CHAPTER 10
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PROXIMITY SWITCH

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Client Coordinator: Todd Kollman, Adaptive Equipment Engineer
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INTRODUCTION

The proximity switch allows persons with physical disabilities to activate a button without physical contact. The device is designed to be 1) portable. 2) small, 3) easy to use, and 4) reasonably priced. Most switch-operated devices are compatible with, and easily adapted to, the proximity switch. The proximity switch operates as a momentary, or latching style, switch to fit a necessary application. Changing between the two settings is accomplished by changing a jumper setting inside the button enclosure.

There are several similar no-touch buttons available. Some are operated using a photo eye and, when the light in the room changes, the button needs to be recalibrated. The new design allows the user to control the device in a hidden manner by placing it under a bed tray, table, or almost any other material up to 1.5″ thick. This causes the button to operate more safely in situations where the user or button could be harmed. The switch has adjustable sensitivity which can be set for a switch activation of 0.75″ away, down to a firm touch on the button's surface.

SUMMARY OF IMPACT

The button allows for an effortless way for clients to use items in their daily life, thus improving the overall quality of life for the user. Practically any switch-operated piece of equipment can be modified to work with the button. The dimensions of the proximity switch are approximately 4″in diameter by 1″ thick. The device is simple to attach to a modified piece of equipment.

A completed device, shown in Fig. 10.1, is currently in use by the client coordinator. He has expressed satisfaction with the device and feels that the button will help improve the lives of many people. He is currently using several of the devices and plans to incorporate more into his facility.

Figure 10.1. Proximity Switch.

TECHNICAL DESCRIPTION

As shown in Fig. 10.2, the proximity switch is composed of five component blocks: 1) a proximity chip, 2) a button touch pad, 3) a relay, 4) an output jack, and 5) power.

The heart of the device is the QT140, a proximity chip made by Quantum. The chip is responsible for sensing a near touch and activating the output. The chip operates by sending repeated groups of five volt pulses, at 10 MHz, to the button pad. It then senses the variation in the signal which causes a change in output. The change occurs when the body is close to the touch pad surface; it essentially acts as a grounding source. When the chip determines a valid switch it activates a five volt on the output pin, which drives the solid state relay. The solid state relay activates the equipment by closing the loop.

A standard 9-volt battery powers the entire system. The button has a power switch to turn the button on and off as it is needed. There is also a jumper accessed through the battery cover, which allows for the changing of momentary to latch style switching.

The device has moderate production difficulty, with the designed system cost of about $45 per unit. This price is significantly less than comparable products.

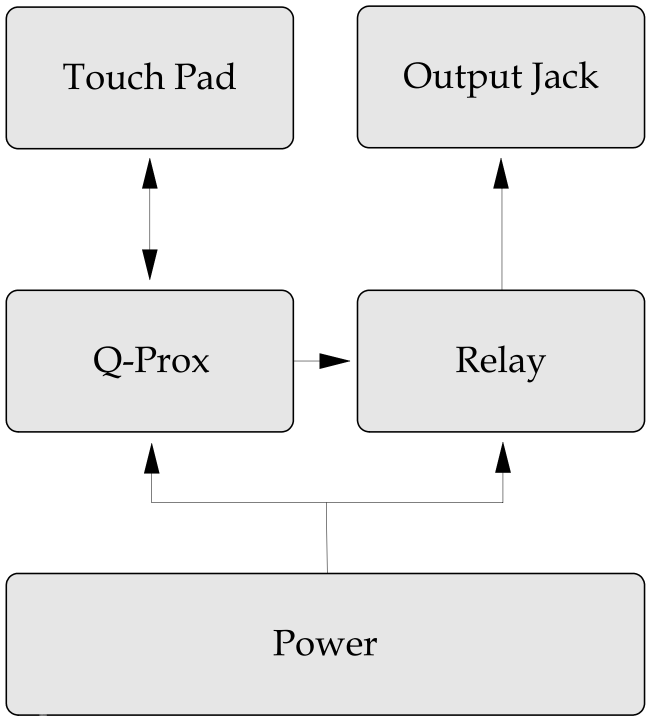

Figure 10.2. System Block Diagram.

INTERACTIVE PUPPET STAGE

Designers: Brian Fix, Jason Drouillard, and Justin Davy
Client Coordinator: Sharon Olson, and Anne Carlsen Center, Jamestown, ND
Supervising Professor: Dr. Roger Green
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INTRODUCTION

The existing puppet stage of a center's for children with disabilities is improperly suited for the needs of the children who attend class there. It is not interactive and does not provide wheelchair access. The client center wants a puppet stage that can accommodate one or two wheelchairs and also provide sound and light stimulation for the students.

SUMMARY OF IMPACT

The new puppet stage allows more interaction for children with limited movement of their entire bodies. The two important senses of sight and sound are stimulated with flashing light emitting diodes (LEDs) and programmable sound effects. The new stage allows multiple puppeteers and audience selection of puppets. The goal of better interaction between the children and the stage is met with the new stage. The completed puppet stage is shown in Fig. 10.3.

TECHNICAL DESCRIPTION

As shown in Fig. 10.4, the stage consists of four component blocks: 1) microprocessor; 2) light system; 3) sounds system; and 4) interface controls. Additionally, the entire system is powered by a 120 volt AC to 5 volt DC converter.

The brain of the stage is the PIC16F876A microcontroller chip. The chip controls the blinking lights and sound chip. When a user pushes one of three buttons, light control signals are sent from the PIC to 8-bit serial to parallel shift register (74HC595). Sixteen modular printed circuit boards are cascaded to provide 128 LED light outputs. Each modular board contains eight LEDs: two red, two blue, two green, and two yellow. The shift registers are connected to three pins on the PIC. Each of the boards is connected in series to produce various light patterns and effects.

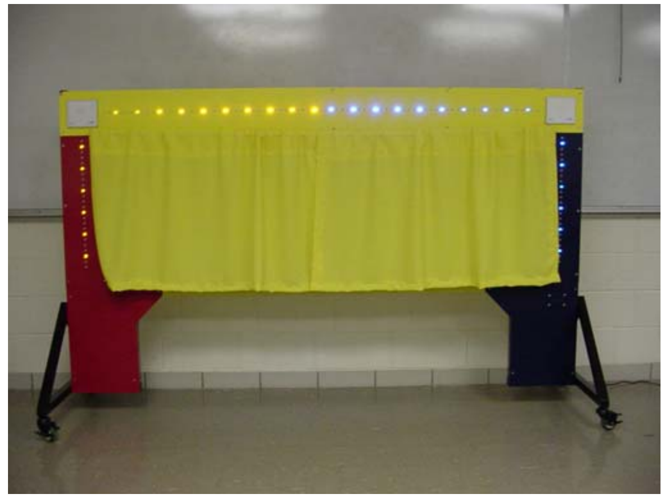

Figure 10.3. Interactive Puppet Stage.

Aside from controlling the 128 LEDs, the PIC16F876A also controls sound effects. On start-up, the PIC checks to see if the stage is in record or playback mode. A toggle switch on the outside of the stage determines record or playback, which is controlled by the teacher. If the stage is in record mode, the student chooses one of three buttons to record one of three messages. When the button is pressed and held, the chipcorder (ISD2560) records through an attached microphone circuit. Releasing the button ends recording. In playback mode, students press buttons to select and play from three available recordings.

The ISD2560 Chipcorder is capable of recording 60 seconds of sound. The 10 address pins on the chip can be configured to start playback or record at 600 locations. This design divides the 60 seconds of sound up into three equal lengths of 20 seconds. If button one is pressed, the chip begins record or play at 0 seconds. If button two is pressed, playback or record begins at 20 seconds. If button three is pressed, playback or record begins at 40 seconds. There is a possibility that if a sound is longer than 20 seconds it can record over the next sound. In order to eliminate this from happening, the PIC only allows a user to record for 20 seconds. When a signal is recorded an end of message bit is placed. When playback begins for this sound the chipcorder will play until it sees the end of message. To obtain the best quality of sound, the highest sampling frequency of 8 kHz is used.

The total cost for the stage was $834.00. Major costs include professional manufacture of 16 printed circuit boards and 128 high output LEDs. The stage frame was donated.

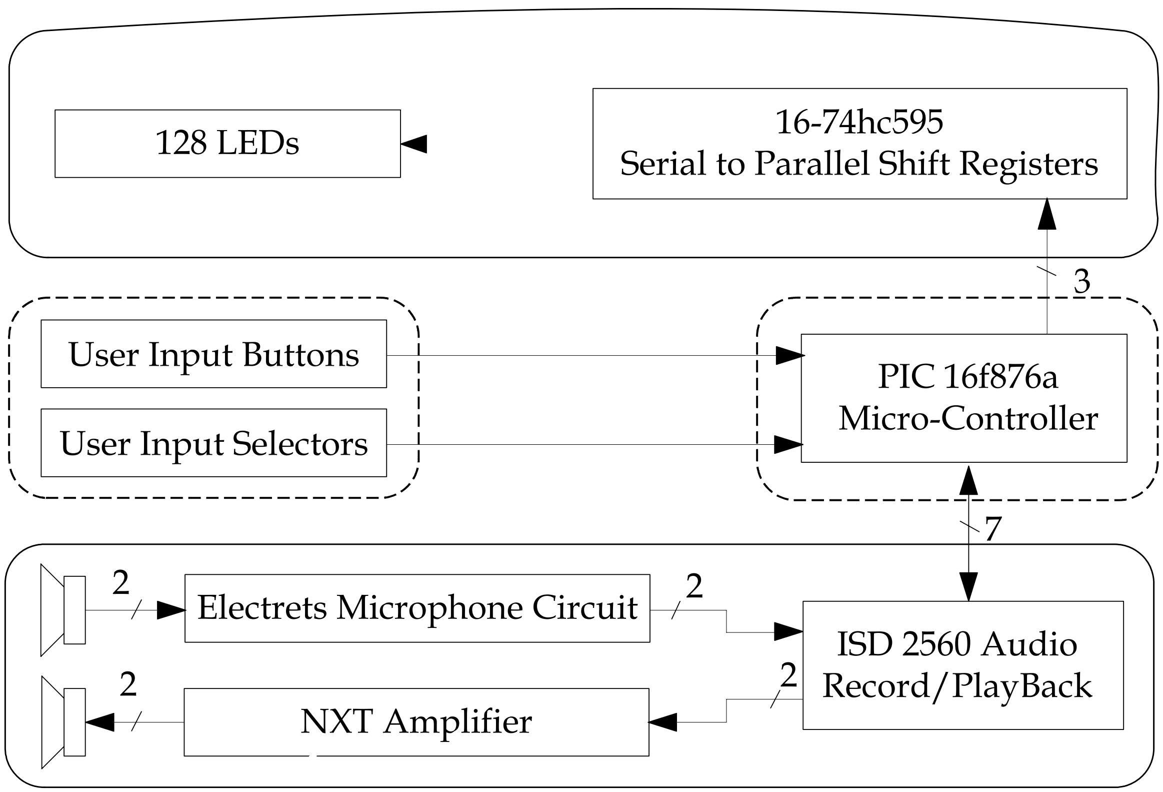

Figure 10.4. System Block Diagram.

WIRELESS INTERCOM SYSTEM

Designers: Brandon J Templin , Justin W. Morgen, Josh J. Kostelecky and Michael D. Carlson
Client Coordinator: Ginny Smith
Supervising Professors: Prof Val G. Tareski, and Dr. Roger A. Green
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INTRODUCTION

The wireless intercom system is designed to provide a direct communication link between two adjacent SVEE rehabilitation homes. The motivation for designing the intercom system is to allow convenient communication between any two of five devices or between all the devices using a broadcast feature.

SUMMARY OF IMPACT

The client requested a simple interface to accommodate all users. The units are designed with very few buttons and low interface complexity; this way any user can learn how to use the device in a short amount of time. The intercom system is a cost effective and relatively easy to use solution that meets client requirements for point to point or broadcast communication.

TECHNICAL DESCRIPTION

The central building block of the system is a PIC microprocessor, as illustrated in Fig. 10.5. Its high versatility allows flexibility in the design and operation of the unit; it also has a simple instruction set, easy-to-use USART, and A/D capabilities for sampling and sending vocal information.

The system is a bi-directional, half duplex, wireless intercom, such that it can communicate between the houses. Each Linx transceiver unit comes FCC pre-certified and with an approximate transmission range of 150 feet. The intercom units are built using in-house fabricated printed circuit boards which are encased in custom built Plexiglas enclosures. Address and talk buttons, volume control, exposed speaker, microphone slots, and LED indicators are on the front of the enclosure, as shown in Fig. 10.6. The back of the case is removable to facilitate repairs or replacements. The system is powered by a 120Vac to 5Vdc wall converter, and plugs into a jack on the lower right side of the case.

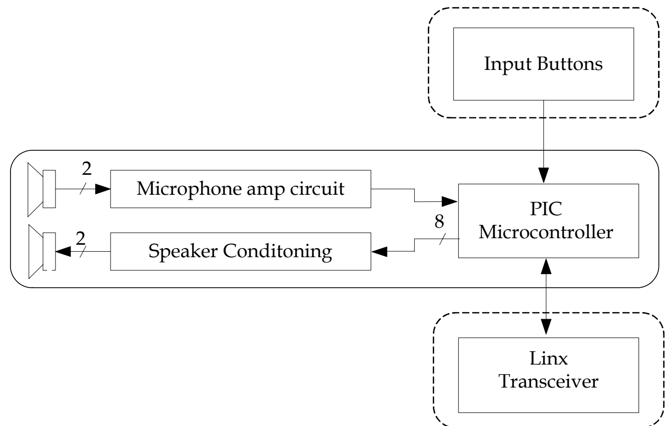
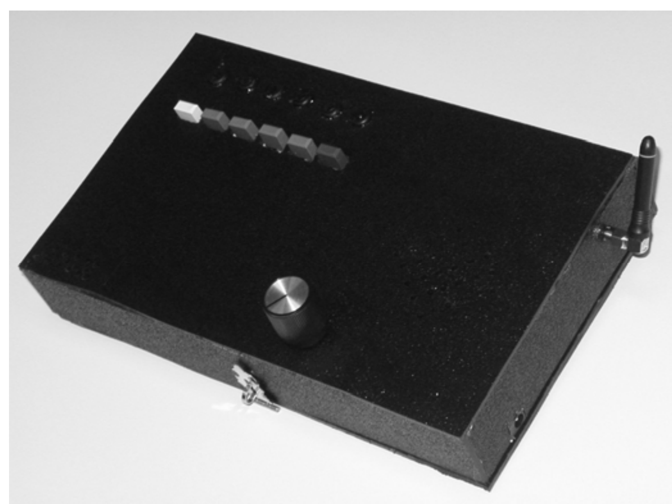


Figure 10.5. System Block Diagram.



10.6. Intercom System.

The unit is designed to allow private talking between two units or broadcasting to all units. By pressing the intended address button (1, 2, 3, 4, or broadcast,) the system sends out an identification byte. The receiving units decode the byte. If the address byte does not match, the unit disregards all audio processing and turns on an “in use” display

LED. If the address byte does match, the unit turns on an "in use" LED, decodes the incoming audio data, and sends it to the speaker.

A software compounding technique is implemented to achieve an acceptable sampling rate for the given system transceiver bandwidth. The compounding encoder is a binary logarithmic scheme used to sample and then transmit two samples per byte. The scheme works by taking an 8-bit sample and assigning it a 4-bit number logarithmically spaced from a DC offset value. After a second sample is encoded, the two 4-bit data samples are concatenated and sent out as a single byte, exemplified in Fig. 10.7. The receiving side then takes each 4-bit number and recovers an approximate 8-bit value. Because data transmission is digital, the system acts as a simple information encryption scheme for privacy where only the proper software decoder is able to properly decrypt the information.

The total cost of parts and materials per unit is $148.13.

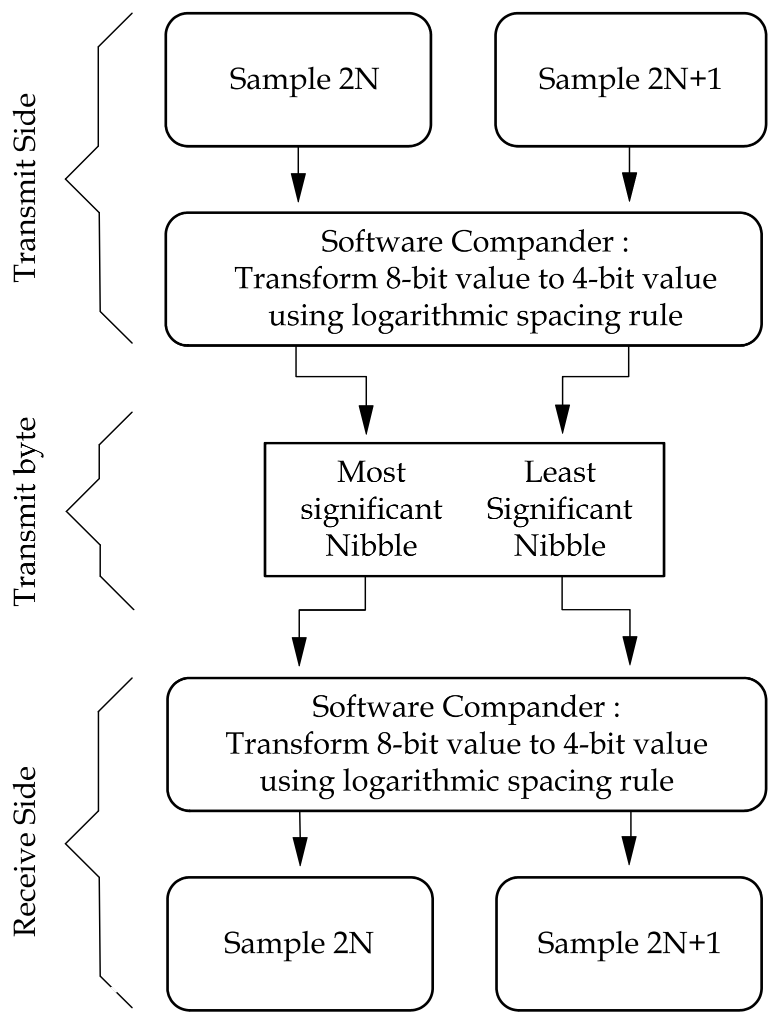


Figure 10.7. Data Flow Block Diagram.

ROBOTIC CONTROL THROUGH TISSUE OPTICS

Designers: Luke Dewey, Brian Turner, and Mike Warner
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INTRODUCTION

When a muscle contracts, blood volume in the muscle is reduced. Additionally, oxygen is needed to fuel a contraction, so changes in the amount of oxygen present can also indicate a muscle contraction. These principles of muscle contractions are the basis of a system designed to control a prosthetic device.

SUMMARY OF IMPACT

This project demonstrates that low-cost optical-based sensors can control a prosthetic arm. Further research is needed to develop an improved method of incorporating a control system from the LabVIEW program used for this project. LabVIEW provides a researcher with an algorithm that can be easily modified during the research process. Once the control algorithm has been fully developed, LabVIEW can be replaced with a small, low-cost microprocessor. With further research, this project can provide a user with a stable, reliable, and low-cost method to control a prosthetic device.

TECHNICAL DESCRIPTION

Fig. 10.8 presents the block diagram for the overall system. The project uses optical sensors to detect muscle contractions for the control of a robotic arm. Red- (660nm wavelength) and infrared- (870nm wavelength) light emitting diodes (LEDs), along with a photo-Darlington transistor, were used to detect muscle contractions. The wavelengths chosen are well suited for determining changes in blood volume and oxygen content

Fiber optics are placed on the skin and then connected to the LEDs. When a contraction or extension of the muscle occurs, different intensities of light are reflected back from the muscle and into the fiber optic. A voltage is created across the photo-Darlington transistor as a result of the light that it detects. The voltage is sent though an amplifier and then filtered to increase the signal and reduce noise. Fig. 10.9 shows a schematic of the sensing unit.

Digital processing is accomplished using LabVIEW, a computer software program. LabVIEW is used to analyze and manipulate the signal input sent into the computer through a data acquisition (DAQ) card. LabVIEW is chosen for research flexibility but will be later replaced by a low-cost embedded microprocessor.

LabVIEW takes samples of the input analog signal to produce a sampled waveform. The program looks for a change in the voltage signal to determine if a contraction or extension has occurred. If the voltage level crosses a certain threshold, an output signal is sent to the robot. It continues sending the 'on' signal until the threshold level is crossed again.

Every person is different and has different contraction strengths based on the muscle being observed. Muscle fatigue plays a role in the contraction strengths observed. When a muscle is fatigued, a smaller threshold level is needed because the strength of a contraction is less. The threshold levels can be manually changed on the LabVIEW front panel to meet the requirements of the specific user.

The outputs from the LabVIEW program are then sent to an H-bridge IC. The H-bridge is a simple, reversible drive circuit. Using the two outputs from Labview, the circuit's logic allows for forward, reverse, stationary and braking motion of the motors. The H-bridge circuit is shown in Fig. 10.10.

The robotic arm, OWI-007, has five DC servo motors that control five different axes of motion. These motions include: 1) hand gripper; 2) wrist rotation; 3) elbow bending; 4) shoulder bending; and 5) base rotation. These motions are similar to the motions a prosthetic arm requires. For this project, only the first three motors mentioned are used.

For three sensing units, H-bridge IC and a robotic arm, the total cost is approximately $160.00. The LabVIEW license and PC cost several thousand dollars, but are not required for a final commercial device.

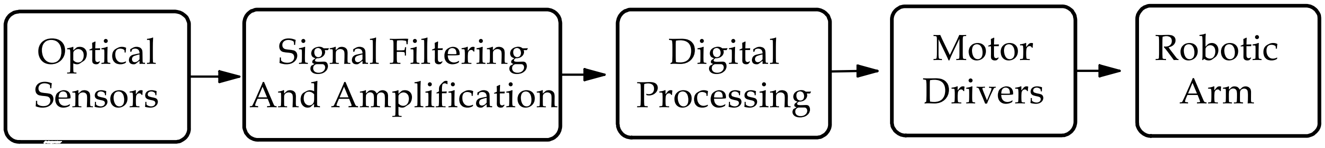

Figure 10.8. System Block Diagram.

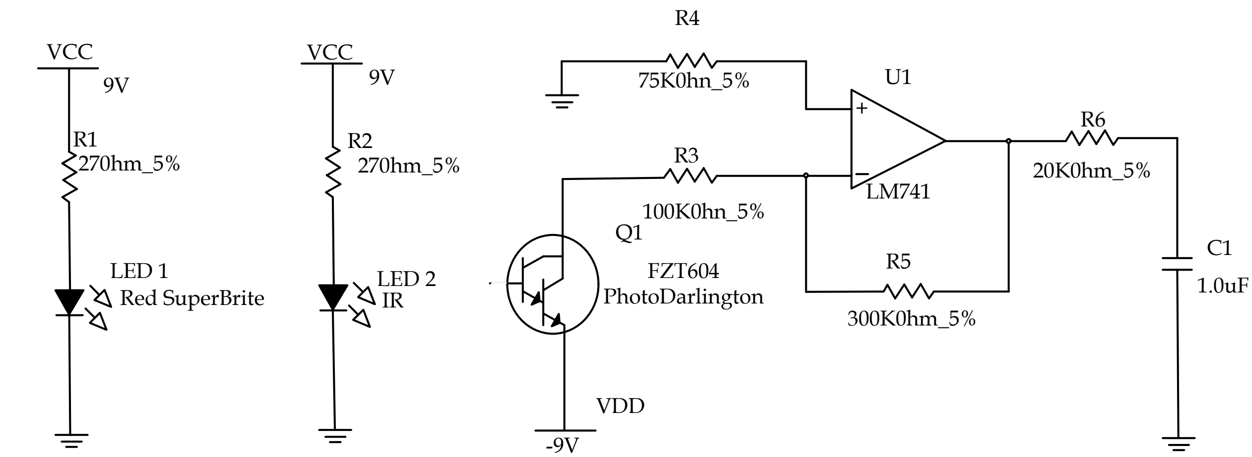

Figure 10.9. Sensing Unit Schematic..

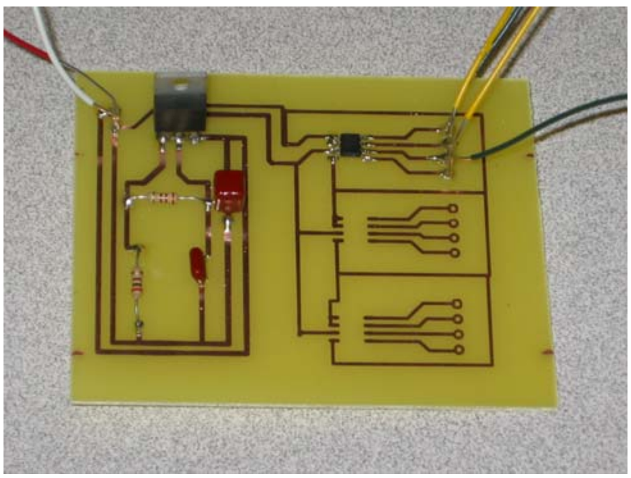

Figure 10.10. H-bridge Circuit.

HANDS-FREE SEATBELT

Designers: Karl Abrahamson, David Skoglund, and Darren Halzle
Supervising Professors: Dr. Daniel Ewert, and Jeff Wandler
Department of Electrical and Computer Engineering
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INTRODUCTION

The Hands-Free Seatbelt system is designed for a person who lacks the upper body mobility necessary to fasten a conventional automotive restraint system. The newly-designed system allows the user to operate a lap belt by using his feet to control the tightness and looseness of the belt. A motor, controlled by a lighted paddle switch, drives the seatbelt spool. A 12V battery powers the system and is recharged by the automobile's power through the power port. In an emergency, a solenoid may be activated by a push button disengaging the seatbelt on the right side. An original equipment inertial locking mechanism locks the seatbelt spool providing the stopping force in the event of a collision. Fig. 10.11 displays the complete system.

SUMMARY OF IMPACT

After years of searching, the client is very excited to finally be secured in a seatbelt while at the wheel of an automobile. The client is now better protected during vehicle operation and is able to comply with existing seatbelt regulations. Although this system is intended for a specific client, the design is universal and can be utilized by a larger group of individuals.

TECHNICAL DESCRIPTION

A system block diagram is given in Fig. 10.12. The central block is the printed circuit board (PCB), which consists of the motor directional control relays, emergency release solenoid relay, and the battery maintenance circuit. Connections to the PCB include: 1) power from the vehicle power port which supplies power to the charging circuit; 2) the emergency release solenoid; 3) the seatbelt spool drive motor; 4) the battery, which is the main source of power for the system; 5) a momentary pushbutton that activates the emergency release mechanism; and 6) a paddle-style toggle switch that controls the direction of the spool.

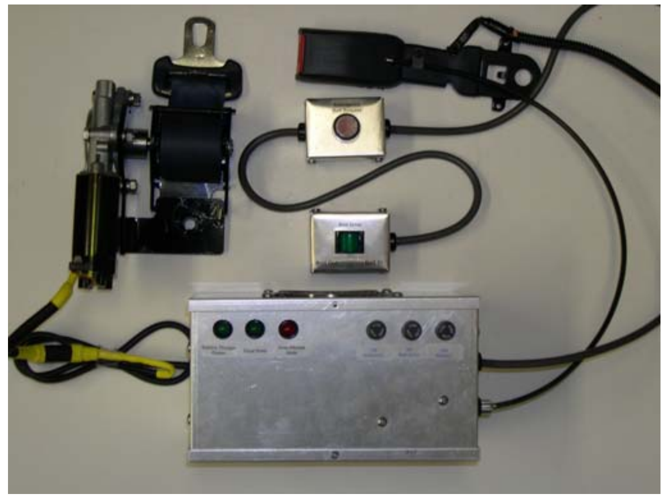

Figure 10.11. Assembled Hands-Free Seatbelt System.

Fig. 10.12 shows the three enclosures of the system. The large aluminum enclosure houses the solenoid, the battery, and the circuit board. The two smaller enclosures house the motor control switch and the emergency release pushbutton switch. The large enclosure is 9″ x 6″ x 5″ and is mounted on the floor behind the driver's seat. There are three fuse holders and LEDs mounted on the box. The fuses are for the solenoid, battery, and motor. There is also a fuse in the power port adapter. The LEDs indicate power and the state of the charger. The two smaller switch enclosures each measure 2″ x 2″ x 3″. The pushbutton is mounted beside the emergency brake between the front seats, and the switch is mounted along the bottom of the center console.

The battery charger circuit is biased, using resistors, to have a steady 13.5 V in the float state which is recommended by the battery manufacturer and a 14.5 maximum charge voltage. The maximum charge current is 3.6 Amps, and 2N1038 transistors limit the current to approximately 1.4 Amps.

The development cost of the hands-free seatbelt system is approximately $750. Much of that cost is required to meet safety concerns. The system would be considerably less expensive without components such as the solenoid, which activates the seatbelt release in an emergency, and the battery, which is present in case of power failure.

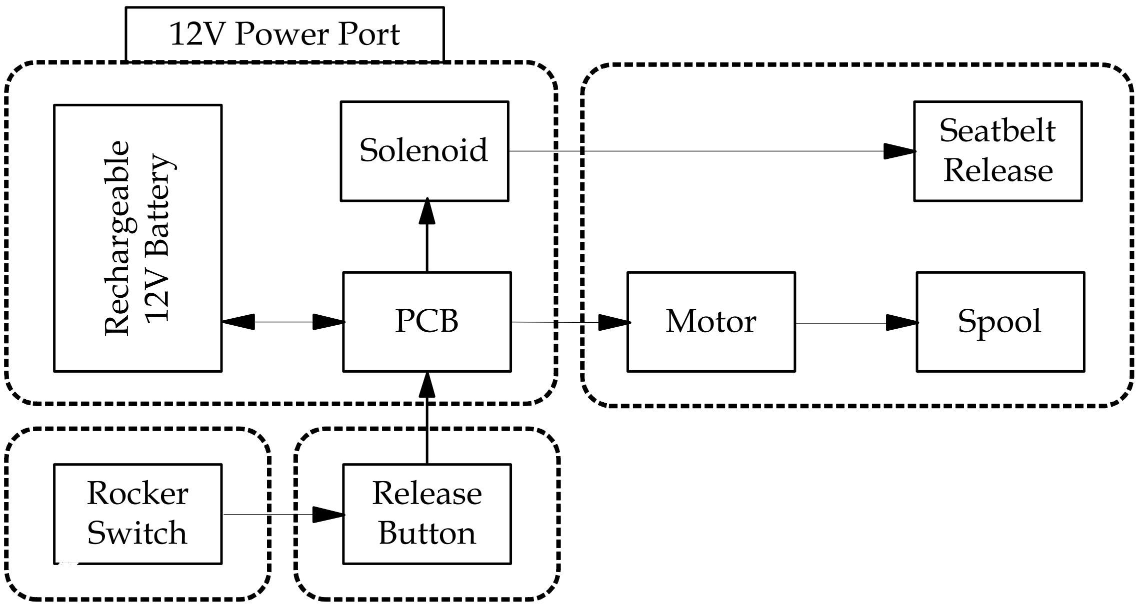

Figure 10.12. System Block Diagram.

WIRELESS VOLLEYBALL SCOREBOARD

Designers: Andrew Bartsch, Phillip Ridl, and Adam Wallace
Client Coordinator: Zaundra Bina
Supervising Professor: Dr. Jacob Glower
Department of Electrical and Computer Engineering
North Dakota State University
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INTRODUCTION

The Wireless Volleyball Scoreboard is designed specifically for a local Special Olympics tournament to reduce the number of tournament officials required at the volleyball matches. By creating a wireless remote controlled scoring system, the need for an off-court scoring official is eliminated. This device is designed to allow multiple units to function simultaneously in the confines of a gymnasium or sports arena. Additionally the device is designed to be portable, durable, and easy to use.

Although similar commercially available scoring systems do exist, these products are typically expensive and are not designed for specific use as a volleyball scoring system. Thus, the new device offers significant advantages over existing devices.

SUMMARY OF IMPACT

By reducing the number of volunteers required to officiate volleyball matches, the Special Olympics' volleyball tournament coordinators can better serve its participants. At 18" x 12" x 8", the device is small enough to be portable yet large enough to be easily read. Because the device is powered by batteries, it poses no safety risks due to power cords. A very simple, yet attractive, design allows for easy operation and promotes device usage. Additionally, the display unit is designed to work with multiple remote units in the event of a lost or damaged remote, which further ensures the durability of the entire unit.

TECHNICAL DESCRIPTION

The Wireless Volleyball Scoreboard is composed of two devices: a handheld (remote) unit and a display (scoreboard) unit. Fig. 10.15 shows the block diagram for each device.

The user interface at the remote unit consists of four buttons: increment home score, decrement home score, increment away score, and decrement away score. Resetting the score is achieved by simultaneously pressing both decrement buttons.

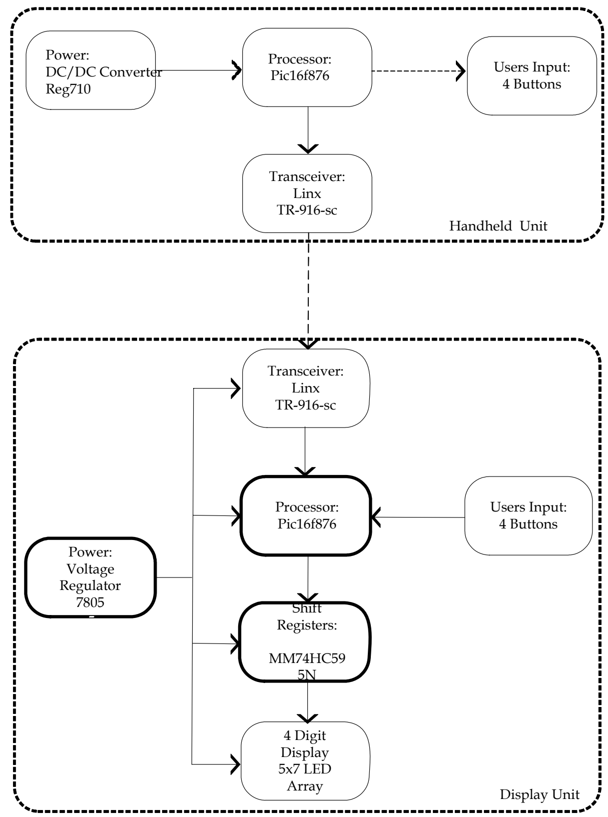

Figure 10.13. System Block Diagram

When one of theses buttons is pushed on the remote unit, the processor sees a low-to-high transition on a corresponding input pin, triggering a series of internal commands at the processor ending with a signal being sent from the processor to the transceiver. The processor's universal asynchronous receiver transmitter (UART) registers then transmits the signal through a transceiver to the scoreboard unit. The information transmitted includes a "barker" to alert the scoreboard unit that a message is coming, an address number unique to the remote unit which sent the data, a byte indicating which button was pushed, and a checksum byte for error checking. Fig. 10.13 shows a graphical representation of the transmitted data signal.

The user input at the scoreboard unit duplicates the four buttons on the remote unit. Additionally, three two-position dip switches are also included. The dip switches are used to match the scoreboard unit to the remote unit's address (the address of the remote unit is set in software). The processor on the scoreboard unit receives input either from the user input buttons on the scoreboard or from the transceiver. The buttons on the display unit operate identically to the buttons on the remote unit; when one of the buttons is pushed, the processor sees a change on one of its input pins and changes the score according to which button was pushed. When the processor receives a signal from the transceiver through the processor's UART register, the processor first checks the address to ensure the data is from the correct remote unit. Next, the error checking byte is analyzed to ensure no errors have occurred in transmission. Finally, the byte identifying which button was pushed at the remote unit is received, and the processor updates the display accordingly.

The display at the scoreboard is comprised of four seven-segment numbers; each segment consists of five light emitting diodes (LEDs). Four eight-bit shift registers with output latches are used to control transistor circuits which drive the LEDs. The two shift registers that control the home and away scores are connected in series such that data is input through the first shift register to the second. Through the processor's serial peripheral interface (SPI) two eight-bit numbers are output, one after the other, to both the home and away scores simultaneously. The score is updated by updating the latches of either the home or away shift registers separately.

The remote unit is powered by two size AA batteries and the scoreboard unit is powered by six size D batteries. When the units are not in use, switches are available to power down both units. Fig. 10.14 shows the completed system.

The overall cost of the device with minimal production is approximately $400. With moderate production levels, the cost would drop substantially.

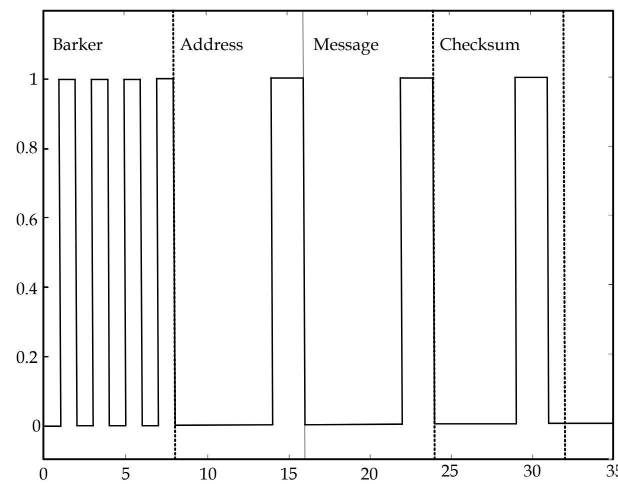

Figure 10.14. Completed System.

Figure 10.15. Completed System.

BOCCE BALL SCORING SYSTEM

Designers: Paul Frisch, Nathan Miller, and Steve Schneider
Client Coordinator: Eric Wassen
Supervising Professor: Dr. Jacob Glower
Electrical Engineering Department
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Fargo, ND 58105

INTRODUCTION

The game of bocce ball is played all over the world and is enjoyed by people of all ages. To begin play, a target ball, called the palina, is thrown onto the playing field. Each team rolls four bocce balls in an attempt to get closest to the palina. At the end, the bocce ball closest to the palina ball scores a point for that team. Fig. 10.16 shows a typical bocce ball and the circuit board to be encased inside.

The bocce ball scoring system enables judges at the Special Olympics to determine which bocce ball is closer to the palina ball by using a wireless system. Following play, a hub unit is placed on the palina ball. When triggered, the hub communicates with the bocce ball to determine the winner. Once the winning ball has been determined, eight light emitting diodes (LEDs) on the winning bocce ball are illuminated.

SUMMARY OF IMPACT

The bocce ball scoring system accelerates and simplifies the judging process. The scoring system provides volunteers of the Special Olympics with an efficient and reasonably accurate method to determine a bocce ball winner. The device correctly determines the winning ball approximately 95 percent of the time. System accuracy may be improved with additional system testing and calibration. The addition of flashing lights to indicate a winner adds a new level of excitement and participation to the game.

Representatives from the Special Olympics are enthusiastic about the design concept, eager to continue system testing, and willing to continue cooperative development. In researching prior designs, no similar systems appear to exist.

TECHNICAL DESCRIPTION

The bocce ball scoring system has three primary design requirements: 1) the hardware must fit inside

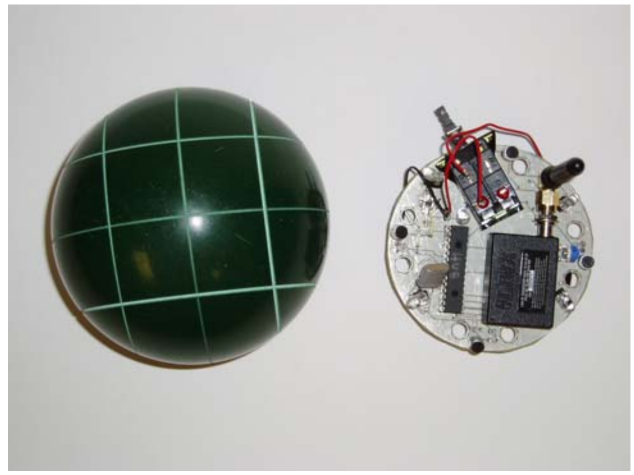

Figure 10.16. Bocce Ball and Circuit Board.

the 107 mm bocce balls; 2) alterations must not affect the trajectory of the bocce balls; and 3) the hub should fit into or over the 57 mm palina ball. Custom circuit boards fit within the bocce balls and surface-mount components to help conserve space. Due to the smaller size of the palina ball, hub hardware needs to be placed over the palina ball once it is played onto the field.

All scoring operations are controlled by the hub, a block diagram of which is shown in Fig. 10.17. Hub operations are controlled by a PIC 16F876 microcontroller. To begin, the hub sends a message using a LINX radio frequency (RF) transmitter to clear timing counters at each of the bocce balls. Next, the hub produces a 3.5kHz audio sound. Given the relatively slow propagation of sound in air, nearby bocce balls detect the tone earlier than distant bocce balls. Once the tone is detected, individual bocce balls stop their timing counters and wait for the hub to request information.

Once sufficient time has elapsed for all bocce balls to detect the tone, the hub individually polls each ball requesting their counter values. All information is again transmitted using the LINX RF transceivers.

Once all bocce balls have reported their counters, the hub determines the nearest ball by finding the smallest counter value. Lastly, the hub communicates to the winning bocce ball and instructs the winner to illuminate its LEDs.

Fig. 10.18 presents the block diagram of the bocce ball circuitry. Again, operations are controlled using a PIC microprocessor. The microphone, amplifier, and band-pass filter circuitry are used to detect the 3.5kHz audio tone generated by the hub. A LINX transceiver, identical to the hub's transceiver, is used for RF communication.

The cost of the completed system is approximately $850, which includes circuitry for the hub and eight bocce balls.

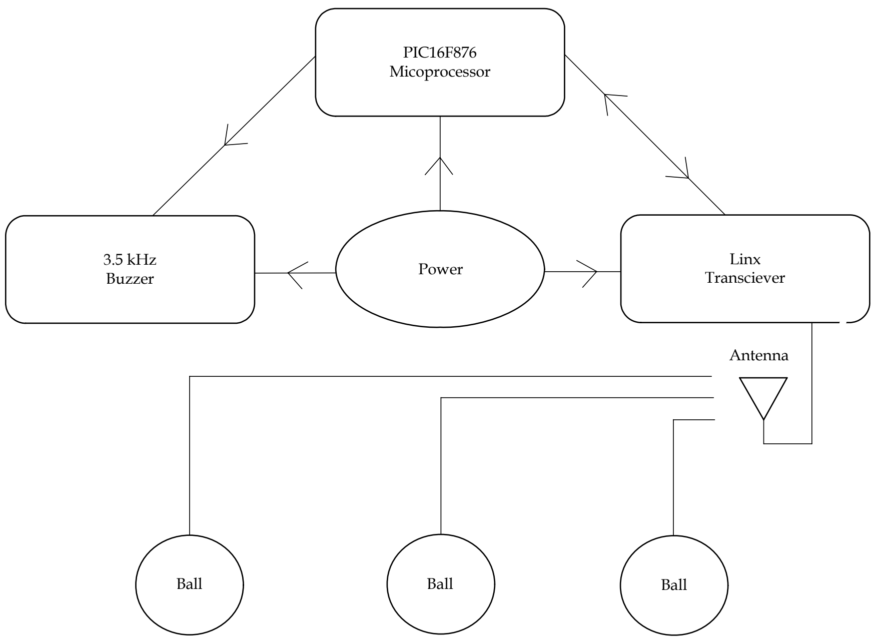

Figure 10.17. Block Diagram of Hub Component.

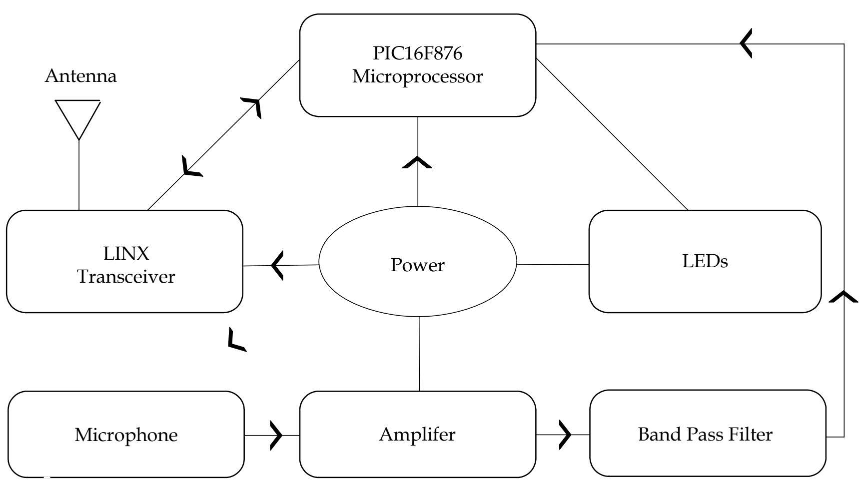

Figure 10.18. Block Diagram of Bocce Ball Component.

IN-ROOM SECURITY SYSTEM

Designers: Brian J. Buresh, Austin R. Van Sickle and Seth L. Maslowski
Client Coordinator: Dave Hoverson, SVEE Group Home, Fargo, ND
Supervising Professor: Dr. Ivan Lima
Electrical and Computer Engineering Department
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INTRODUCTION

This in-room security system (IRSS) is designed to provide notification to group home staff members when a person with special needs attempts to leave his quarters without permission. The IRSS provides a non-intrusive means of monitoring a client with special supervision needs. It is the goal of the a client group home to provide its residents with an environment that is as comfortable and non-disruptive as possible. Since loud alarms are disruptive to residents, the silent alarm of the IRSS appeals to the group home.

SUMMARY OF IMPACT

The design criteria for the IRSS were defined by the client contacts and caregivers. The primary requirements were that the system be: 1) capable of alerting caregivers; 2) non-intrusive; and 3) mobile. Some residents of the home require constant one-to-one supervision from a caregiver. Since it is not realistic to dedicate a staff member to one resident for the entire day, it is necessary to assign a resident to what is called in-room time, during which the resident is not permitted to leave his room. With the IRSS, a caregiver can adequately monitor the special needs resident while tending to other residents' needs. With the tendency of some residents to cause disruption by initiating an alarm state purposely, the silent alarm of the IRSS is well-suited for the application.

TECHNICAL DESCRIPTION

The IRSS consists of four independent units including two sensors, a base station, and a pager. The units communicate wirelessly to make the system easily relocated. The system's block diagram is shown in Fig. 10.20. When one of the magnetic sensors is activated, either by a door or window being opened, the corresponding sensor unit transmits to the base station. In the event that the base station is not reset in less than one minute, the base station sounds a backup audio alarm. When

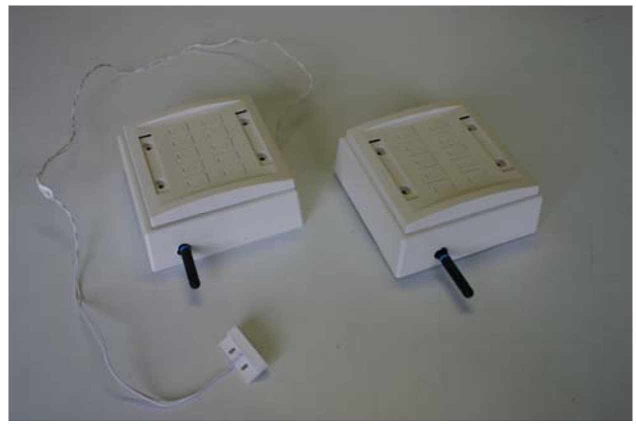

Figure 10.19. Completed In-Room Security System.

the pager receives the signal, it activates a vibrating motor to alert the caregiver.

In the sensor units, magnetic switches are used to activate the sensor circuits when either the door or window opens. Each sensor circuit is composed of a PIC microcontroller, a transmitter, and an antenna. The microcontroller continually checks to see if the sensor is activated. Once an open door or window is detected, it transmits a signal to the base station and pager units. Linx transmitters and antennae are used for modulation and transmission from the sensors. Four AAA batteries supply power for each sensor unit.

In the base station unit, Linx transmitters and antennae are again used, as well as Linx receivers for demodulation of incoming signals. A PIC microcontroller processes incoming signals and to generates outputs. An AC/DC converter supplies power to the base station. The unit requires 5V DC, which is stepped down from a 120V AC wall-outlet.

In the pager unit, the same wireless components and microcontroller are utilized. The pager is powered by three AAA batteries. A voltage divider circuit is used to convert the 4.5V battery supply to the 2.6V (1.3V per motor) required by the vibrating motor.

Resistor values are chosen to ensure that the motors' 130mA rating is not exceeded. A toggle switch is present in the pager to conserve battery life, since the microcontroller draws current whenever the unit is powered. The finished unit is shown in Figure 10.19.

The total cost of parts and material for the entire system is approximately $700.

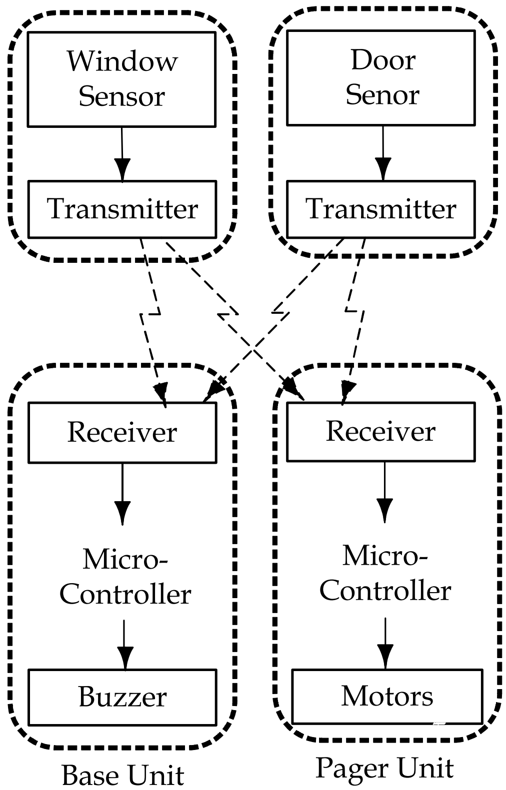

Figure 10.20. System Block Diagram.

WANDER ALERT SYSTEM

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INTRODUCTION

The wander alert system allows greater freedom of movement for residents of a local group home, while still monitoring their location. This system tracks the location of a person, and reports back necessary information. When the person walks outside of a given range, an alert is sent. The administrators at the home are alerted by a discreet pager-like device. The tracking device uses GPS to monitor the individual, and a wireless transmission system to send information.

There are current commercial devices that operate using the same principles as this device but they are designed to cover a larger area and use satellites to transmit information. While effective, these systems are expensive and incur monthly charges.

SUMMARY OF IMPACT

The wander alert system assists the staff and residents of the SVEE home in a comfortable and reliable way. The homes do not have the time or the staffing to watch individuals as they walk every day. If an individual walks away from the home while using the wander alert system, this information is quickly sent to the administrator. An early alert reduces the time taken to search for a lost or missing resident. The system can be worn at all times, is portable, and does not hinder the wearer. The wander alert system frees the administrators from worry, and opens more time for other tasks.

TECHNICAL DESCRIPTION

The wander alert system is a two part system: 1) the tracking system; and 2) the alert system. As is seen in Fig. 10.21, both components are portable, operate independently, and communicate using a radio link.

The Global Positioning System (GPS) tracking system is based on the LassenSQ chip made by Trimble Navigation Limited. This chip connects to

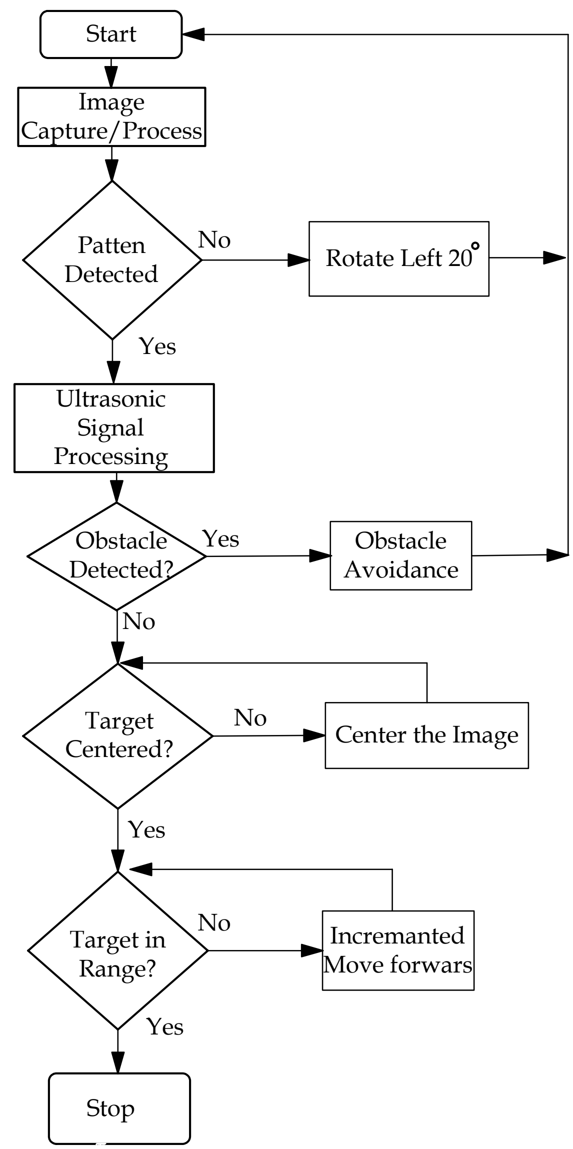

Figure 10.21. Wander Alert System Block Diagram.

an embedded antenna made by Trimble, and receives and decodes the GPS data. The Lassen SQ is chosen due to its small size, and relatively low cost. The data from this chip is sent over a serial data line at 9600 baud using the Trimble Standard Interface Protocol to a Microchip processor.

A PIC16F876 processor receives the serial data from the GPS and translates the information. It determines if the user is in or out of the set boundaries. The PIC controls the transmitter and sends information serially at 2400 baud to a radio transmitter. There are three different codes that can be sent by the tracking device: 1) in range; 2) out of range; and 3) no GPS signal. When coordinates are available, the in range and out of range signals are sent once every three seconds. The code for no GPS signal is sent when the updates from the GPS have not contained coordinates for approximately 15 seconds. This signal helps determine when the connection between transmitter and receiver is working.

A Linx TXM-433-LC is used to communicate with the receiver system. This single chip transmitter only requires power, input, and an antenna to operate. It sends data at rates up to 5000 baud. This chip is designed to fit within Part 15 specifications of the FCC rules and transmit 300′ or more. A one-quarter wavelength loop type antenna is used for its good directionality and small size.

Each component in the transmitter is picked for low power usage. The batteries selected are all AA rechargeable with an output of 1.2 volts. With all components at full power, the transmitting system's batteries last at least 9 hours.

The alert unit is also designed to be portable and reliable. The receiver is the Linx RXM-433-LC, which complements the TXM-433-LC. It has similar specifications and requires only a power connection and antenna to operate. The receiving antenna is identical to the transmitting antenna.

The data received by the receiver is sent to a PIC16F876 processor. At startup, an LED displays the state being unknown. This state does not change until data is received from the tracking system. When an out of range, in range, or unknown signal is received, the corresponding LED is lit. The processor also monitors the time since last signal reception. When approximately 45 seconds have passed, it is assumed that the tracker is out of range, and an LED is lit.

Each component on the alert system is designed for extended use. At maximum power, the receiving system's batteries last more than 36 hours.

The total cost for parts is approximately $140.

AUTONOMOUS VEHICLE

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INTRODUCTION

The goal of this project is to aid people who are blind with certain everyday tasks through the use of an autonomous vehicle.. For jobs such as delivering a package, throwing away trash or putting a dinner plate on a table, these individuals use techniques such as counting steps or guide sticks.

SUMMARY OF IMPACT

The autonomous vehicle can guide a blind person around his or her environment or deliver an item from one point to another. The autonomous vehicle is designed to search for a predetermined object, navigate to that object, and drop a package at that destination. The design, while not yet refined for real world use, lays the foundation for practical future development.

TECHNICAL DESCRIPTION

As shown in Fig. 10.22, there are five main blocks that play a role in the functionality of this robot vehicle: 1) vision system; 2) sensor system; 3) locomotion system; 4) power system; and 5) central processing system.

The vision system is controlled by a laptop and a camera. The camera acquires a picture which is saved on the hard drive of the laptop. Image processing techniques such as contrast enhancement and edge detection are calculated to discriminate changes of light or color. In order to recognize the target, recursive functions implemented in C detect the desired target. The pattern recognition techniques are size, rotation and distance invariant. Once the correct image is detected, the robot vehicle will drive to that object. This program runs from a laptop, which communicates with the camera through a USB port.

The sensor system involves the implementation of an ultrasonic sonar ranger. Transducers are used for collision avoidance, collision detection and surrounding area mapping. The microprocessor-

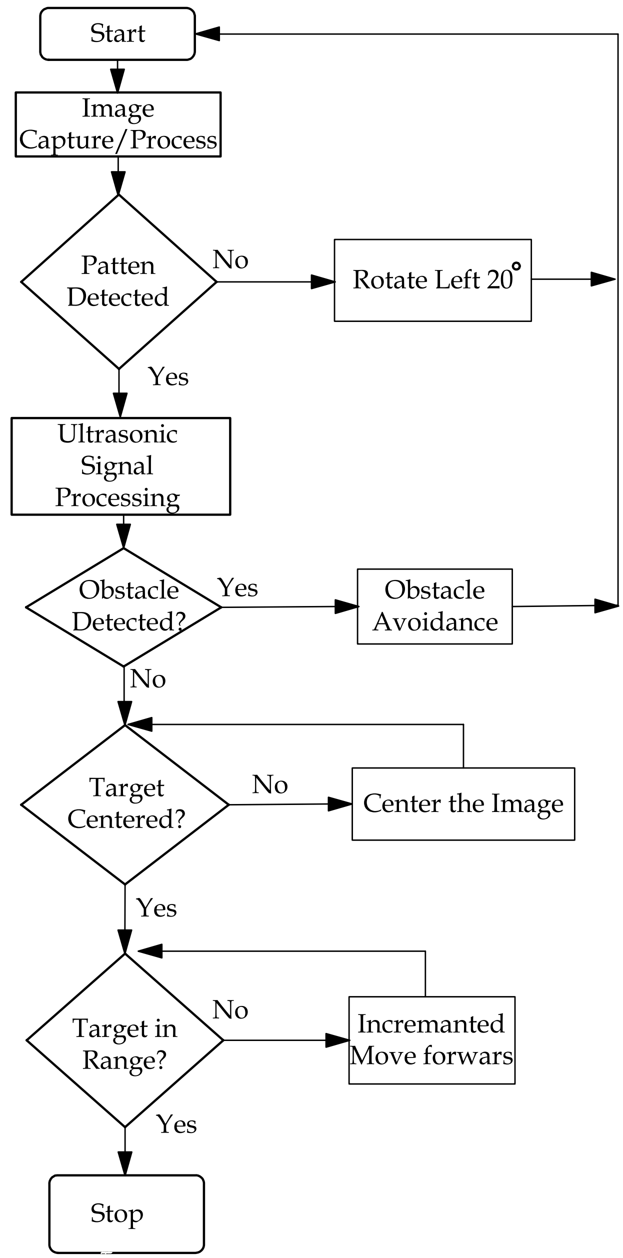

Figure 10.22. Vision System Flowchart.

controlled ultrasonic ranger is attached to the front of the robot to calculate the distance between the robot and any object with a range between approximately 29 centimeters to five meters. The propagation time of the pulse and speed of sound are then used to calculate the proximity of any object with respect to the transducers.

The case, wheels, and motors provide locomotion for the vehicle. Two stepper motors (8V DC, 2 A) allow the vehicle to rotate at any angle and move forward or backwards. The overall dimensions of the vehicle are 79 cm x 35 cm x 60 cm (length, width, and height respectively).

The power supply is comprised of two 12V batteries connected in parallel. These 12 ampere-hour batteries provide ample voltage and current for the vehicle. Voltage regulators provide the regulated 5V and 8V levels needed to power the LED and TTL components.

The total cost of the autonomous vehicle not including the laptop is $743.

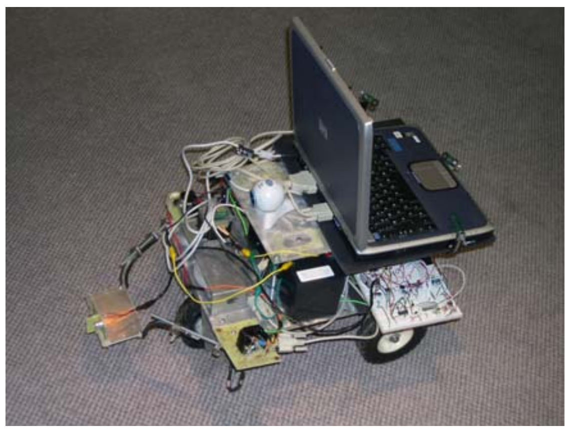

Figure 10.23. Autonomous Vehicle Components.

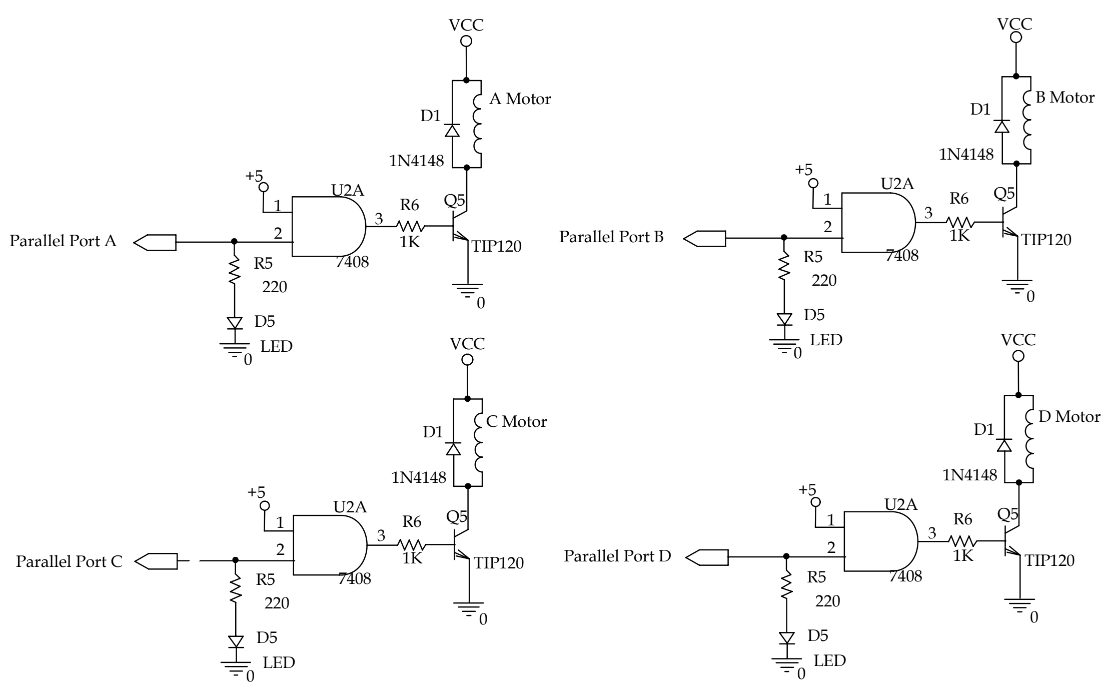

Figure 10.24 Motor Control.