CHAPTER 6
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Talking Thermometer

Designers: Stacie Bjerke, Steve Essler, Mike Huge, Erik Hanson, and Dominic Kunz
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INTRODUCTION

Waking up in the morning, looking at the temperature on a thermometer, and dressing accordingly is a sequence of events which many of us take for granted. However, to a visually impaired individual, this everyday occurrence is far from routine. They may have to listen to radio or television, or even guess at the temperature in order to be properly prepared for the outside temperature.

SUMMARY OF IMPACT

A talking thermometer has been designed so that a visually impaired person has easy access to the outdoor temperature at the push of a button. The device, shown in Figure 6.1, will audibly inform the user the temperature in degrees Fahrenheit.

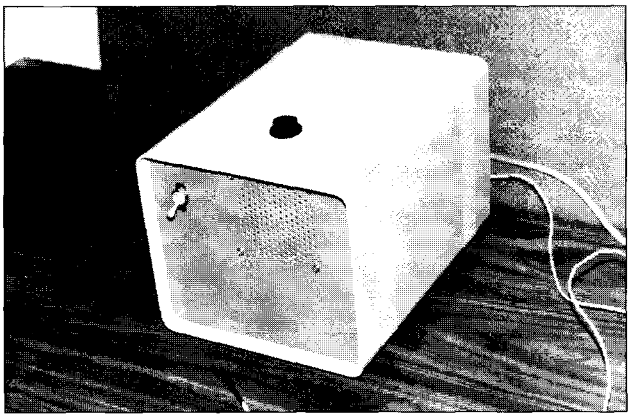

Figure 6.1. Photograph of the Talking Thermometer.

The talking thermometer consists of a temperature sensor that is hung out of a window, and an electronics unit near the window that changes the temperature input into an audio output. A visually impaired person is then able to press a button to determine the outdoor temperature.

TECHNICAL DESCRIPTION

The talking thermometer combines three types of technology: temperature sensing, microprocessor interfacing, and voice synthesis, to audibly inform the user of the outdoor temperature. The device will hopefully make an everyday task easier for the visually impaired.

The talking thermometer consists of three major design blocks: a temperature sensor, a microprocessor, and a voice synthesis chip (see Figure 6.2).

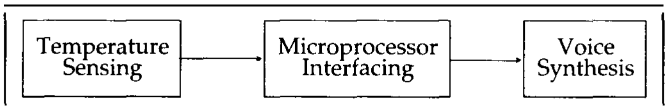

Figure 6.2. Block Diagram of Talking Thermometer.

The temperature sensor unit, shown in Figure 6.3 (also called sheet 1 in the diagrams), uses a RTD (Resistive Thermal Device, a variable resistor that varies with temperature) to measure the outdoor temperature. A constant current source supplies current to the RTD. Thus, as temperature changes, the voltage across the RTD changes accordingly. The analog voltage signal is then amplified, and utilized by the microprocessor unit.

The microproccesor unit and power supply is illustrated in Figure 6.4 (also called sheet 2 in the diagrams). The microprocessor used in this design is the 68HC11 made by Motorola. This microprocessor first converts the analog temperature signal to a digital signal with its on board A/D converter. Illustrated in Figure 6.5 (and also called sheet 3 in the diagrams) is an additional circuit for debouncing and pulse control utilized in the other units. Microprocessor software specially written for this project is used to determine which addresses to access on the voice chip based on the digital temperature reading. These addresses are passed to the voice synthesis unit.

The voice synthesis unit, illustrated in Figure 6.6 (also called sheet 4 in the diagrams), has numbers and words programmed at given addresses. This unit receives the addresses from the microprocessor, and “speaks” the outdoor temperature by accessing the proper address. An amplifier and speaker make the spoken temperature audible to the user. The voice chip used in this design is the ISD 1020 (Information Storage Device).

The total cost of building the talking thermometer was $204.27. This included all the components, as well as the encasement for the components.

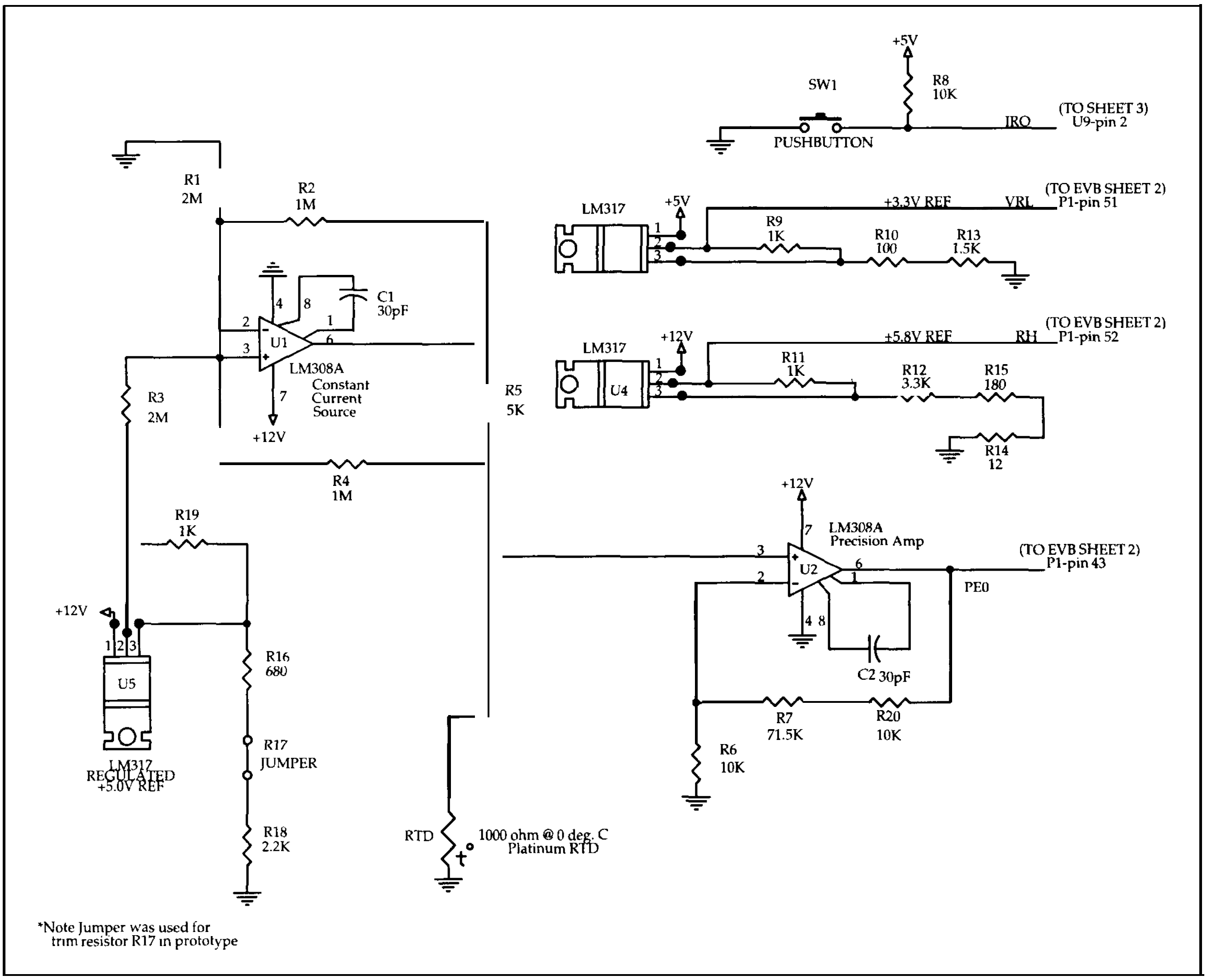

Figure 6.3. Temperature Sensing and Voltage References of the Talking Thermometer.

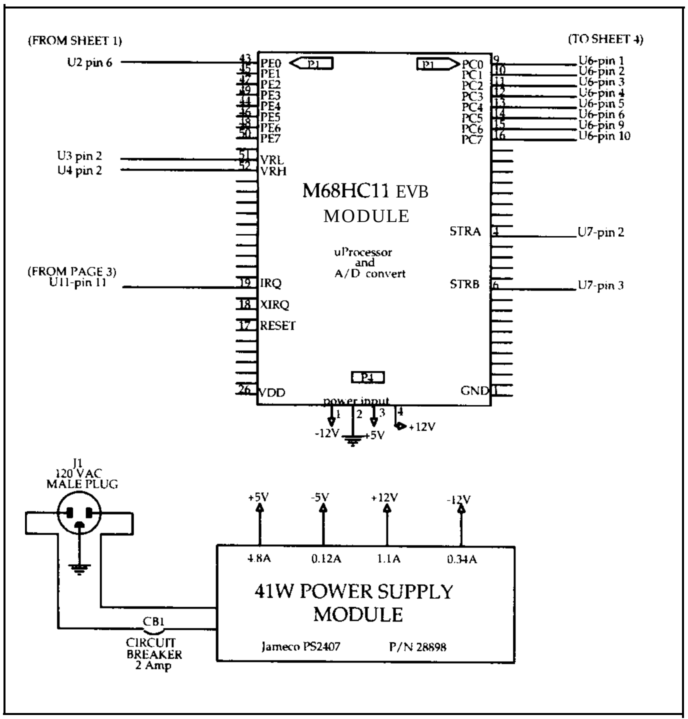

Figure 6.4. Power Supply and Microprocessor Unit of the Talking Thermometer.

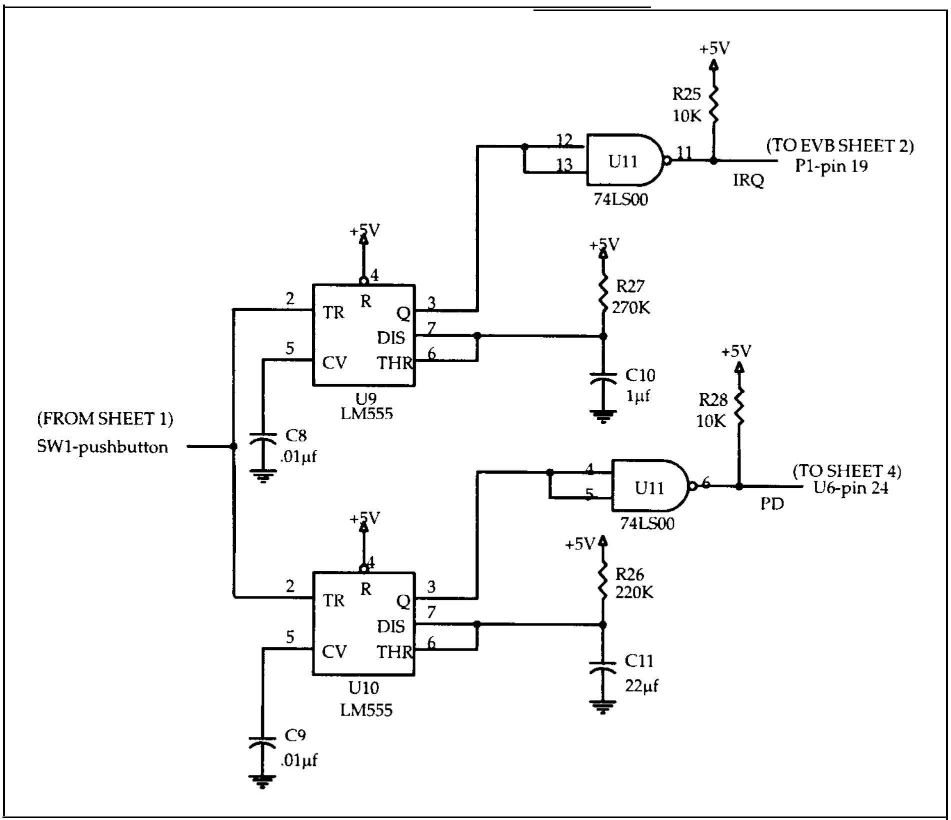

Figure 6.5. Debouncer and Pulse Control of the Talking Thermometer.

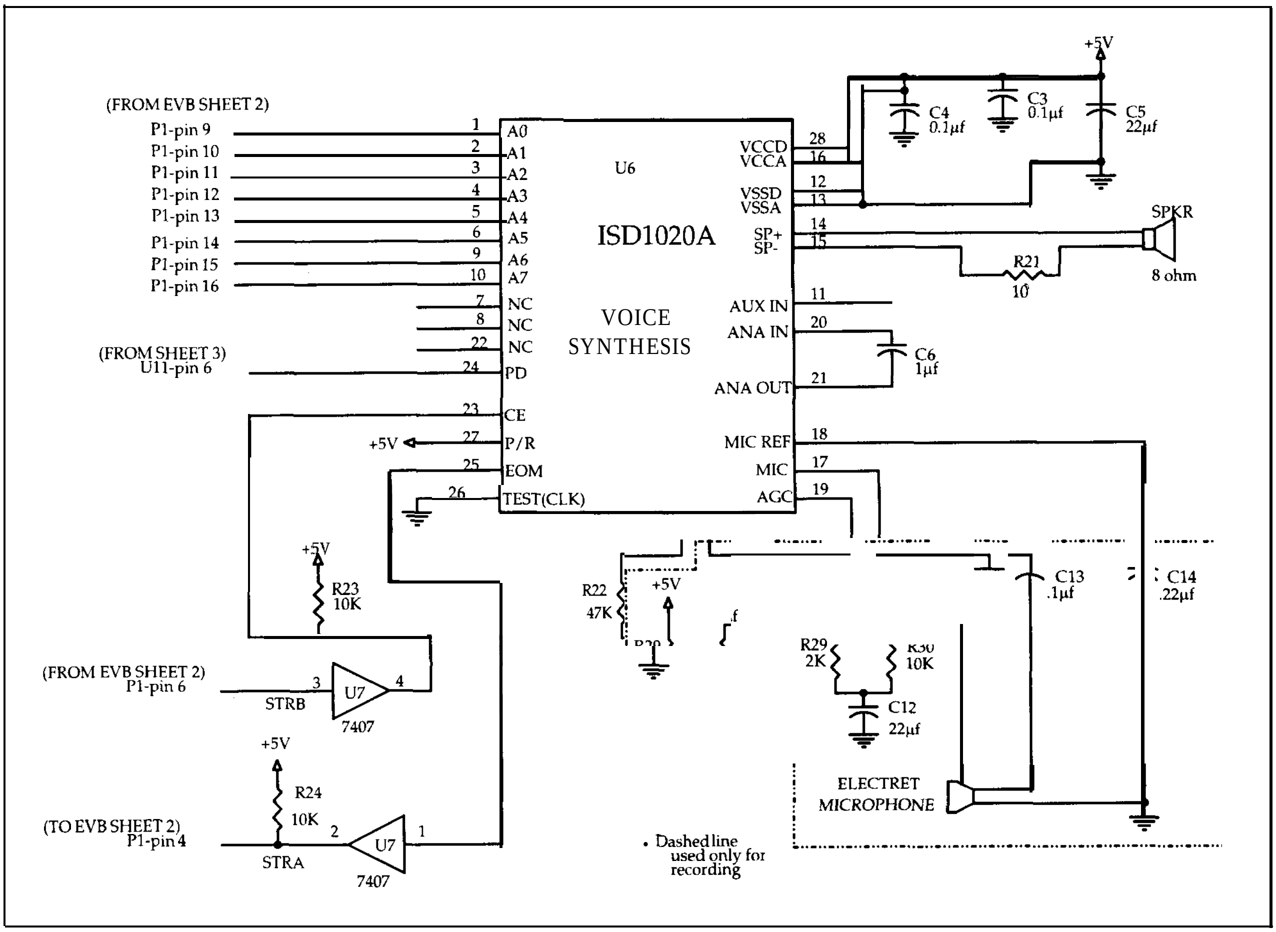

Figure 6.6. Voice Synthesis Section of the Talking Thermometer.

Electronic Memory Game

Designers: Steven Kubis, Michael McElmury, Thomas Schaff, and Muhammad Irfan
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INTRODUCTION

The electronic memory game is designed as an aid to improve concentration and short term memory of young children. During the game, players match pairs of numbers (O-9) that have been randomly placed on the 4 by 5 number board. Each location has a push-button below it which is used to select that specific location. If the two locations chosen match, they remain lit. If not, both disappear, requiring the student to remember their location so they can be matched correctly. When all pairs have been matched, the game ends. The game is for one or two players. The game is shown in Figure 6.7.

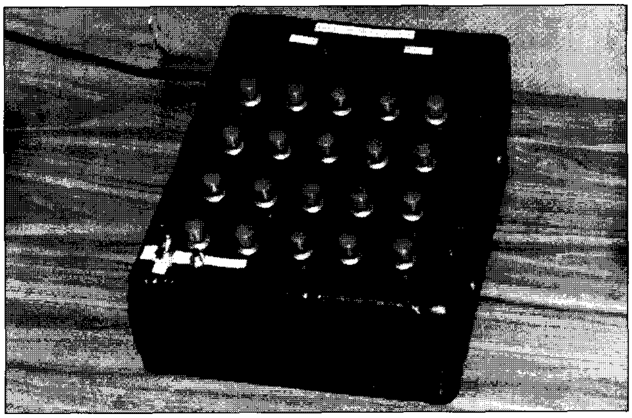

Figure 6.7. The Electronic Memory Game.

SUMMARY OF IMPACT

The electronic memory game helps students improve short term memory and concentration through a fun activity which does not require supervision. The electronic nature of the device helps hold student interest better than more conventional memory improvement aids, such as flash cards.

TECHNICAL DESCRIPTION

The electronic memory game design is partitioned into five basic blocks. These are the MC68HC11 microcontroller, the power supply, the game controlling software, the game inputs, and the game outputs, as illustrated in Figure 6.8.

The heart of the game is the MC68HC11 microcontroller. All functions of the game are controlled by this chip. This microcontroller is chosen because of its built-in input and output capabilities. All components in electronic memory game are powered by a commercially available DC power supply which converts 110-V AC to 5, 12, and -12 volts required for the game. The power supply used is internally fused and UL approved.

The software for the electronic memory game was developed using two different design tools. The first is the TM2 compiler, which is a “Modula-2 like” higher level language which is used to generate machine code for the MC68HC11. TM2 is the main method used to write the software. In addition, assembly language routines are included where needed. The software is converted into machine code and stored in an EPROM to be used by the MC68HC11.

The software is divided into three parts These are Setup, the Wait State, and the Interrupt Service Routine. During setup, the game generates random numbers and lays out the number board. The board is cleared and several internal flags are set to control the flow of the game. Now the game is ready to begin. A short song is played to indicate this and the game enters the Wait State. The Wait State is nothing more than an infinite loop waiting for a button on the keyboard to be pressed. Once a location has been chosen, the Interrupt Service Routine (ISR) is entered. This routine checks to see if another location is chosen. If so, the first location remains lit and a second is chosen. If two locations have been chosen, the ISR checks for a match or non-match, scores accordingly, and plays the appropriate match or non-match sound. If a match is made the score is increased. If no match is made, the two locations darken and it becomes the other player's turn. The Wait State is resumed, and the process continues as before. If ten matches are made, the ISR plays a finishing song and the game ends.

There are two main user inputs for electronic memory game. These are the twenty button keyboard and the on/off-number of players switch. The twenty button keyboard uses the 74HC923 keyboard encoder and single pole push buttons to form a binary number corresponding to the location chosen. The on/off-number of players switch acts as the power switch for the game. It also allows the user to choose one or two player mode. In one player mode, it always remains player one's turn. The main output of the electronic memory game is the twenty digit display board made up of seven-segment displays and 74HC4511 decoder/driver/latches. These are in parallel and a decoding arrangement is used to insure that only one location is updated at a time. The other outputs are the score and sound. The score consists of two decade counters cascaded with the output fed to a seven segment driver and display. The sound is produced by toggling one of the output pins of the MC68HC11 at the audio rate. The output is fed to a 741 operation amplifier to drive an 8 ohm speaker.

The electronic memory game is placed inside a fiberglass case to meet the guidelines of being non-conductive yet durable. The approximate cost for the game is $250.

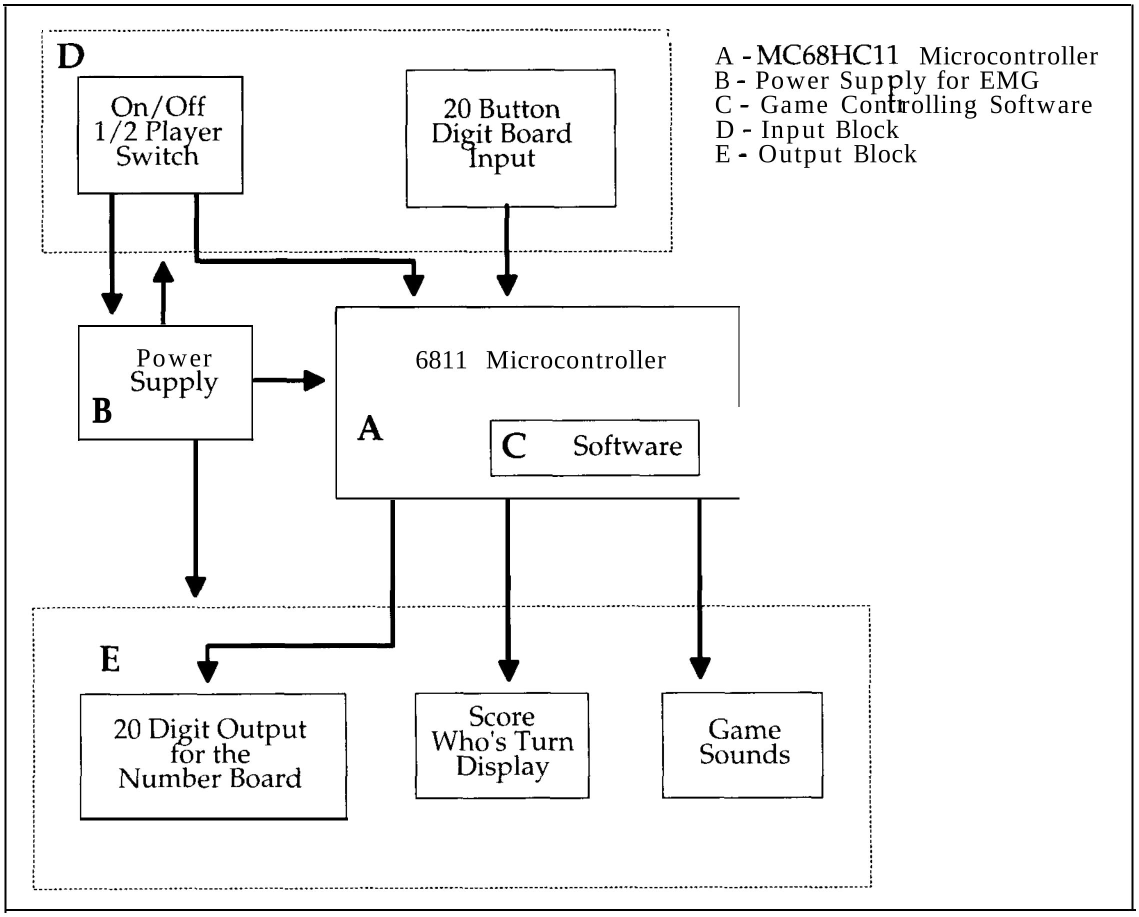

Figure 6.8. Components of the Electronic Memory Game.

The Teaching Telephone

Designes: Christine Lynner, Douglas Hauck and Richard Livdahl
Client Coordinator: Bonnie Lier
Supervising Professor: Dr. Dan Ewert
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INTRODUCTION

The Teaching Telephone is designed to teach mentally handicapped children how to use the phone. It is designed to be realistic, self-contained and separate from the regular phone system. The system is designed around a 68HC11 microcontroller and several chips from Mite1 Corporation. The micro controller offered an inexpensive and reliable means of supervisory control of the system.

SUMMARY

The school normally uses a two phone system which is totally contained in one classroom. This situation is unrealistic to the children. The Teaching Telephone system allows the connection to three phones, each in a separate room. This creates a more lifelike situation.

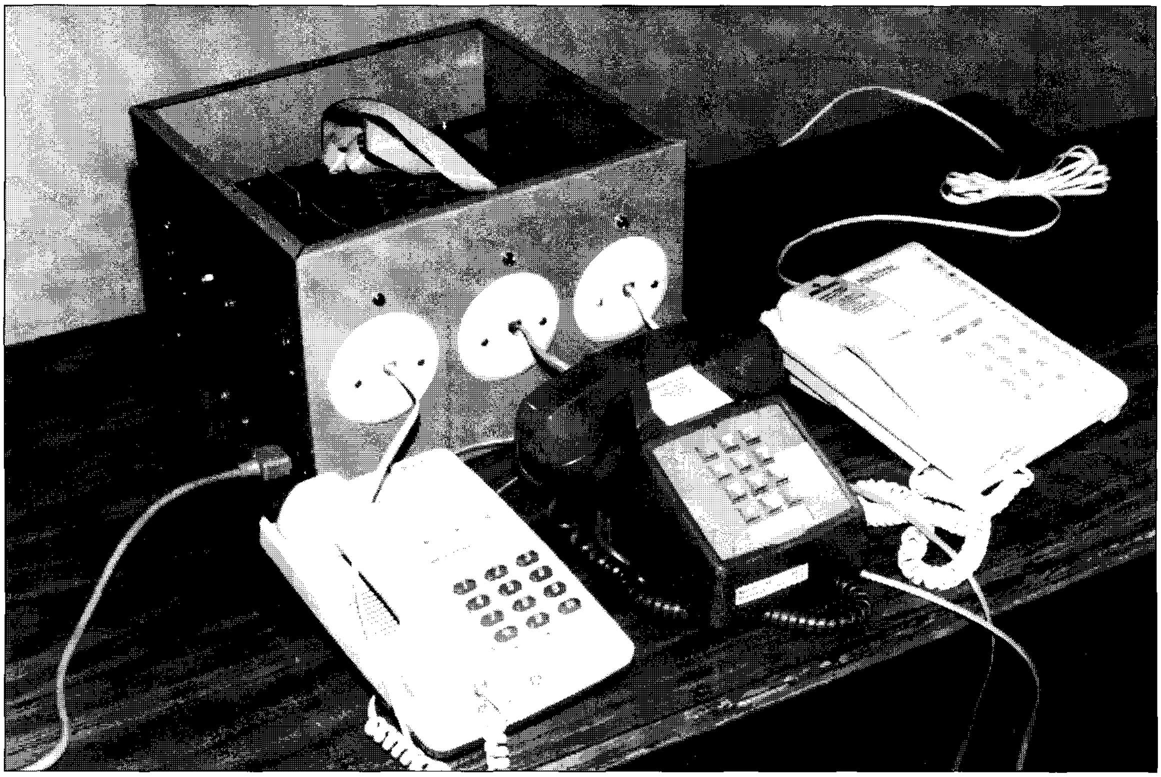

Figure 6.9. The Teaching Telephone.

TECHNICAL DESCRIPTION

The system uses Motorola's 68HCll microcontroller to monitor the status of the other chips and to provide control signals to these chips. This is the heart of the design.

Three Mite1 Subscriber Line Interface Circuits (MT88500) interface the telephone lines and their respective relays, and provides connection to the other phone lines. Other uses include converting bi-directional speech data to single-ended speech data, providing battery feed and off-hook detection.

The Teltone M-991 Call Progress Tone Generator provides dial tone, busy signal and an audible ring back to the calling phone. Each phone has a separate M-991 controlled by the microcontroller.

The Mite1 MT3271BE Dual Tone Multifrequency (DTMF) Receiver chip provides a digital representation of incoming phone numbers to the microcontroller. Again, each phone has its own DTMF Receiver. The data from the Receiver informs the 6811 to validate phone numbers and to **change** numbers on the phones. To **change** numbers, dial 000-0000 from the phone whose number one desires to change. The 6811 sends an acknowledgment tone to the phone and the user dials the new number. The M-991 sends busy signal to phones dialing invalid numbers (numbers not stored in the 6811 as belonging to one of the other two phones). This also happens when the third phone dials one of the other two when it is off-hook. The 6811 detects these conditions.

The 6811 sends a signal to the SLIC that controls the relay for each phone. The relay switches between battery feed and ringing voltage. A 120-V AC to 88-V AC 60 Hz transformer sends the ringing voltage. A 24-V DC to DC converter supplies battery feed.

One relay connects the phone line of each phone and the microcontroller enables it when a connection is detected. The SLIC chip detects when a phone is hung-up and sends the microcontroller a signal. The microcontroller then disables the relay (sends it zero volts). In contrast, when a phone is picked up, the SLIC chip sends an off-hook signal, and the 6811 sends five volts to the phone's relay, as well as a dial tone through the phone's M-991 chip.

The approximate cost of the project is $321. However, most of the chips were graciously donated to the project.

Wheel of Color

Designers: Dennis Buckley, David Gira, Doug Klein, Corey Kolke, and Jason Wanner
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INTRODUCTION

The purpose of this design is to create a game similar to the Wheel of Fortune for the residents of Eventide Lutheran Home. The game consists of an electronic wheel surrounded by four player stations. The wheel has five different colors, two "lose a turn" spaces and a "bankrupt" space. The colors, and the other spaces are arranged randomly around the wheel. One to four players can play the game, if the one player option is chosen, the game will simulate another player.

SUMMARY

The game is designed to be used by the elderly. Therefore, certain adaptations are made to accommodate certain disabilities. These adaptations include: high intensity bulbs for vision impairment, large easy to push buttons, high volume for hearing impairment, size and weight requirements for easy transportation and storage

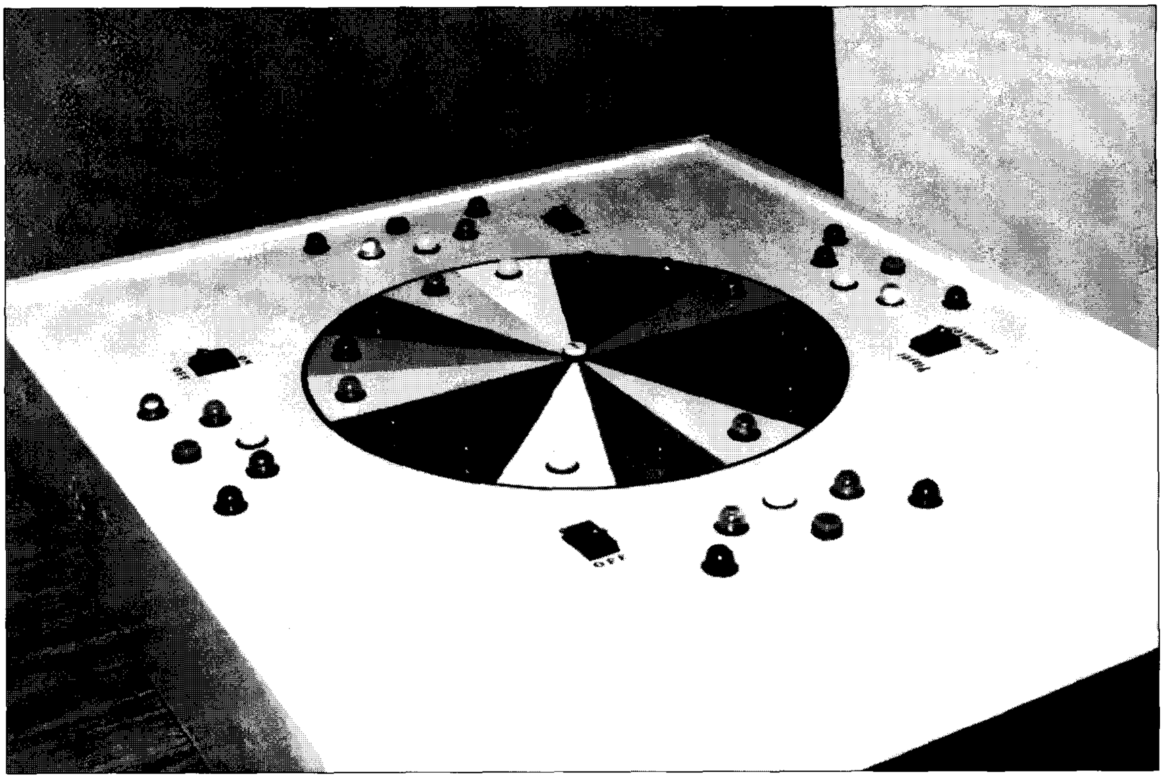

Figure 6.10. The Wheel of Color.

TECHNICAL DESCRIPTION

The Wheel of Color is composed of two major sections: a central control unit and four player stations. It uses discrete TTL digital logic throughout the design. The central control unit controls the operation of the wheel and the player selection. Each player station keeps its own score and provides the player interface. The sound control section controls the different sounds that are used for different events during the progress of the game

The main element of the central control unit is the programmable logic array, PAL22V10. There are five input lines to the PAL. The first two lines tell the PAL when a spin button has been pressed and when to go onto the next station. The third line notifies the PAL when a player has collected all five colors and thus wins the game. The fourth and fifth lines clock and reset the game respectively. The PAL outputs adjust the wheel conditions and update score information.

The player stations are each connected individually to the central control unit. The primary component of each player station is the 74LS174 HEX Latch. Whenever a player spins a new color, a latch is set, and whenever a player spins a bankrupt or the game is reset, the HEX Latch is cleared.

The game itself is $3' \times 3' \times \frac{1}{2}'$, and weighs approximately 20 lbs. The most expensive part of this project are the bulbs and sockets, totaling $90. The total cost of the project is $250.

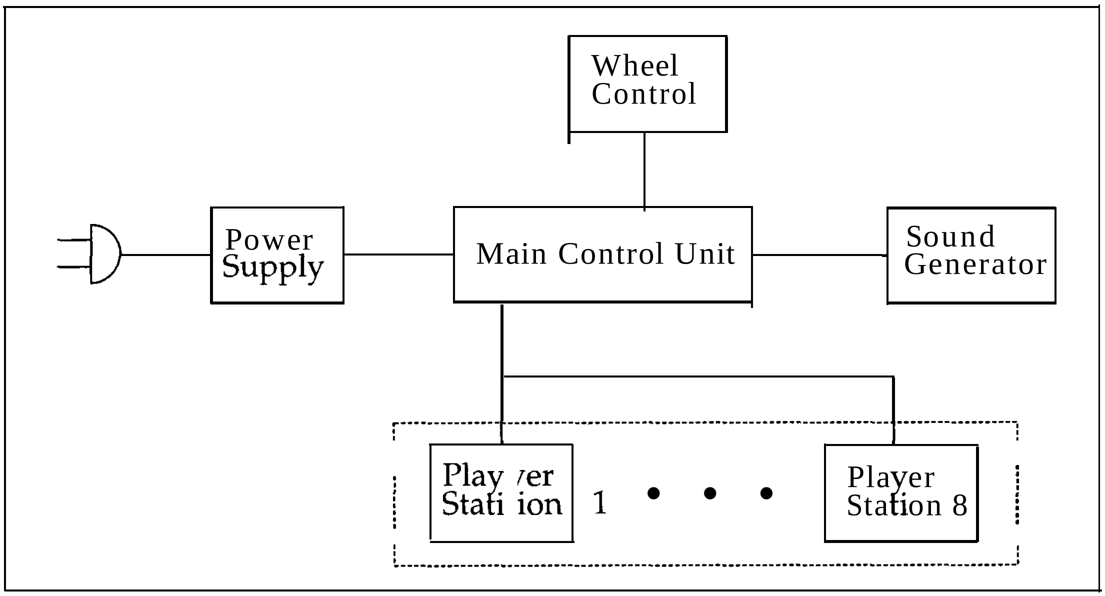

Figure 6.11. Elements of the Wheel of Color

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