# CHAPTER 19
# UNIVERSITY OF WYOMING

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# CLASSROOM NOISE LEVEL INDICATOR

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## INTRODUCTION

A noise level indicating system was designed to be used in an elementary school classroom or lunchroom. The system provides a user-friendly method of allowing students to self-monitor the level of noise within a room. It is especially useful for children with cognitive or hearing impairments to know when noise has reached an unacceptable level.

The entire system is contained within and on a standard traffic light. The traffic light is equipped with three 40-Watt light bulbs that illuminate corresponding red, yellow, or green faceplates. The stoplight is mounted on a stable stand with swivel wheels for mobility. The system stands approximately six feet tall and easily fits through any standard door. If necessary, the stoplight can be removed from the stand.

## SUMMARY OF IMPACT

The system is controlled by a microprocessor, an HC11 by Motorola. It is complete with a user-friendly control plate. The plate displays the current noise level in dB within the classroom on a liquid crystal display along with the current ranges that correspond to various light colors. These range levels have light-emitting diodes mounted directly below each range for a visual representation of the light to which the range corresponds. The green range has a green LED below it, the yellow range a yellow LED, and the red range has a red LED. The range levels are fully adjustable by turning a knob. One potentiometer has control over the upper level of the green light and the lower level of the yellow light. A second potentiometer has control over the upper level of the yellow light and the lower level of the red light. The setup ensures that only one light is on at a time.

The system is equipped with a buzzer, which the user may turn off at any time. The buzzer will only be activated in the event that the red light has been on in excess of 35 seconds and will immediately be disabled when the light is no longer red or the toggle is turned off.

## TECHNICAL DESCRIPTION

There are five inputs to the microphone outputs from the two different microphone amplifications. The original signal from the microphone must first go through an RMS to DC converter before it is amplified and inputted to the microprocessor. It is inputted into the analog to digital converter of the microprocessor which then compares the voltage to a series of thresholds to determine the current dB level in the classroom. The next two inputs are from the two potentiometers. These potentiometers set the ranges for the three lights of the stoplight. The two inputs are also sent into the analog to digital converter to compare the input voltages and determine corresponding dB levels for the various ranges. The first potentiometer sets the upper level of the green light and the lower level of the yellow light. The second potentiometer sets the lower level of the red light and the upper level of the yellow light. The last input to the microprocessor is the toggle switch, which allows for the buzzer to be activated in the event of a red light. The first three outputs are the connections to the lights of the stoplight through three solid state relays. These outputs are determined both by the microphone input and the user input. More specifically, the microprocessor assesses the current dB level in the classroom and determines which light needs to be activated based upon the ranges for each light as set by the user. The buzzer output, our fourth output, is determined by the microphone, the user input, and a timing system to activate the buzzer. The fifth output is the LCD. The first line of the LCD depends on the microphone input. The first line displays the current dB level in the classroom. The second line of the LCD depends upon the user input. This line shows the ranges corresponding to the various light colors. The last three outputs are the red, yellow, and green light emitting diodes that indicate how the ranges correspond to the lights (see Figure 19.1).

The total cost to build this system was about $80, with some of the key components, including the stoplight, donated by various organizations.

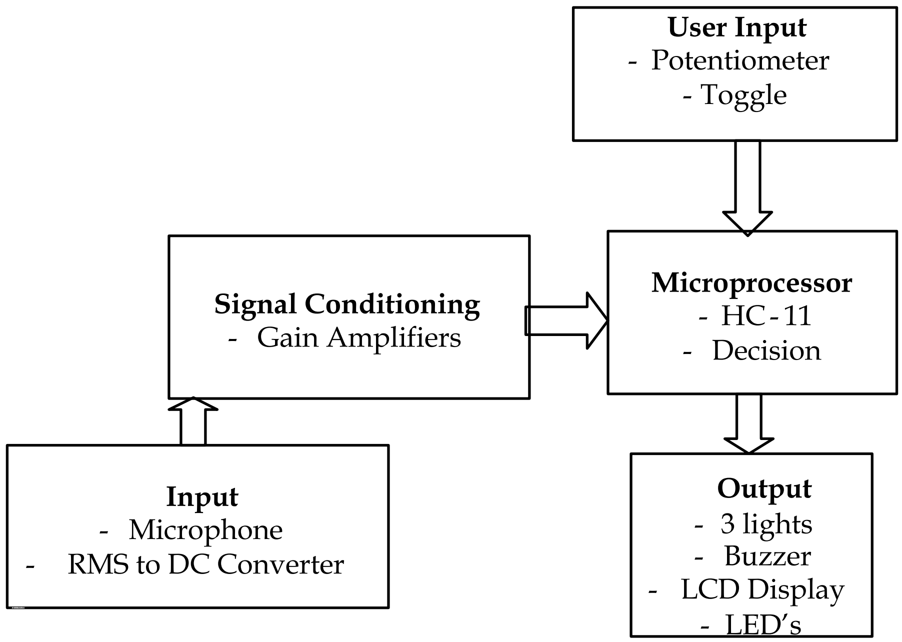


Figure 19.1. Block Diagram of Classroom Noise Level Indicator.

# COMMUNICATION ASSIST DEVICE

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## INTRODUCTION

The main objective of this project is to enable a child with cerebral palsy more communication ability with minimal help from others. The device uses a voice chip with limited memory to record messages that the child can play back. The messages can be recorded by anyone, such as a parent or teacher. Once the messages are recorded, the child will be able to use the device with little or no assistance.

As the child's vocabulary grows, the messages can change. The device can hold many different messages. This is accomplished with laminated sheets of pictures or words placed over the 16-key keyboard interface. The child presses a key to play a message.

The number of pictures and words is adjustable, and the device can detect which sheet is on the keyboard. As the child's skills increase, he or she can move to a larger number of squares per sheet, which eliminates the need to buy a new device.

The device uses batteries and is portable and.

## SUMMARY OF IMPACT

The communication assist device helps children by helping them communicate with others. This device also gives children a sense of independence, because is requires little help from others to operate.

## TECHNICAL DESCRIPTION

This project uses a DVM-58D digital voice module from Rayming to store messages. The device incorporates an MC68HC711E9 microprocessor from Motorola to control the voice chip and determine which memory location is needed. The code is written in C and then downloaded into the HC11.

The microprocessor uses four light emitting diode detector pairs to determine which laminated sheet is placed over the keyboard. Holes are placed in each sheet, with a total of 16 different combinations, and these holes line up with the detectors. When something comes between the emitter and the detector, such as a sheet, the microprocessor reads it.

This device has two modes of operation, play and record. It determines these modes with a pushbutton. When recording the user must press the record button and a key on the keyboard; this is intentionally made to require careful input so that messages are not accidentally changed.

The keyboard consists of 16 keys. The microprocessor can determine which key is pressed and, from there, calculate from which memory location it has come.

The total cost of the project was approximately $132.

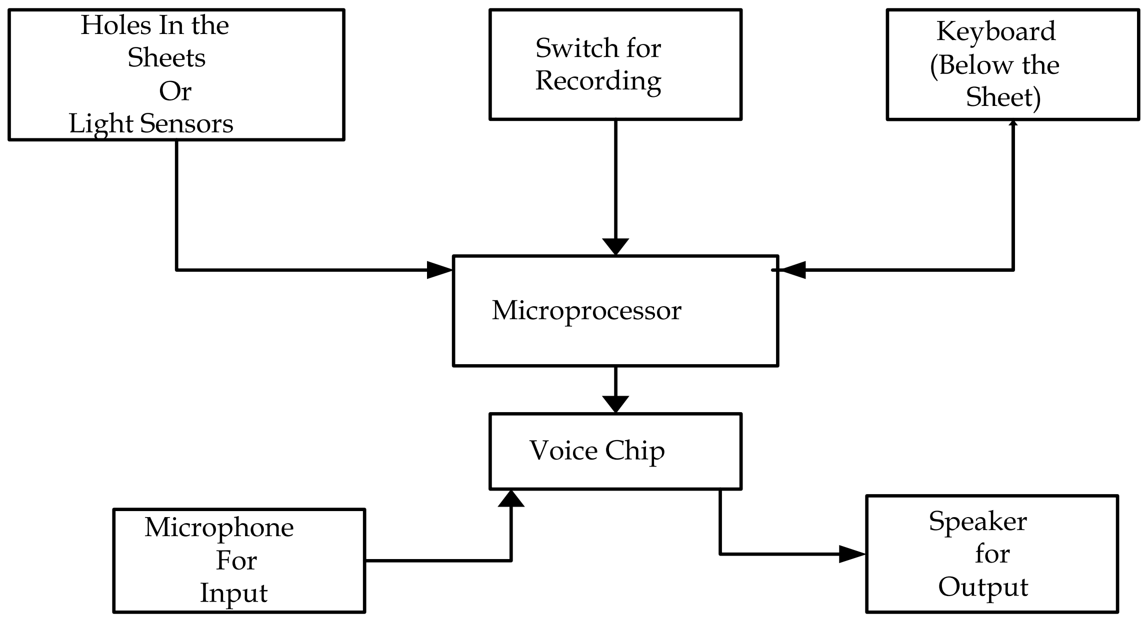


Figure 19.2. Block Diagram of the Communication Assist Device.

# ADJUSTABLE COMPUTER WORKSTATION FOR YOUNG CHILDREN

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## INTRODUCTION

A physical therapist for a school district requested a workstation for children of varying ages and sizes having a range of disabilities that require various accommodations. Accommodations must serve children using wheelchairs, children with cerebral palsy, and students with visual impairments.

## SUMMARY OF IMPACT

The project provided one workstation that is user-independent and easy to move. It looks like a typical workstation, and accommodates a variety of children with disabilities.

## TECHNICAL DESCRIPTION

Design criteria were that the workstation:

- Be safe, durable, and easy to use,
- Fit all the children with varying disabilities,
- Look like a typical workstation,
- Be large enough to be wheelchair accessible,
- Be small enough to be moved around easily,
- Be lightweight and durable for easy moving, and
- Include a desktop that varies in height, from 28.0 inches to 45.75 inches.

The base of the workstation was made from a c-shaped piece of 6061-T6 aluminum with caster wheels connected to each corner. The two front wheels have locks so that the desk will not move while the children are working on it. Birch, a lightweight and strong material was used for the top, and laminate was applied to the top for extra durability.

Actuators were chosen as the main lifting mechanism of the desk, as they can withstand the vertical forces applied to them. However, in order to eliminate the moments acting on the top of the workstation, telescoping legs, made of 6061-T6 aluminum, were built around the actuators, and then two bushings were placed inside the telescoping legs to eliminate the moments.

It was decided to tilt only half of the top of the workstation so that the other half could be used for a computer monitor. A scissor lift was chosen to achieve the requested tilt, 75 degrees. This was accomplished with a small motor connected to a piece of right-handed all-thread welded to a left-handed piece of all-thread. Located on these pieces of all-thread were two special nuts that were machined in the machine shop. There were also two special nuts machined for the top part of the scissor lift. These were placed on an aluminum tube connected to the top of the workstation. There are two aluminum bars between these two sets of special nuts to connect the top with the bottom. The top of the desk was hollowed out in order to fit the scissor lift and all the electrical boards for the scissor lift and actuators. The mechanisms were blocked from the children's reach. The motor was connected to a toggle switch, turning the all-thread and moving the special nuts in and out to lift and lower half of the top of the workstation. This half can be raised to an 81 degree angle and lowered to a 0 degree angle and could be stopped anywhere in between.

The tilt was needed because many of the children have problems seeing their work if it is too far away, and many of them have a limited length of reach.

The two toggle switches, one controlling the tilt and the other controlling the height of the desk, are both located in the front of the workstation for easy access. These toggle switches were recessed so they cannot be bumped accidentally.

Figure 19.3. Completed Workstation.

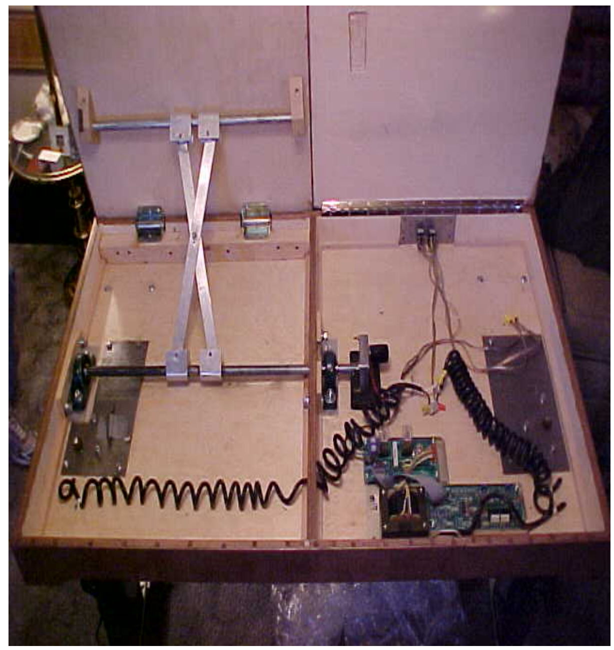

Figure 19.4. Inside Components of Workstation.

# DIGITAL SHOWER TEMPERATURE CONTROLLER

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## INTRODUCTION

Some people with disabilities also have difficulties working mechanical valves or sensing water temperature. Sudden changes in water temperature while taking a shower are not only annoying but can also cause serious injury. The digital shower temperature controller provides an easy-to-use interface, allowing a user to automatically control the water temperature in a shower.

## SUMMARY OF IMPACT

The user enters a temperature into a keypad using the menu-based operating system displayed on a liquid crystal display (LCD). The controller then adjusts the water temperature until it is within three degrees of the user-defined temperature. The device maintains the user-defined temperature regardless of the input water pressure or water flow as long as the input hot water temperature is greater than or equal to the requested temperature.

## TECHNICAL DESCRIPTION

The digital shower temperature controller consists of hardware, software and non-electrical mechanical parts. The hardware portion consists of the embedded controller, sensors, interfacing hardware, solenoid valves, and hybrid stepper motors with optical encoders. The non-electrical mechanical portion consists of the mechanical gate valves used to control water flow, a delay tank, and the copper pipes used to connect all of the components.

The HC11 is used as the embedded controller to control all of the hardware for this design. The software is programmed in C for simplicity. Located in a box, which is the only part visible to the user, are two LCDs and a keypad. The HC11 is directly attached to the two LCDs, which are used to provide a menu system that is easy to follow and use. A keypad is also directly attached to the HC11 to provide the user with the ability to interact with the embedded controller. All of the other hardware for the design is located in a separate box, which is installed into the wall where the shower is located.

The hardware, which is located in the box in the wall, includes the solenoid valve switching board, the temperature sensor signal conditioning board, the motor control board, the power supplies, and the hybrid stepper motor drivers.

The solenoid valves, located at several different locations, use 24 VAC, which required an interfacing board using mechanical relays. The relays are switched on and off using power MOSFETs because the coil voltage is 24 VDC. These solenoid valves provide safety features that shut down the output water if the system fails to control the temperature properly. They also give the user the ability to use standard knobs in the event that they do not wish to use the controller.

The temperature sensors are the LM34. Due to the analog-to-digital converter (ADC) resolution of the HC11 being 19.25 mV, a signal conditioning board was necessary to take full advantage of the ADC's zero to five range. The signal conditioning board takes a voltage of 600 mV to 1.4 volts from the temperature sensors and converts it to zero to five volts going into the ADC. This transducer interface gives the system a temperature range of 60° F to 140° F and a resolution of greater than .5 °F.

The motor control board provides the Transistor-Transistor Logic (TTL) compatible signals necessary to control the hybrid stepper motor drivers. An interfacing circuit was required because the drivers require more current than the HC family can provide. The hybrid stepper motors used in conjunction with the drivers have a resolution of 1.8 degrees per step with a total number of 200 steps per revolution. When the drivers are used in micro-stepping mode the resolution of the motor is increased even further to 0.18 degrees per step. Optical encoders are also employed with the motors to provide feedback, providing the motors with the ability to automatically close without the need to keep track of how far open or closed the mechanical gate valves are.

The non-electrical portion of the design is kept as simple as possible with two standard brass gate valves and a delay tank. The hybrid stepper motors are attached to the gate valve to provide for control over the water flow through the system. A tank is employed before the output of the system but after the mixing chamber to provide a delay in the output water and give the motors more time to adjust the temperature to the correct value. This tank is large enough to provide a delay of approximately 25 to 30 seconds.

The general operation of the design follows. First, the user enters the target temperature, from 65° F to a maximum defined by the user but no greater than 135° F. The user then enters the length of time the system is to run. The program then takes an average of several temperature sensors located thoughout the system. Using this average, the processor does an error check to make sure the temperature measurements are within tolerances of their normal operation. Then, using the average provided by the temperature sensors, the processor adjusts the cold water flow using the stepper motors and gate valves until the temperature on the output of the system is within three degrees of the user-defined value. The hot water is kept constant through the entire process with the valve being open to an amount that is defined by the user through a separate menu option. The time it takes to complete the task of getting the temperature to within the three degrees varies between 30 seconds and two minutes, depending on the initial water temperatures. Once finished, the user can either press a button or wait for the time entered to expire. Once either of these two things occurs the system will automatically shut down and reset for the next use.

The total cost for the project is approximately $750.

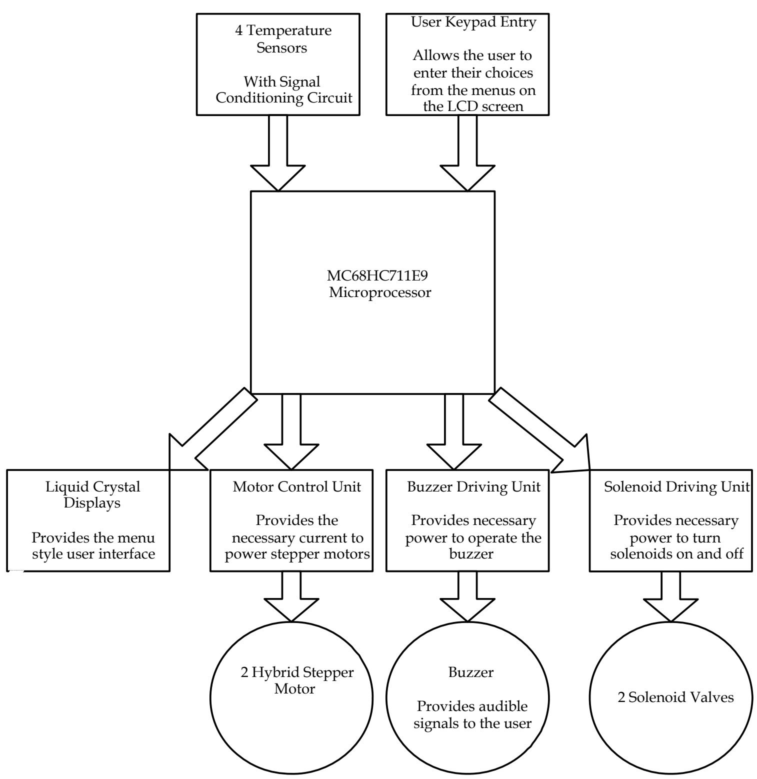


Figure 19.5. Block Diagram of the Digital Shower Temperature Controller.

# SKI BRA FOR SKIERS WITH DISABILITIES

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## INTRODUCTION

A ski bra is a device that allows a person with a physical or cognitive disability to enjoy the sport of skiing. The ski bra clamps onto the tips of skis to keep the tips together.

The project objective was to design a more efficient and effective ski bra than those that are currently on the market. The current ski bras are a safety hazard because they often fall off the ski tips while in use. The plastic stopper has very little contact area on the ski tip, resulting in a weak attachment that is easily disrupted by slight movement. The plastic used in the stopper is a hard plastic, which does not allow for any give when the knob is tightened down. With no deformation, the stopper does not conform to the ski tip, forming a weak attachment. Where the steel rods meet between the skis, they clank and knock together with ski movement causing extra pull on the rods. The pull causes an extra force to be added to the rods, which then pull on the ski attachments weakening the connection between the plastic stopper and ski tip. If there is a strong enough pull the ski attachment can become loose or even fall off. When the ski bra falls off, there is less control for both the skier and the tetherer. This causes the ski bra to become unmanageable in ski lines and around lift equipment. The skier's skis can also become separated, causing a loss of control or entanglement of the skis. As a result, the skier may fall and be injured.

Current designs do not allow for natural variations in the skier's foot stance. Therefore, only one ski stance width is allowed and it is a close unnatural stance. A skier's stance should be adjustable depending on the size and ability of the skier. When a ski stance is too close together, it causes a loss of balance and control. The close ski stance of current designs results in limited maneuverability of the skies, such as edging side to side during turns. The current ski bras are also difficult to manage by both the skier and tetherer. With the skis bras continuously falling off, there is an ongoing need to readjust them to either make sure that they are snuggly on the ski, or to place the bra back on the ski. This is time consuming for both the skier and tetherer. Also, the current ski bra does not allow much adjustability for the different sizes and shapes of skis that are currently on the market. There are two sizes available: one for a straight ski, and one for a shaped ski. The shaped ski bra only fits a limited number of shaped skis. If the bra does not fit tightly around the ski tip, it will not stay on the ski. Also, if the ski tip has a plastic covering, the plastic stopper does not have enough room to clamp onto the ski, even if the metal encasement does fit around the ski tip. These limitations are a restraint to the use of the ski bra.

## SUMMARY OF IMPACT

Individuals without sufficient leg muscle control do not have the ability to participate in sports such as skiing without assistance. The ski bra for individuals with disabilities can help them learn to ski. Additionally, the ski bra allows the user to actively use muscles, which may help some individuals regain the ability to use muscles on their own.

The ski bra has to be able to stay on the skis to reduce the possibility of loss of control. It also has to be able to accommodate the skier's size and weight. The new design (Figure 19.6) has an adjustable stance to fit skiers of different sizes.

## TECHNICAL DESCRIPTION

The ski tip attachment is 5000 series aluminum. The aluminum is 8 ½ inches long, 1/8 inch thick, with four bends each at 15 degrees to form a 'box' fit around the ski tip. On the inside sides of the attachment there is a thin piece of 60 durometer neoprene to help enclose the ski tip and provide a tighter fit around the ski. Neoprene is used due to its flexibility and resistance to water. For each single ski attachment there are two knobs with 10-24 inch threads that go through the aluminum and attach to a rectangular piece of 5000 series aluminum and neoprene. Using a rectangular piece of aluminum and neoprene, instead of a round stopper similar to what is currently used, increases the amount of contact between the plate and ski tip, forming a more solid clamp.

Each individual ski attachment has two parts: the inner and outer sides. The inner side of the attachment (i.e. the right side of the left ski attachment or the left side of the right ski attachment) has a fixed hole position, while the outer side has an adjustable hole position. A slit is milled at a 30 degree angle to allow for the ski attachment to adjust to fit a wide range of ski shapes. On the bottom side of the slit, a ½ inch wide 3/16 inch deep hole is also milled to fit a weld nut. Around the hole, 4-40 holes are drilled and set with a washer and a screw. The washer acts as a guide for the weld nut to slide up and down the slit without falling out. On the inside, a single hole is drilled and a weld nut was milled for the desired fit. The weld nuts provide stability when the knobs are turned while moving the rectangular plate up and down. In addition to the adjustable holes, the inner and outer sides are connected with a rivet acting as a pivot point. This connection helps facilitate in the movement of the separate parts to fit around multiple skis. On the inner side, a studded shielded spherical female rod end, 3/8-24 inch threads, is connected to the ski attachment. A shielded ball joint was chosen to help prevent dirt, snow and ice from getting into the joint. The ball joint allows the skis to be tilted on their edges and the ski tips to move back and forth. The skier may stand with tips pointing straight out, or with tips pointing at one another, forming a point.

The slider mechanism is used to control the forward/backward motion of the skis. The slider rod is 5/16 inch 6061 T6 aluminum in a closed U-shape. The rod is cut to 22 inches then bent at each end to close the loop. A three-point weld is used in the middle of one side to complete the loop. To hold the loop in place, one side is fixed. To obtain the sliding motion, a 0.8 inch long plastic sleeve is fabricated to fit along the rod. The sleeve is then press fit into a shaft collar. To absorb impact of the slider while sliding along the rod, rubber stoppers are placed at each end of the rod just before the bends. To hold the stoppers in place, the rod is grooved 1/16 inch deep and wire was wound on the outside to be sure that the stoppers have a tight fit to the rod. The sleeve is free to move a distance of eight inches along the rod. The adjustable ski stance mechanism is composed of telescoping rods that connect the ski attachment and slider mechanism together. The outside tube of the telescoping rod is threaded into the rod end, which is connected to the ski attachment and the other end has a threaded clamp collar threaded onto the outside. A rod is placed inside the tube under the threaded clamp collar, and the other end of the rod is threaded into the shaft collar on the slider mechanism. With the rod and tube joined together, the clamp collar is used to tighten and loosen the connection for a quick and easy adjustment.

When placed on skies, the ski bra performs well and shows many improvements over the current models.

Figure 19.6. Ski Bra for Skiers with Disabilities.

# VOICE ACTIVATED REMOTE CONTROLLED CAR

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## INTRODUCTION

A controller was designed to give children who have limited use of their hands the ability to play with remote controlled cars.

## SUMMARY OF IMPACT

The microprocessor is the basis for the design. It is able to take a command from the voice recognition processor, determine what that command is, and tell the transmitter what signal needs to be sent to the car.

The voice recognition processor used in this design initially only had an 80 percent reliability rate, but it was improved to a 90 percent reliability rate in the final design.

## TECHNICAL DESCRIPTION

Every remote controlled car comes with a transmitter that sends the signal from the microprocessor to the car. The microprocessor sends a pulse width modulated signal to the transmitter depending on what voice commands are received, and the transmitter then relays this signal to the car. Bringing the three main parts of the design together was the final obstacle that had to be overcome in order to make the design a success.

The HM2007 voice recognition processor is the device that receives a verbal command from the user of the controller, and then sends a number that corresponds to that command to the microprocessor.

The project includes the following features.

• Speed control of the car

– "Faster" slowly increments the speed up to 1/3 of maximum

– "Slower" slowly decreases the speed until the car stops

– "Cruise" holds the car at its current speed

– "Stop" stops the car

– "Reverse" backs up the car

• Controlling steering

– "Right" will incrementally turn the wheels right

– "Left" will incrementally turn the wheels left

– "Lock" will hold the car with the current turning radius

– "Straight" will point the car straight ahead

• "Wheelie" is a fun command that makes the car's front wheels pop up into the air for a short time.

Figure 19.7. Voice Activated Remote Controlled Car.

Figure 19.8. Voice Activated Remote Controlled Car.

# SPEAKER VOLUME DISPLAY

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## INTRODUCTION

Some individuals who have hearing impairments do not have the ability to obtain auditory feedback of their voice volume level. A speaker volume display was designed to address this challenge. Two tasks are performed by this display. The first is to alert the person with a hearing impairment that his or her current voice level is too loud by way of a DC vibrating motor. The second is to alert the user of a high surrounding noise level by the way of an LED bar graph.

## SUMMARY OF IMPACT

At maximum conditions, this device consumes no more than 155 mA from four, alkaline, 9V batteries. This device lasts for 30 - 40 hours operated at normal conditions (i.e., when the surrounding noise level is lighting half the LEDs on the bar graph and the vibrating motor is not activated more than once every 10 minutes).

## TECHNICAL DESCRIPTION

This product is designed to be portable for the user and has two components. The first is the battery pack and circuitry. All the electronics are contained in a 6x4x2 inch plastic enclosure that mounts on a belt clip, which can then be placed on the hip for easy access. The second component is a microphone that is connected to the enclosure on one end and to a collar clip on the other (this is for the user's volume level). A toggle switch, shown in Figure 19.9, allows the user to turn the device on/off. Once on, there are three levels of sound on the Speaker Volume Display. If the user enters different volume level surroundings, the Speaker Volume Display can adjust. The levels can be adjusted by a rotary switch shown in Figure 19.9. The first stage (low) adjusts the Speaker Volume Display to the lower dB range (55 – 85 dB). The second stage (medium) adjusts the display to the middle dB range (80 – 100 dB). The third stage (high) adjusts the display to the upper dB range (95 – 120 dB). Along with these features, the Speaker Volume Display alerts the user when voltage levels of the alkaline batteries are low. This is accomplished by a blinking green LED seen in Figure 19.9 and is mounted on the plastic enclosure. The Speaker Volume Display is lightweight and powered by fairly small batteries.

Two block diagrams are shown in Figures 19.10 and 19.11 to illustrate how the hardware will be set up for the Speaker Volume Display. Figure 19.10 refers to the surrounding noise level and 19.11 refers to the user's voice level; a band-pass filter is used to allow only the human voice range frequencies to pass. Each diagram shows the basic schematics implemented. The full wave rectification for both is accomplished with a fast AC to DC converter and the averaging is done for two seconds. The


Figure 19.9. Speaker Volume Display and Microphone on Collar Clip.

comparison block consists of a Schmitt trigger (comparator with hysteresis) for gradual switching. One block not included in either block diagram is the low battery voltage monitor circuit. Once the battery voltage becomes too low, or the batteries become discharged the green LED on the enclosure of Figure 19.9 blinks twice per second alerting the user a battery change is needed.

The Speaker Volume Display is very accurate with its corresponding decibel levels provided earlier. The first level is very sensitive. In level 1, the vibrating motor turns on when the user's volume level exceeds 82 dB. In level 2, the vibrating motor turns on when the user's volume level exceeds 95 dB. In level 3, the vibrating motor does not turn on since it is not practical for a person's voice to be above 110 dB.

The overall cost of the Speaker Volume Display is $90.00.

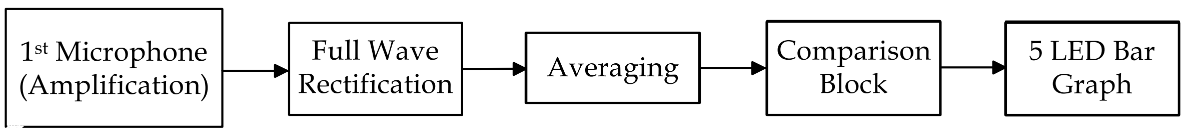


Figure 19.10. Block Diagram of Surrounding Noise Level Circuit.

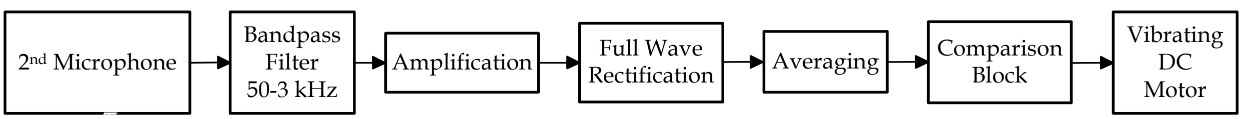


Figure 19.11. Block Diagram of Individual's Noise Level Circuit.

# WRIST COMMUNICATOR

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## INTRODUCTION

The Wrist Communicator is an easily programmable, portable, talking communication aid that is designed to be worn on the wrist. The device can play up to twelve, five-second prerecorded messages. The Wrist Communicator could be used in many applications, from making quick notes to helping children with speech impairments communicate with others who may not understand sign language to storing pre-recorded reminders for people with mental disabilities. The device has up to 75 seconds of recording time, and the messages can easily be changed for any situation. The messages are divided into four different categories, with three messages per category, for easy situational manipulation. The device is powered by long-lasting lithium batteries.

## SUMMARY OF IMPACT

There are currently other devices on the market that accomplish similar tasks as the Wrist Communicator. In the Sammons Preston Rolyan Fall 2003 Pediatrics catalog there is a device for sale that has 75 seconds of recording time and is divided into 8 messages. It retails for $158.95, whereas the cost to produce a Wrist Communicator is around $40.

The Wrist Communicator (Figure 19.12) has 12 messages of approximately five seconds each. Other existing communication aids employ robotic or computerized voices to convey the messages which are not easily changeable and usually do not fit on the wrist. The social aspects involved for children using such a device is much better when the voice emanating from the communication aid is human rather than robotic. A common device employed by individuals with communication difficulties is often called the "big board," and is awkward for children to carry.

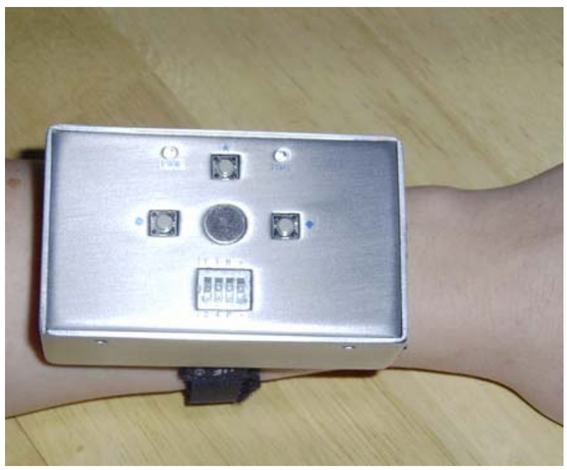
## TECHNICAL DESCRIPTION

There is a small four-pin dual inline package (DIP) switch that turns the device on, selects if the device is in play or record mode, and changes which category the device is currently in. The two category switches are the first two switches from left to right. Each category is set up to have three messages each, yielding a total of twelve messages. The categories could include a school environment, a home environment, or a play-time environment, for example. It is helpful to remember where messages are stored. Also, the switches reduce the amount of buttons needed to recall all twelve messages. The switches are employed in a binary manner. With the two switches there are four different possible positions that they could be in: both up, one up and one down, both down etc. There are two LEDs. One is a power on LED, and the other illuminates for five seconds to let the user know that a message is being played back or recorded. A microphone is included to conveniently record new messages when desired.

An Atmel AT90LS8535 (8535) is the microcontroller that controls the operation of the Wrist Communicator. The 8535 is a 44-pin microcontroller that has 32 I/O pins (four ports). The 8535 has eight Kbytes of programmable flash that has an endurance of up to a 1000 write/erase cycles. These programming cycles are accomplished using the on-board SPI system for in-system programming with a programming board. It has 512 bytes of EEPROM with an endurance cycle of up to 100,000 write and erase cycles, and 512 bytes of SRAM. The typical power consumption at 4 MHz is 6.4 mA, which is ideal for battery operation. Even though the Wrist Communicator is a micro-controlled device, a digital recording and play back IC is the center of the Wrist Communicator's functionality.

Winbond's ISD2575 (2575) ChipCorder provides high-quality, single-chip, record/ playback solutions for 75 second message applications, and is the heart of the Wrist Communicator. The 2575 is a CMOS device that is a 28-pin device which includes an on-chip oscillator, microphone preamplifier, automatic gain control, antialiasing filter, smoothing filter, speaker amplifier, and high density multi-level storage array. The 2575 is, of course, microcontroller compatible. Recordings are stored into one-chip nonvolatile memory cells, providing zero-power message storage lasting up to 100 years. The device is battery operated and portable. Also, it is convenient and cost effective to have batteries that do not need to be changed frequently. The batteries must be small so as to fit in a device that will be worn on a child's wrist. The CR2430 is a lithium battery specific for electronic devices that meets the needs of the Wrist Communicator. This battery has a nominal voltage of 3.1 volts and a rated capacity of 300 mAh, so two batteries are connected in series to provide the needed five-volt supply. It is estimated that it would take approximately 15 seconds to turn the device on, replay the message, and then turn it off. For this to occur, approximately 350 mAs of battery life would be used per message and 7000 mAs per day. If this level of usage is sustained, the 350 mAh batteries should last for about five months.

Currently, a second prototype is being constructed to reduce the size of the wrist communicator.



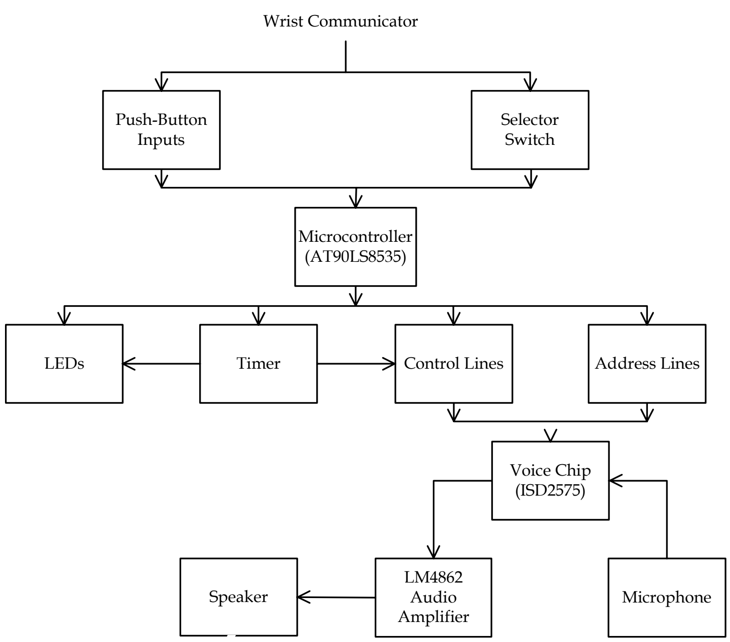



Figure 19.12. Wrist Communicator.