parts and labor was $990.

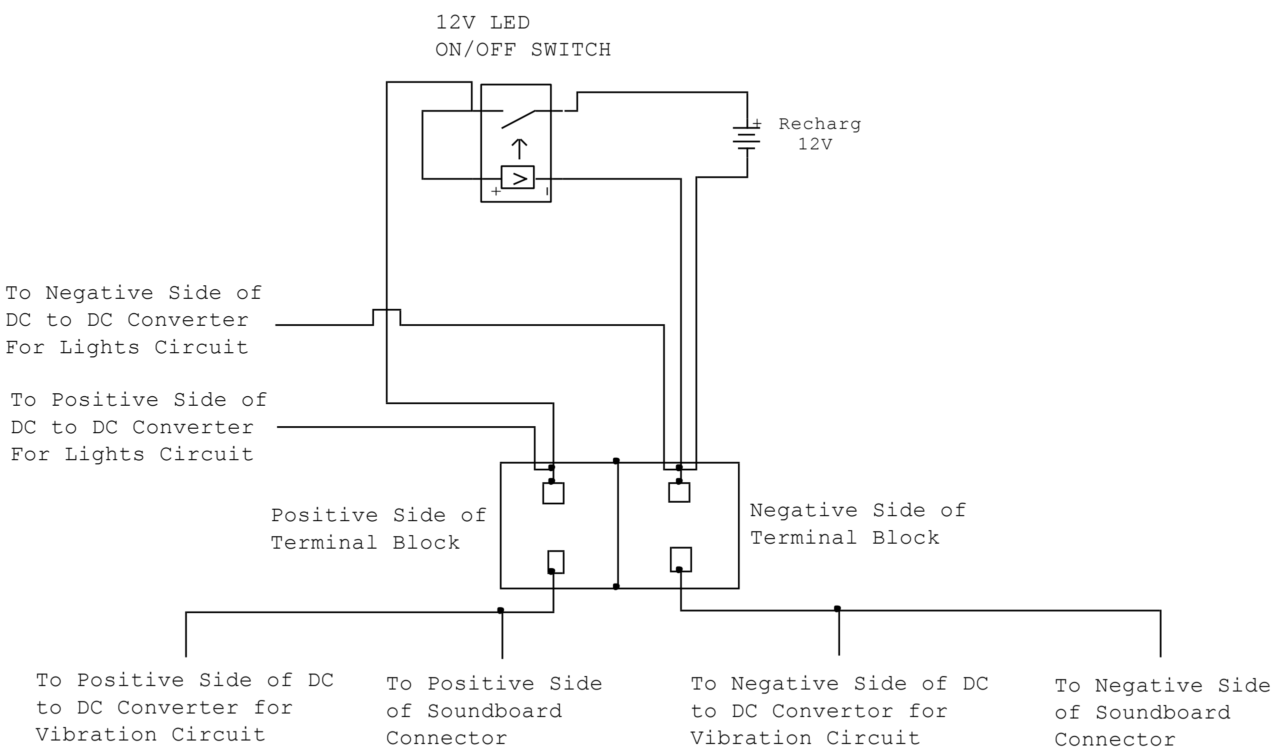

Fig. 20.11. Circuit Diagram of On/Off Switch and Terminal Board

SOUND AND LIGHT DOME

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INTRODUCTION

The Sound and Light Dome uses sounds and lights to help calm agitated students. Researchers have shown that color and light modifications are correlated to diminishing aggressive behavior and decreasing blood pressure. In classroom settings, sometimes students display agitated behavior that cannot be controlled easily. In that case a "relaxation room" can help. The "relaxation room" is usually somewhat small, comfortable and dimly lit with blinking lights, and soothing music. With insight on how colors can affect mood, the client coordinator proposed designing a sound and light dome for use as a means of calming children with disabilities.

Only one similar product has been patented and commercially sold. However, this product only adapts to the recognition of the user's voice pitch and can only be placed on the ceiling. The client supervisor requested a device that is wall mountable and that responds not only to pitch and volume of a student's voice, but also to musical tone variance. The new design meets these criteria.

SUMMARY OF IMPACT

The client coordinator was pleased with the final product. The dome was mounted on the wall. A student was brought in to interact with the dome and observe the changing lights to the radio. The user sat quietly while watching (Fig. 20.12). Ideally, the device will facilitate calming of agitated students, which will help to improve the overall classroom environment.

TECHNICAL DESCRIPTION

Stereo input or the subject's voice can trigger the light display. This device displays a certain color based on the frequency and volume of the input signal. The device operates on 120 VAC and houses a color organ that powers four LED bulbs. The color organ has four frequency channels (low, mid-low, mid-high, high) and a sensitivity channel to adjust the intensity of the sound input to the circuit. The dome is wall- mountable. It is constructed from a wooden box frame (23 x 23 x 5 inches) with a reflective dome (18 inches in diameter) that projects LED bulbs onto an outer acrylic plastic dome (20 inches in diameter) and is equipped with speaker jacks, intensity adjustment and microphone.

Fig. 20.12. Client Observing Sound and Light Dome.

This product is operable by plugging the device into a wall socket and connecting speaker wire to the outer two speaker jacks. When the switch is activated (the white dot is pressed down) the device will emit lights. The lights illuminate when the user speaks into the microphone or when music is played. The microphone can only pick up a signal within 6 feet of the Sound/Light Dome. Most of the lights operate at around the same starting frequencies but have different ending frequencies.

In order to achieve optimal lighting onto the dome, a reflective base dome was added to reflect most of the LED light (Fig. 20.13). Most of the components in the dome are easily replaceable; the LED bulbs can simply be replaced and the speaker jacks are attached on the outside of the product.

Since this product runs on wall voltage, certain safety precautions were taken. The circuit itself was placed in a grounding box with grommets used to secure all wires going into and out of the box. Also, all wires connecting the lights to the circuit were shrink-wrapped and covered as to not expose any wire that carries the wall voltage supply. Lastly, a lock has been placed on the device itself so only the teacher can operate and replace any parts inside the device as needed. This product has a long shelf life and will be reliable for up to 100,000 hours of operation if used properly.

The total cost of parts and labor was $770.

Fig. 20.13. LEDs and Reflector Dome.

ACCESSIBLE WHEELCHAIR TRAY

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Client Coordinator: Ms. Cassandra Hoagland, United Rehabilitation Services
Supervising Professor: Dr. David Reynolds
Biomedical, Industrial and Human Factors Engineering Department
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INTRODUCTION

The Accessible Wheelchair Tray was designed to assist a client who is in a wheelchair. The client has spastic Cerebral Palsy (CP). Spastic CP is characterized by muscle stiffness and movement difficulty. Because of limited motor control, the client has difficulties looking at objects that are on a flat table; he needs his learning material at eye height. A tray was designed that can tilt up and down so that his teacher can adjust the angle steepness depending on what he is doing.

The client uses a switch-operated device to speak; it is sometimes knocked down by spastic movements. A place for that device was created on the tray surface so that the client, with the help of his teacher, can operate it efficiently. An attachment to hold papers is provided on the tray surface so that when the client draws or paints, the paper can stay in place while the teacher helps the user with his hand movement.

SUMMARY OF IMPACT

The client supervisor said that she liked the design ideas that were implemented, such as: the personalized painting, rounded edges for safety, padded arms, lightweight material, and the indentation in the tray for the switch. The client was able to start using the tray immediately (Fig. 20.14). The various features of the tray enable the client to work more independently.

TECHNICAL DESCRIPTION

Polyvinyl chloride (PVC) expanded foam was used as the main material in this design. PVC foam was chosen because of its various characteristics and applications. The characteristics include: 1) light weight, 2) high strength, 3) ease of cleaning and 4) ease of fabrication. The support rods were made

Fig. 20.14. Client Using the Accessible Wheelchair Tray.

from aluminum alloy. The dimensions of the tray were based on the dimensions of the client's wheelchair. The dimensions of the parts are as follows: 1) tray top is 16″x22″x1″; 2) tray arms are 8″x4″x1″; 3) side beams are 14″x2″x1/2″; 4) aluminum rods are 11.36″x1″; and 5) support beam is 1″x21″x1″.

Large clamps are used to affix the tray to the arms of the wheelchair (Fig. 20.15). Large thumb screws can be tightened to hold the support arms in place at the desired angle for the tray tilt. Hinges hold the main tray piece to the arm structures. A paper clamp is screwed into the main tray piece for holding paper. Various pins and screws hold the other pieces of the structure together. Padding covers the arms of the structure. The tray can be adjusted to accommodate different wheelchair widths. The tray was given a custom paint job.

The total cost of parts and labor was $630.

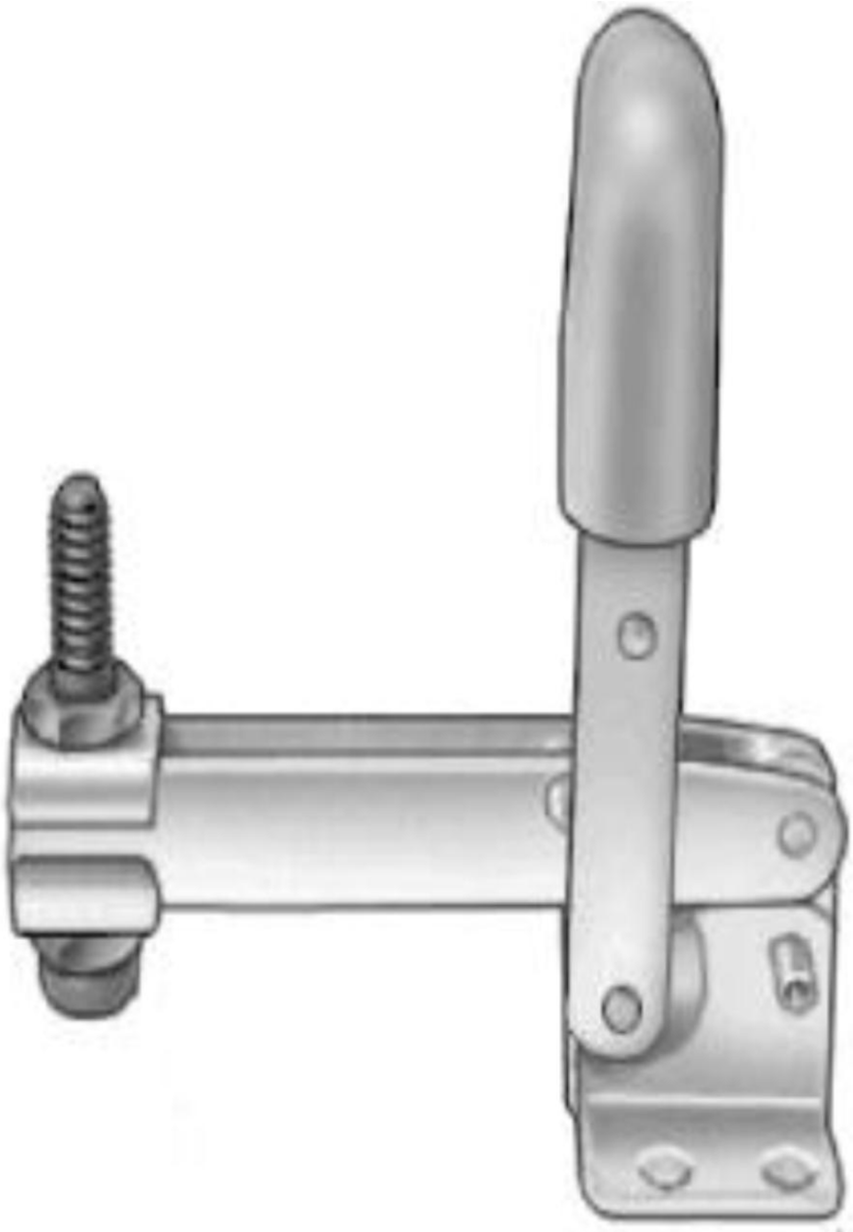

Fig. 20.15. Clamps That Attach Tray to Wheelchair.

TOUCH SCREEN FOR COMPUTER AND INTERACTIVE DISPLAY

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Supervising Professor: Dr. Ping He
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INTRODUCTION

The users of a computer in an elementary school are primarily children with cerebral palsy, autism and conditions involving motor impairment. To interface with different learning programs, they use a TouchWindow® (Riverdeep Interactive Learning, Edmark Corporation) in place of a standard mouse. The TouchWindow® functions as a mouse, so that rather than moving the cursor to a desired position clients can touch the screen where they would like for the cursor to go.

The users would sometimes knock the window off the monitor. This prevented the children from using the equipment and also created risk of injury or potential damage to the computer in use. Due to these concerns, the client coordinator requested a new method of attaching the TouchWindow® to the monitor. The clients also have difficulty interacting with the original software that the TouchWindow® uses. The client coordinator requested new software for the children to learn with and enjoy while using the TouchWindow®.

Three solutions were created. First, a steel frame was fabricated and attached to a 17″ monitor. The TouchWindow® sits in the frame while in use. An interactive program that helps the students learn colors, shapes and cartoons was written. Also, a wireless keyboard and mouse were purchased for each classroom to reduce the clutter around the computer station and facilitate efficient removal when the TouchWindow® is in use.

SUMMARY OF IMPACT

The client coordinator expressed satisfaction with the way in which the TouchWindow® was secured to the monitor. The interactive software program provides a tool that the students can use to learn and have fun. The software is easily navigated by the students and keeps their attention when the teacher is attempting to assist other students. The inclusion of a wireless keyboard and mouse simplified the area around the computer workstation. The client coordinator is able to remove the keyboard and mouse from the immediate workspace when a child is using the computer, but is still able to use them at a distance to help children complete tasks if they encounter difficulties.

Fig. 20.16. Client using TouchWindow® with Steel Frame and Interactive Software.

TECHNICAL DESCRIPTION

The final project is shown in Fig. 20.16. The frame is constructed of steel because of its relative light weight, cost (free – donated from National Machinery Company), and ability to be welded. The dimensions of the TouchWindow® were used to design the dimensions of the frame. The frame is 12.75″ tall, 14.75″ wide, and 1.875″ thick. The bottom portion is 1.875″ tall, 14.75″ wide, and 1.875″ thick. It has a 0.787″ x 9.45″ rectangle cut out to ensure the buttons on the monitor are available for use when the frame is in place. The frame is coated with a black oxide to prevent corrosion, smooth the surface and improve its aesthetic appeal. Industrial strength Velcro was used to affix the steel frame to the computer monitor. Based on grip strength, the only individuals able to remove the structure are the teachers.

The software was written using the Visual Basic programming language and was programmed using Microsoft Visual Studio .Net 2003. The source code creates an executable file that may be run on the school's computers (which use Windows XP Pro). To use the program, the student simply double-clicks on the icon from the computer's desktop, and from there the child is able to navigate through the program learning about colors or shapes or playing with cartoons (Fig 20.17). The software is reliable in that the student can loop through the program as many times as he or she likes without the program having errors or malfunctions.

The total cost of parts and labor was $755.

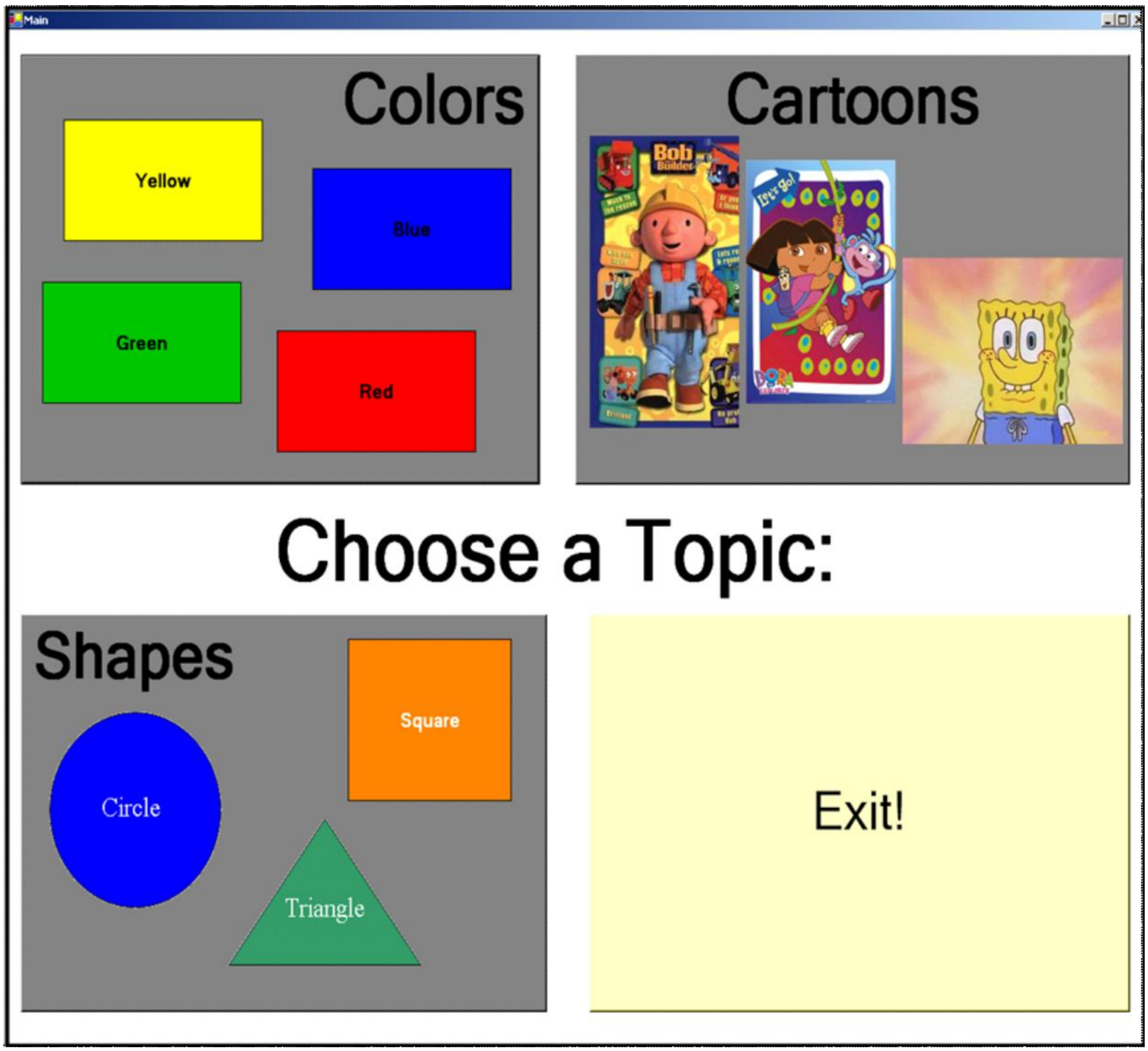

Fig. 20.17. Front Interface of Interactive Program.