CHAPTER 11
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SWITCH-ACTIVATED VOICE CONTROLLER

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INTRODUCTION

This design project was built for individuals who cannot speak. When the user pushes the appropriate button on the device, it produces a preprogrammed audio request. The design prototype allows selection from a set of four preprogrammed audio requests.

SUMMARY OF IMPACT

This portable switch-activated voice controller allows a person who has trouble speaking to choose from a set of preprogrammed requests. Each button on the device corresponds to one of these requests. The portable switch-activated voice provides a greater sense of independence and confidence for individuals who have a loss of vocal ability.

TECHNICAL DESCRIPTION

The first step in designing a switch-activated voice controller was to find a device capable of recording the voice. The Chipcorder ISD1100 series met the needs of this project. The ISD1110 chip was selected, because it is capable of recording and playing 10 seconds of a voice. It comes in a 28-pin dual inline package. The power supply required by the ISD1110 is 5 volts, which was achieved with a 9-volt battery and a 5-volt regulator.

The switches are simple tact switches capable of activating the ISD1110 by pulling certain pins LOW (to ground). The speaker is an eight-Ohm speaker. In order to create the switch-activated voice controller, several ISD1110 chips were placed in parallel. Since the recording is only done once, a separate recording circuit can be used to record the signal. This minimizes the need for resistors and capacitors. Once the signal is recorded, the chip can be placed in a play mode.

One feature of the ISD1110 is the capability to play up to 10 seconds of a recording. The 10-second slot can be addressed into 80 segments. Each of these segments is a minimum of 0.125 seconds in length.

Figure 11.1. Switch Activated Voice Controller.

Most of the messages this device is intended to record are short messages. Some examples of these messages are “I need to go to the bathroom”, or “I'm thirsty.” By utilizing the addressing capabilities, four messages can be recorded using only one ISD1110 chip.

Because only one chip is used, it provide recording and play with just five resistors, seven capacitors, and a microphone. An inverter chip was used to interface the tact switches with the ISD1110 record, play, and addressing functions. The 7404 TTL chip was chosen for this design.

The switches labeled Location four, Location three, and Location two are all connected on one end to a pull up resistor, which is connected to + 5 volts. When the switch closes, current flows through the pull-up resistor, and the input to the 7404-inverter chip drops to 0-voltage. The inverter chip converts the 0-volt signal to a 5-volt signal, and this signal is then fed to the address bit. When the address bits are high, the recording will begin at that address. Locations two, three, and four set address bits A4, A5, and A6 high. There are 80 different addressable locations, beginning at 00000000 (010) and going to location 0100 1111 (7910). A 0.125 s block separates each location in time. The eight addressing bits from lowest to highest are A0, A1, A2, A3, A4, A5, A6, and A7. A4 alone references location 0001 0000 (1610), A5 alone reference location 0010 0000 (3210), and A6 alone references location 0100 0000 (6410). Activating the PLAYE' button produces a message between locations 0 and 15 that can be played for a duration of 16*.125 = 2 s. Location two is from address 16 to 31, also producing a time of 2 s. Location three can play from address 32 to 63, producing a time of 4 s. Location four is from address 64 to 79, producing a time of 2 s.

It is possible to break the time durations into equal durations of 2.5 s beginning at locations zero, 20, 40, and 60. In binary, this is locations 0000 0000, 0001 0100, 0010 1000, and 0011 1100. This is implemented by adding a 2x4 decoder, tying A5 and A3 together, and tying A4 and A2 together. Then manipulating A4 and A5 would allow for playing/recording from locations one, two, three, and four.

Using time durations of equal length would require a decoder and an inverter. The decoder is necessary to decode bits A5 and A4. One consideration for any design is current consumption. The ISD1110 chip draws 15 mA for operation. The 7404 chip draws less than 10 mA during normal operation. A 9-volt battery can supply the necessary current.

The recording can be accomplished by tying the REC' pin LOW and speaking into the microphone. Playing can be either edge-triggered by PLAYE' or level-triggered by PLAYL'. Playing is initiated in an edge-triggered manner, because the design includes tact switches. In addition, there is no need for the PLAYL' pin.

The ISD1110 also has a pin to connect to an LED, which can be lit while the device records the voice. This pin is RECLED'.

The overall cost was approximately $80.

DIGITALLY SECURED RF CONTROLLED OUTLET

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INTRODUCTION

This project features a design to allow people with physical disabilities to wirelessly control household devices. The design consists of a digital transmitter and receiver that use 12-bit encoding. This is done to avoid false triggering due to electromagnetic interference caused by other nearby transmitters. The design accommodates up to four household appliances.

SUMMARY OF IMPACT

The designed prototype allows individuals limited mobility to have wireless control over household appliances. This provides a greater sense of independence around the home. The design consists of a handheld transmitter box with four switches that can switch a series of four electrical outlets on and off.

TECHNICAL DESCRIPTION

The transmitter and receiver used in this project are the 300 MHz amplitude modulations used for garage door openers. To avoid false triggering, both the transmitter and the receiver are communicated via a 12-bit sequence security code. This is accomplished by using a Holtek 12-bit series of encoders and decoder chips. The signal at the transmitter is encoded using a 12-bit encoder.

To accommodate an outlet box with four outlets, four bits are reserved for data. The remaining eight bits are used as the security combination bits. The design sets the same combination for all eight bits in both the encoder and decoder. This allows the device to know the data are being sent from the person controlling the outlet, and not by an interfering signal in the air.

After setting the combination at the transmitter and receiver boards, one is able to set up the external hardware needed to use the garage door opener as a radio frequency transmitter. Both transmitter and receiver require 12 volts for operation. Radio-Shack power converters are used to obtain the required 12 volts from a regular wall outlet. The encoder and decoder require 5 volts for their operation. Therefore, a 5-volt DC regulator capable of generating 5 volts from any DC supply greater than 5 volts is used.

After a switch corresponding to the desired remote appliance is pressed, the output signal is 12-bit encoded and transmitted to the receiver. At the receiving end, the received encoded data is decoded. The voltage levels on the four data pins on the decoder are either 5 volts or 0 volts, depending on whether the device is switched on or off. 5 volts are used to turn on a relay and drive the selected household appliance.

The overall cost was approximately $140.

Figure 11.2. Digitally Secured RF Controlled Outlet.

SWITCH-ACTIVATED SPEED DIAL

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INTRODUCTION

This design features a switch-activated speed dial system capable of storing and dialing up to 10 telephone numbers. This device would benefit older individuals and individuals with disabilities by allowing them to press two buttons on a keypad instead of entering an entire string of digits. A keypad is used to program the device by entering the desired number sequence via a processor. Upon decoding, the processor sends a series of digits to a dual tone multi-frequency (DTMF) generator for acoustic coupling to a telephone handset.

SUMMARY OF IMPACT

The prototype allows individuals with physical disabilities, limited finger movement, or poor memory to have speed dial access to a set of 10 preprogrammed phone numbers. A particular phone number is dialed by pressing two buttons on a keypad as opposed to entering an entire string of numbers. The switch-activated speed dial system enables the individual to have faster and more convenient means of contacting emergency personnel, friends, and family.

TECHNICAL DESCRIPTION

A keypad is used to program the device by entering the desired number sequences. The output of the keypad is given to the input of an encoder (MM74C922). The encoder selects one element in the array of numbers and letters on the keypad and sends the information signal to the basic stamp. The basic stamp sends a series of preprogrammed numbers to the tone generator. A crystal is connected to the tone generator, which then produces the required DTMF frequencies. These frequencies are then amplified through the speaker for acoustic coupling to a telephone handset.

The processor for the circuit is the BASIC Stamp II (BS2) by Parallax. The BS2 has two K of EEPROM, which is used to store the executable program and all data. 32 bytes of RAM serve as variable space and I/O pin interface for the BASIC program.

The BS2 chip is a 24-pin DIP consisting of numerous surface-mount IC's (voltage regulators, a crystal oscillator, a microcontroller, a BASIC translator, etc). The carrier board for the BS2 contains a prototyping area, a 9-volt battery clip, and an RS-232 serial port for program downloading and debugging. This serial port is connected to the serial port on a personal computer (PC). BASIC code is written in the BS2 editor program and downloaded to the module via the serial interface. Program debugging is accomplished by running the program on the BS2 while it is connected to the PC. When inserted into the program code, the DEBUG command returns a simple text message or the value of a variable.

The basic stamp code consists of a short main program and several subroutines. There are three subroutines. The dial subroutine is used to recall one of 10 stored telephone numbers by a simple two-button sequence. First press the A button, followed by any digit, zero through nine. Each digit represents a memory location that can hold up to 11 digits (one + area code + seven digit number). If a digit does not follow an A button press, the program will reset to the top. The DTMF tones for each digit are generated for 125 ms, with 25 ms of silence in between.

The store function is used to save a telephone number in one of 10 locations in EEPROM. This function works by first pressing B, then dialing the phone number, then pressing B again, followed by the desired memory location represented by digits zero through nine. During this process, a short blip signifies that a valid key has been pressed. As the phone number is entered, the program counts and saves the total number of digits. The program will only save the first 11 digits that are pressed, because this is the maximum size that was designed for the storage. Pressing B at any time during the phone number entry signifies that there are no more digits. The phone number and the number of digits are saved to EEPROM. The number corresponding to the digits is used in the dial function.

The manual function is signaled when a digit is pressed without immediately pressing A or B beforehand. This allows manual dialing of any digit sequence. DTMF tones are generated as long as a key is being pressed.

The C and D keys serve no function and are ignored in all subroutines. The design enclosure was constructed using a high quality durable plastic. The rectangular case contains the circuitry, a speaker, and a 9-volt battery. A hole was drilled on the bottom of the case to screw the speaker in place. The speaker was mounted upside down to amplify the DTMF frequencies as much as possible. Four small holes were drilled on the bottom of the case to screw the circuit board in place. The circuit board was mounted on top of the speaker. The mounting screws were covered with plastic cylinders to avoid interference between the metal screws and the circuitry. The casing for the 9-volt battery was mounted next to the circuit board.

The keypad, LED, and switch were mounted on the cover. Four small holes were drilled in the center of the cover for the insertion of the keypad legs. A fifth hole was drilled in the center of the cover to connect the wires from the keypad to the encoder on the circuit board underneath. Two additional holes were also drilled. One was for the LED and another was for the switch. Once all the circuitry was in place, the cover was mounted with a screw in each corner. Rubber legs were mounted on the bottom of the case so that the device would be lifted off the surface.

The overall cost was approximately $160.

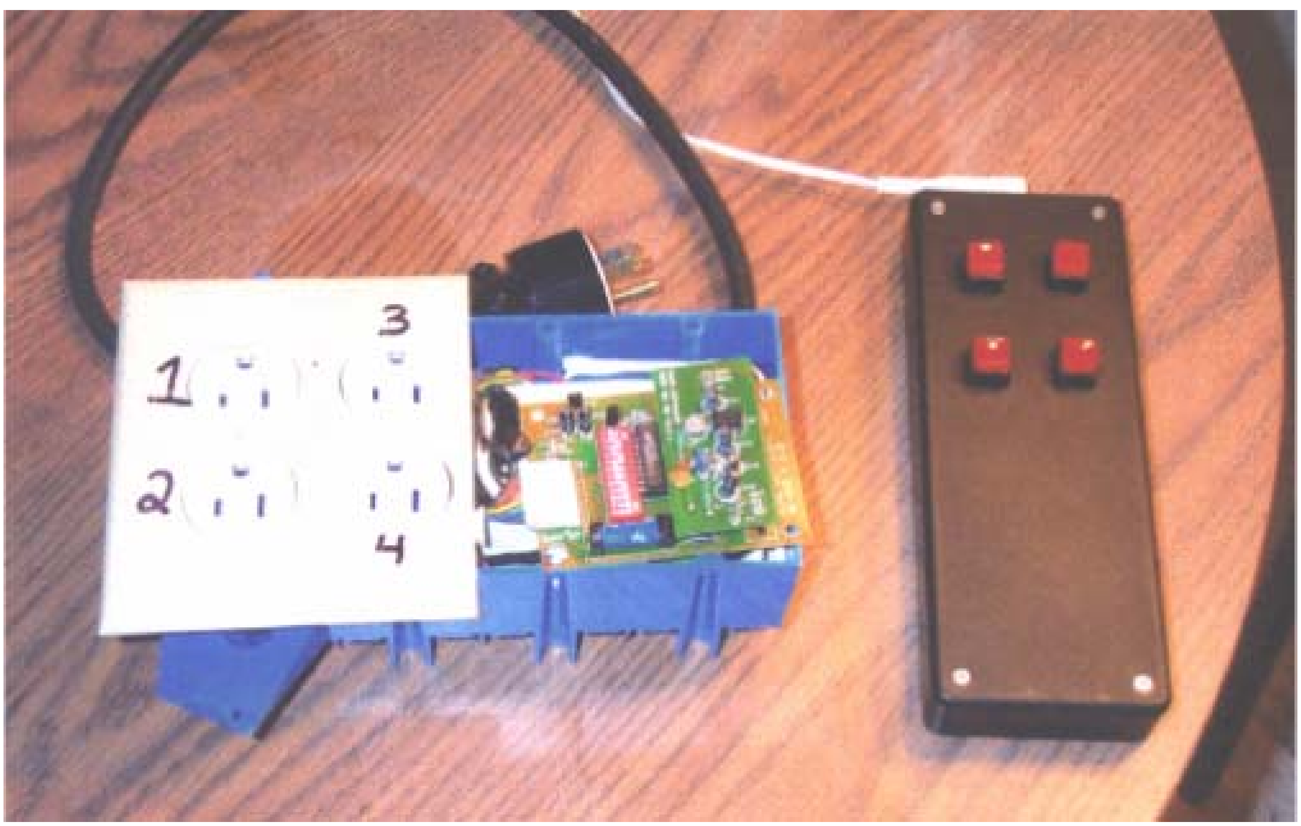

Figure 11.3. Digitally Secured RF Controlled Outlet.

WIRELESS KEYLESS ENTRY

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INTRODUCTION

In this project, a wireless keyless entry was designed to enable an individual with disabilities to unlock a main entrance door to a house via a key-chain transmitter.

SUMMARY OF IMPACT

The prototype provides individuals with limited mobility wireless access to a residence. The receiver unit can be integrated into commercially available intercom systems.

TECHNICAL DESCRIPTION

The main components of the design project are an encoder, transmitter, receiver, decoder, door-latch drive circuit, and power supply units. The transmitter unit is a 300 MHz AM RF key-chain transmitter from Skylink. This transmitter receives a coded signal from the encoder and uses this signal to modulate its 300 MHz carrier. The encoder delivers a 12-bit code in serial format to the transmitter. The first eight bits of the encoder are address bits, and they must be matched to the decoder address bits to allow the transmitted signal to be received. The final four bits of the encoder are data bits, which are processed by the decoder only if the address bits are matched. The operating voltage of the transmitter/encoder key chain is 12-volt DC, and the operating current is 6.6 mA. This voltage is obtained from a 12-volt battery.

The decoder used in this project is a 12-bit decoder from Ming Microsystems. The first eight bits of the transmitted code must match the address bits of the decoder. After matching occurs, the last four bits are passed on to the data output of the decoder. The valid ID relay closes and remains closed until the incoming signal is no longer present. The four data bits latch and remain in the state in which they were programmed by the last transmission until they are changed by the next transmission. In this project, only one data bit was set high because there was only one device for the transmitter. However, the other data bit could be utilized for future expansion of the project to control additional devices.

The drive circuit uses the transmitted signal to permit power to travel to the door latch, which opens the door. Once the transmitted signal is received, the transmitted data is outputted through the data pins. The data pins are active low. Because the design requires a high output for the drive circuit, the desired data pin is passed through an inverter. The drive circuit is based on the totem pole configuration of a Darlington transistor that allows AC or DC current flow to power the door latch. The inverted output data bit is connected between the base and the emitter. When the transmitted signal flows through the base, the transistor allows the current to pass from the collector to the emitter and activate the door latch. The collector and the emitter are connected to intercom pin one and pin two respectively.

For the project, a 300 MHz AM RF receiver board from Min Microsystems (Part # RE-99) was used. The RE-99 receiver requires a wire antenna for the most favorable operating distance. The wire antenna can be insulated or non-insulated and is soldered to the antenna connection point on the receiver. A 22-gauge wire cut to 9.36 inches was used for optimal performance. The operating frequency of the receiver is adjusted by turning a variable capacitor on the top of the receiver board. Once it was determined that the decoder was operating properly, the receiver and transmitter pairs were tested. First, the address bits on the decoder were matched to the address bits on the encoder. If the addresses match, the transmitted signal closes the valid ID relay on the decoder motherboard. If the relay does not close, the variable capacitor on the receiver board is tuned to a point where the transmitted signal can be received and processed. This closes the relay. This procedure can be repeated at various distances up to 200 ft away from the transmitter.

The intercom system used for this project is a NuTone Model IK-15 Door Answering Intercom. This intercom system is powered by a standard 120 AC signal. The signal is routed through a 120/20 transformer that was also supplied by NuTone. The system is equipped with two-way speakers. One speaker is for visitors, and the other is for the resident. The resident has a talk/listen button and a door release button, which allows the visitor to open the door by pressing the button. Pressing the door release button allows the 20-volt AC output of the transformer to flow to the door release. This flow activates the door latch.

The overall cost, including the intercom system, was approximately $200.

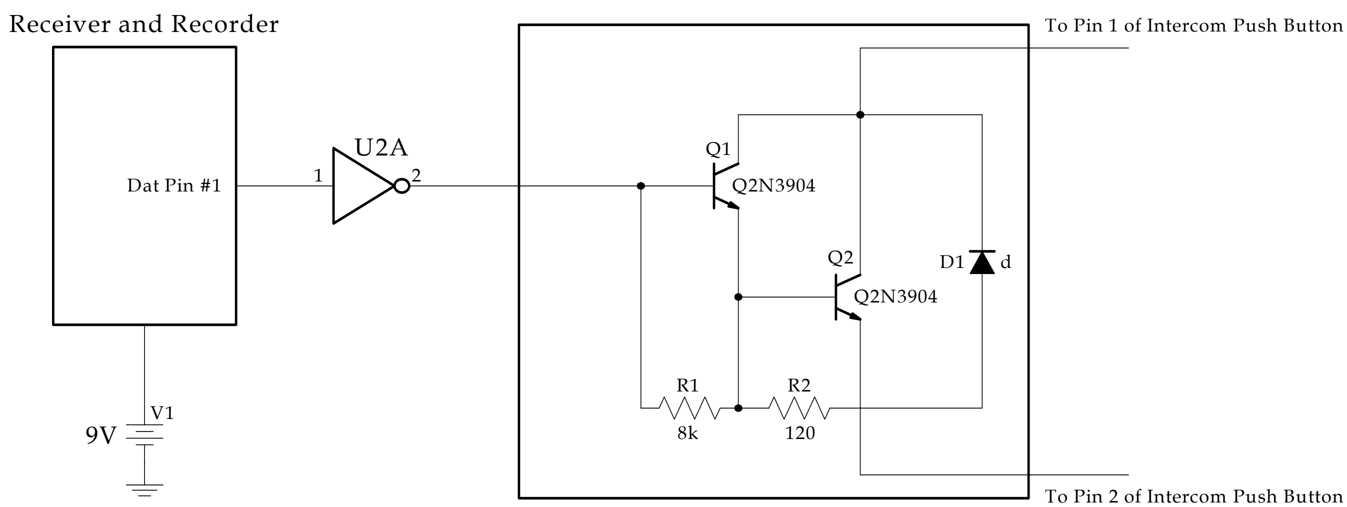

Figure 11.4. Schematic of Wireless Keyless Entry for Connection to an Intercom System.