CHAPTER 9
NORTH DAKOTA STATE UNIVERSITY

College of Engineering and Architecture
Department of Electrical Engineering
Fargo, North Dakota 58105

Principal Investigators:

Daniel J. Krause (701) 237-7616
John D. Enderle (701) 237-7689

The Implementation of a Voice Recognition Computer Interface System

Designer: Cherylynn Fausel
Client Coordinator: Mark D. Smith
Supervising Professors: Drs. Daniel Krause and John Enderle
Department of Electrical Engineering
North Dakota State University
Fargo, ND 58105

INTRODUCTION

Voice recognition has been the subject of research for more than twenty years and has finally become available to the public for home use. This could become a very important tool for the physically disabled.

This design project is a voice recognition computer interface system. It allows an individual to talk into a microphone and have the personal computer (PC) act as a word processor, typing the spoken words on the monitor and subsequently store them into a word processor file. The design itself includes the user speaking into a microphone contained in a headset. The microphone will transmit the spoken message to the voice recognition system that will send the appropriate signal to the host computer. This design project includes teaching the disabled person how to use the system, training of the system to his voice, and interfacing the system to his existing PC set-up.

The idea for this project was suggested by Mark Smith, a quadriplegic who because of limited arm and hand use, has a difficult time typing for any duration on a keyboard. Mr. Smith was in an automobile accident in 1986 at the age of twenty-five. In the accident a disc was crushed in his vertebral column, which severely bruised his spinal cord, leaving him with C5-C6 quadriplegia (the disc was between the fifth and sixth vertebra). He has some muscle control in his arms, no finger dexterity, and is completely paralyzed from the chest down. Through many hours of physical and occupational therapy, he has strengthened the muscles that he is able to control so that he is able to use a PC. Mr. Smith types one key at a time, using a poker stick strapped to his hand. It is a very slow process. On the average, he can type five to ten words a minute; after a few hours of typing, his wrist muscles become fatigued and he is no longer able to continue. By using this voice recognition system, this problem would be eliminated.

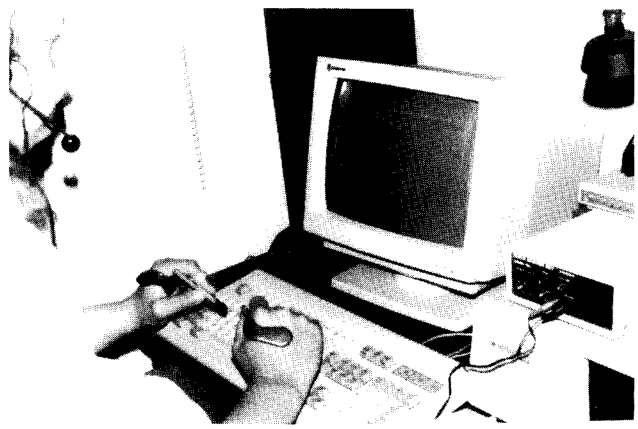

Figure 9.1. Voice Recognition Computer Interface System.

SUMMARY OF IMPACT

Mark Smith is a very bright individual and is quite quick to learn, so teaching him how to use the system was very easy. We found that the initial idea of a voice recognized word processor worked well. After using the system for a while, it was decided to add commands for a CAD drawing program. Mr. Smith is quite mechanical and is very interested in computer drafting. The Voice Master Key (VMKey) also performed the CAD commands very well.

Mr. Smith was an auto mechanic and body shop repair person and the accident that left him a quadriplegic ended his career. The adjustment to life in a wheelchair was difficult and despairing without a profession to look forward to. When he was fortunate enough to be able to purchase a modest computer system, he thought that he might be able to become a productive person again. However, due to the partial loss of muscle control in his arms, he found that after typing for a while, his wrist muscles became fatigued and he was unable to continue to type. With the use of the VMKey and being able to program the voice recognition system to suit his needs, he has found that he has increased his computer working time. He feels that with the use of the VMKey system, a career as a computer draftsperson could now become a reality.

TECHNICAL DESCRIPTION

Six steps in the recognition of speech that are common to most voice recognition systems are: 1. converting the input analog signal into a digital form by sampling, 2. compressing or selecting the relevant data for subsequent processing, 3. determining the boundaries of the word, 4. detecting patterns within the word, 5. pattern classification, and 6. association of pattern sequences with words in the vocabulary.

The input stage consists of a microphone preamplifier. An analog-to-digital converter (ADC) changes the input to a digital representation of the analog voice signal. The input microprocessor (#1) receives the data from the ADC and determines when a voice signal, as opposed to noise, is present. It also detects signal peaks (local maxima and minima) and records their amplitude and the time interval between peaks. This significantly reduces the amount of data that must be handled in subsequent processing. The selected data is passed on to processor #2, which decides when the compressed data constitutes a pattern and then generates parameters based upon the type of pattern. Processor #3 uses the sequences of parameters to decide which word has been spoken and sends the information to the host computer. The host computer then carries out the spoken command, either printing the word or controlling the external device. The voice recognition unit employed in this project is the "Voice Master Key System II" and is produced by the Covox, Inc. company of Eugene, Oregon.

The software is loaded directly into its own directory onto the hard drive. The VMKey requires about 64 kbytes of memory and is a "Terminate and Stay Resident" program. This means that it should be loaded into resident memory before any other application programs are loaded. This is to ensure that there is no conflict in memory storage addresses, which could cause the system to crash.

The next step is to decide which application programs the VMKey is going to control. A word processor package has been chosen as the application program to implement using VMKey. This was chosen because it was felt that a voice controlled word processor would help Mr. Smith to the greatest extent.

Although any word processing program can be implemented using VMKey, PC Write (V 3.03) was chosen because it was the most familiar to Mr. Smith Selecting the vocabulary for the VMKey was the next phase. The words were selected by several criteria. Uniqueness of words is the most important selection criterion. One should choose the vocabulary of recognition such that no two words sound alike. Another selection criterion is to select words that have some sort of meaning concerning the command that it is supposed to represent. It makes it easier for the user to remember the chosen vocabulary by picking appropriate words for their respective commands. A selection criterion of not as great importance is the length of the word.

In order for the VMKey to recognize words, it must first be "trained" to the user's voice. Training is the process of spectrally sampling the voiced input and creating a pattern template. This gives the system a vocabulary of words that can be recognized. The word that is to be recognized is placed in the template by following the menu commands, and then it is spoken three times into the microphone while the VMKey is "listening." This has been found to be the most efficient number of times to average the data that establishes a distinctly recognizable pattern without losing its uniqueness.

The VMKey is capable of recognizing up to 64 recognition commands. The program contains 16 levels each capable of storing 16 macros. A macro can be as short as a single character, or as long as a paragraph. Any one of the 64 voice recognition commands can be assigned to activate a macro in any one of the 16 levels. This potentially allows a single voice command to have several meanings. Macros can also call up other macros anywhere within the 16 levels.

The final cost of the voice recognition system was approximately $225. This does not include the cost of the existing computer system.

Human Voice Frequency Analyzer

Designer: Bill Higgins
Client Coordinator: Vicki Riedinger
Human Communications Resources
Supervising Professor: Dr. Daniel Krause
Department of Electrical Engineering
North Dakota State University
Fargo, ND 58105

INTRODUCTION

This voice analyzer was designed to provide visual feedback of the frequency content of a human voice. This design will assist speech therapists in teaching children to change and control the pitch of their voice. The design consists of a microphone, amplifiers, filters, and LED bargraph display. The filtering is the heart of the design. They are used to separate the different frequencies of the voice signal into ranges. The filters have a passband of 0 to 1000 Hz, which is divided into 6 ranges. Each bargraph displays the relative loudness of one range of frequencies. The unit is battery-powered and portable.

The design is very basic. The main improvement would be increasing the attenuation of the filters. This would eliminate much of the overlap between the frequency ranges. Changing the frequency ranges could also improve the operation. Only allowing frequencies in the normal voice range could improve accuracy.

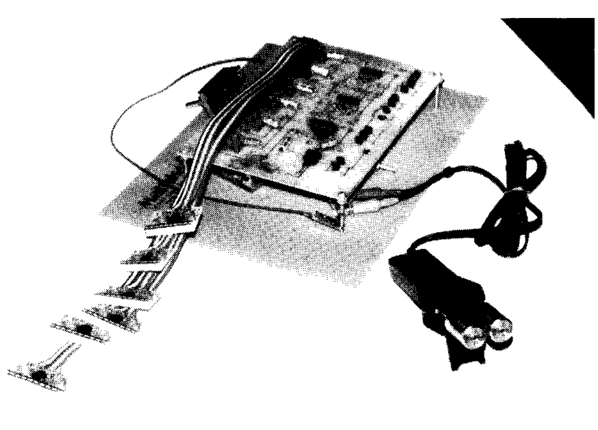

Figure 9.2. Picture of the Human Voice Frequency Analyzer

SUMMARY OF IMPACT

It has not been established that visual feedback will help with voice therapy. This unit will be used by Human Communications Resources to try to establish this. The hearing impaired will benefit by having more natural sounding voice.

TECHNICAL DESCRIPTION

The design consists of five parts: microphone, audio amplifier, filters, standardizing filters, and LED bargraph display. Fig. 9.2 shows a block diagram of the design. The microphone changes the voice signal into an electrical signal of the same frequency. The audio amplifier is needed to allow for better processing of the signal. One lowpass filter (cutoff frequency = 100 Hz) and five bandpass filters (100 to 1000 Hz) are used. They will attenuate frequencies outside their passband. After each filter there exists a standardizing amplifier. The gain is determined by the gains of the microphone and filter. A bargraph is connected after each standardizing amp.

With an average voice level (65 db), the microphone will output about 2-5 mV peak signals. This needs to be amplified before the filtering is done. The audio amplifier has a gain of 100 that is sufficient. A LM386 op amp is used in this design. Since it operates on a single voltage supply, its output contains a constant DC voltage and the voice signal. A DC blocking capacitor is placed after the output to allow only the voice signal through.

Active filters are better than passive filters in the audio range, so they are used in this design. The filters are all second order Butterworth types. The lowpass filter cuts off at 100 Hz. The bandpass filters' ranges are 100-200, 200-300, 300-400, 400-500, and 500-1000 Hz. Since low order filters are used, overlap exists between the ranges. The bandpass filters have the same circuit layout, only the component values change.

The standardizing amplifiers are used to adjust the gain of the signal relative to other ranges. They will adjust the gain so that a 65 db sound at one frequency appears the same on the bargraph as a 65 db sound at different frequency.

The LED bargraph display expects the filtered and amplified signal to be in a range of 0 to 5 volts. For each of the 10 LED's in the bargraph there is associated a comparator. The comparator voltage values are between 0 and 5 volts, in increments of 0.5 volts. If the signal voltage is greater than the comparator voltage, the associated LED is lit. This comparison is done for each comparator, 10 times for each of the 6 bargraphs.

The design was tested by using a single frequency sine wave as the input to the filters. The attenuation of the filters was checked by varying the frequency. As the frequency was varied, the bargraph displays changed accordingly. The gains of the standardizing filters were also checked at the peak frequency of each filter. Some changes resulted from this test and were incorporated in the final project.

The final cost of the project is about $75.

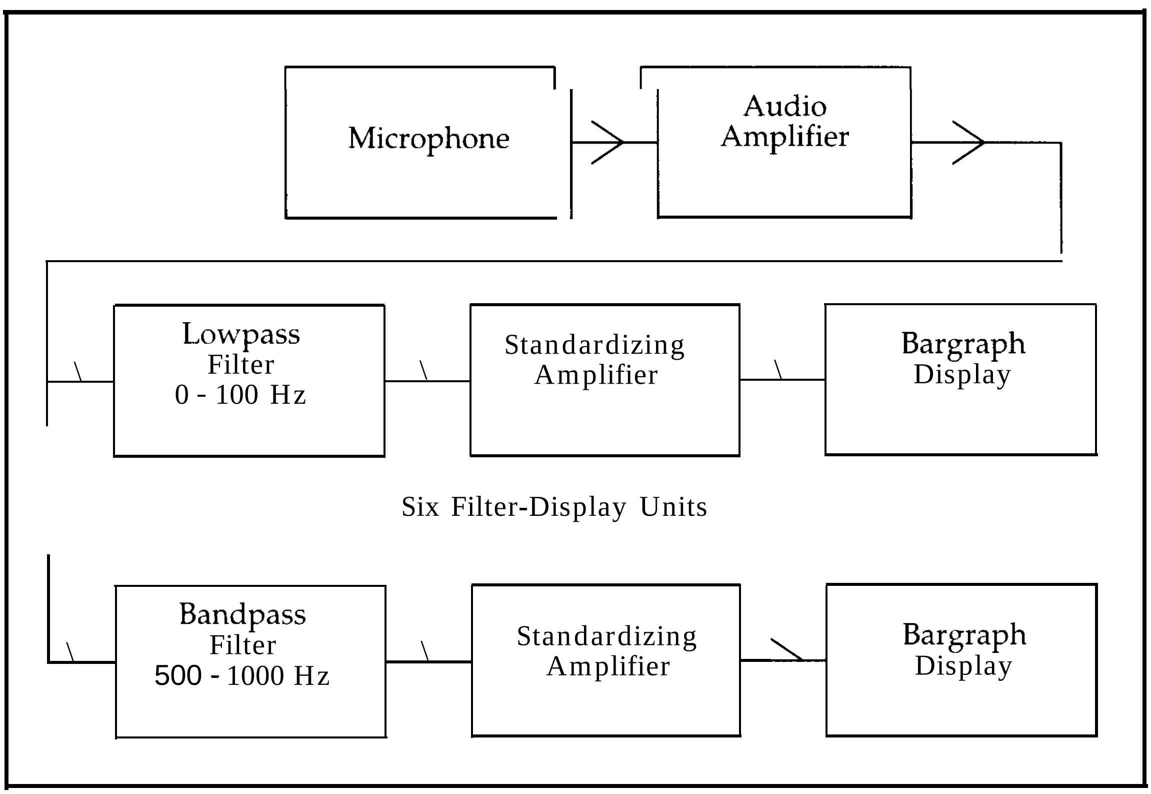

Figure 9.3. The Human Voice Analyzer Block Diagram

Infrared Child Monitoring System

Designer: Paul Kahlbaugh
Supervising Professor: Dr. Daniel Krause
Department of Electrical Engineering
North Dakota State University
Fargo, ND 58105

INTRODUCTION

This senior design project is specifically designed for a family in which the parents are hearing impaired and will be used for monitoring their children's movements. The parents who will use this device need a way to listen for their children at night. The monitoring will be provided by using a warning light, radio transmitter and receiver, and a passive infrared motion device.

Passive Infrared (PIR) is the term used to designate infrared light coming from sources other than the PIR unit. Infrared light can be emitted from anything warm, this means the human body is a good source for infrared light emissions. The PIR unit is attached to a radio frequency transmitter, consisting of the transmitting chip, relay control circuit, and power supply. Once motion is detected by the PIR unit, A relay will activate the transmitter, sending a 49MHz radio wave to a receiver located somewhere in the house. The receiver can accurately process the incoming radio signal at a distance equal to that of cordless telephones. This receiver unit consists of a receiver chip, a warning light, and a power supply.

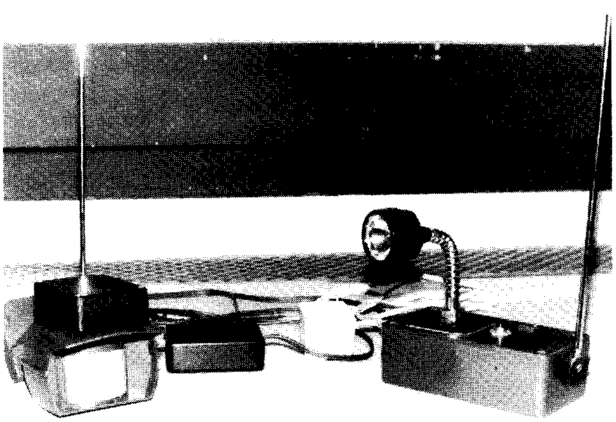

Figure 9.4. Picture of an Infrared Child Monitoring System.

SUMMARY OF IMPACT

Parents have a concern for their children's well being. In this case, it is difficult for the parents to monitor their children's movement at night. This system will provide some measure of monitoring the children's night time movements since neither parent can hear. The system can be placed anywhere there is an 120 Volt outlet and may be used for monitoring movement in other situations as well as children's movements.

TECHNICAL DESCRIPTION

The design presented in this report consists of the PIR, the transmitter, the receiver, and the warning light. The PIR is a commercial unit adapted to this design. The PIR was part of an automatic light control system that was purchased at a local hardware store. Both the receiver and transmitter use eight pin dual-in-line packages, and are to be used as a pair for best results. The transmitter has the part number LM1871 and is manufactured by the National Semiconductor. The chip can be used to transmit six independent channels at frequencies up to 80MHz. This low powered chip can operate on a 9V battery, but for this design a 120Vac to 9Vdc plug-in power supply was used instead. A block diagram of the child monitoring system is shown in Fig. 9.4.

The transmitter is set up to operate at 49MHz by adjusting the values of circuit parameters. Once the transmitter is calibrated for the correct operation, it transmits three independent pulses to the receiver such that only these pulses can trigger the output and cause the warning light to turn on. This is very beneficial since many public radio controlled devices operate at 49MHz, which in regular systems would cause interference in such a device. This prevents false triggering of the warning light.

The receiver consists of a single chip with the part number LM1872, which is the mate chip when used with the transmitter. The circuit for the transmitter was also provided by National Semiconductor. The outputs of this receiver chip consist of four digital and two analog channels. Only the digital outputs were used since the output of the chip only had to be either on or off to operate the warning light.

For further protection against false triggering, a delay circuit was included between the chip and the warning light such that it takes about two seconds before the warning light turns on. This will help the system be free of any nearby interference and cause the receiver to operate without false alarms. This delay circuit consists of two separate portions to control the warning light. The first is a 2N2222 transistor connected to give a delay response. When the receiver output goes high, a capacitor starts to charge. When voltage across the capacitor becomes 1.2V or greater, the transistor will turn on and forward bias a diode. This turns on a silicon controlled rectifier (SCR). The SCR is in series with the warning light, so the warning light comes on.

Once the warning light turns on it will remain on to notify the user that motion has occurred. This feature is provided in case the user is sleeping, away from the unit, or testing the system. To set the system back too normal, the passive infrared unit must not be detecting motion, which stops the transmission of the radio wave to the receiver and shuts the transistor off. The SCR will still be on. Thus, a reset switch is mounted on the counsel of the receiver unit for resetting. When pushed, the reset switch will stop current flow through the SCR and consequently shut the warning light off.

This project was built for a part cost of $65.

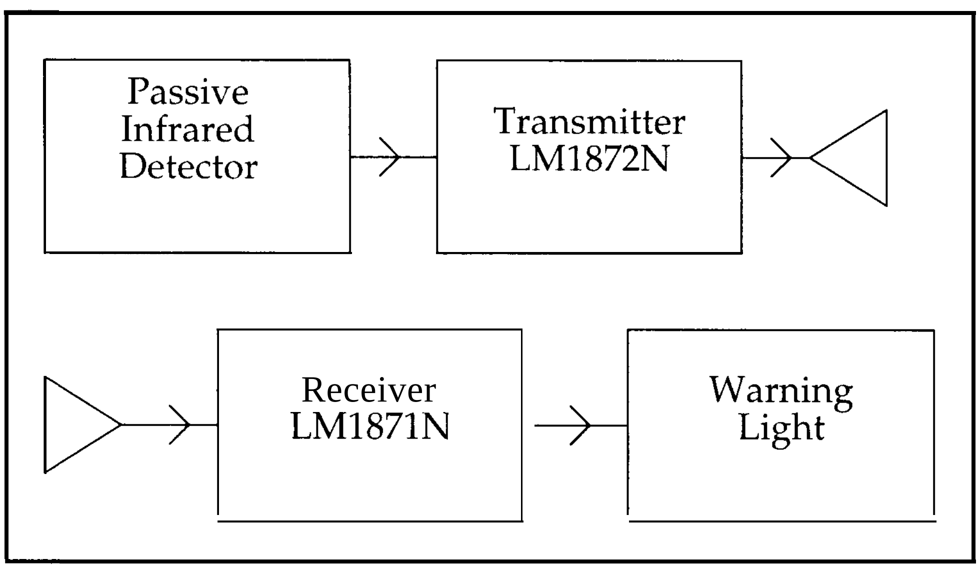

Figure 9.5. Functional Block Diagram

A Microprocessor Controlled Page Turner

Designer: Todd M. Officer
Supervising Professor: Dr. Daniel Krause
Department of Electrical Engineering
North Dakota State University
Fargo, North Dakota 58105

INTRODUCTION

The RAMA (remote automated manuscript advance) can aid a handicapped person with the simple task of turning pages in a book. This device will turn pages on command thereby enabling the person to read without assistance. The page turner is also adaptable to various types of switch controls depending on the capabilities of the individual. The RAMA will turn a single page on command from a remote switching device. It is designed to rest on a table top with the book plane titled at thirty degrees. The first prototype is only capable of turning pages in the forward direction. A general description of the microprocessor controlled page turner and a discussion of the theory of operation is presented in this paper.

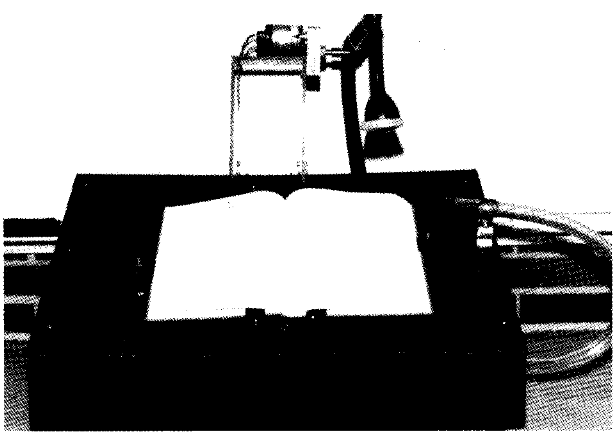

Figure 9.6. Picture of a microprocessor controlled page turner.

SUMMARY OF IMPACT

The page turner gives the disabled user an independence that is taken for granted by most readers. The suction and blowing system did provide a mechanical method for turning pages. Unfortunately, the RAMA's microprocessor failed after the initial burn in period. The transients caused by the switching of high currents required to run the vacuum and blower motors caused catastrophic failure. A redesign is needed before the full impact can be evaluated.

TECHNICAL DESCRIPTION

The user starts the page turning procedure by triggering a switch that produces a TURN PAGE command. A TURN PAGE command starts a DC gear motor to lower an arm containing a suction cup. When the page is attached to the page by suction to the arm, the gear motor reverses and lifts the page from the book. When the page reaches a certain height, a blower is activated and the suction device is detached from the page, allowing the page to be turned to the other side of the book. The above process is controlled be a Motorola 68HC11 microprocessor.

The page turner case is constructed of 1/4" Plexiglas. All the electronics, power supplies, blower, and vacuum are mounted inside the case, except for the DC gear motor that is mounted on top of the page turner. The case is lined with a sound absorbing material that helps filter the excessive noise created by the vacuum pump.

The book mounting allows an open face book to be placed on top of the page turner by spring action clips. The spring action clips will allow the hardback covers of the book freedom to shift as the book is read. As the pages are turned the front cover will move closer to the book plane and the back cover will move away from the book plane. The book plane is tilted at approximately thirty degrees to allow user comfort while reading.

The arm mounted on the top of the page turner is run by a DC gear motor. The DC gear motor is controlled by the microprocessor allowing for either forward or reverse operation. The arm is telescopic allowing adjustability for different size books.

The suction device consists of a Electrolux vacuum, latex tubing, and a suction cup. The suction cup is attached to the end of the telescopic arm. The microprocessor will turn on the vacuum thus creating a suction in the suction cup via the latex tubing. This suction will attach the page to the suction cup on the arm end. This will allow the page to be lifted from the book by the arm.

The blower device is a squirrel cage blower located inside the case. A tube connected to the blower will direct the air flow across the pages of the open book. When a page is being lifted from the book by the suction device, the microprocessor will enable the blower. The forced air created by the blower will flow across the open face of the book, thus turning the page. The controller is a 68HCll Motorola microprocessor with an external logic and relay network for enabling the motors.

The software will wait for a TURN PAGE command in an infinite loop. When a TURN PAGE command has been given, the controller will enable the DC gear motor in the forward direction or arm down movement. This will move the suction cup on top of a page. An arm down indicator switch will instruct the microprocessor to enable the vacuum and reverse the direction of the DC gear motor. After a brief wait routine the microprocessor will enable the blower and disable the vacuum. When the arm has reached the up position, the arm up indicator switch will instruct the microprocessor to disable the blower and DC gear motor.

After the arm has been parked the software will return to the beginning and wait for a TURN PAGE command. The arm down indicator switch is a microswitch mounted inside the suction cup on the arm. When the suction cup touches the page, the switch will pulse the microprocessor. The arm up indicator is a microswitch mounted behind the rotational path of the arm. When the arm contacts the switch, a pulse will be sent to the microprocessor. This will be the arm parked position.

The TURN PAGE command switch is a momentary contact switch mounted on a remote box. When the switch is depressed it will pulse the microprocessor to begin the software routine. This switch can be interchanged with other types of switches depending on user ability.

The power supplies consist of one 15 VDC supply and one 5VDC ±12VDC power supply. The 15 volt supply is used to power the DC gear motor and blower. The other power supply is used for the microprocessor and supporting electronics. The Electrolux vacuum is supplied with 120 VAC from a wall outlet.

The goal of this work was to design and construct a device that will turn pages of a book for a handicapped user. The RAMA will accommodate most size books, and turn a single page every time the TURN PAGE command indicator switch is depressed. Problems exist with the noise generated from the vacuum and the inability to turn pages in the reverse direction. Future work on the RAMA could eliminate these problems to make a more workable product. The cost of this project is estimated at $750 in material costs.

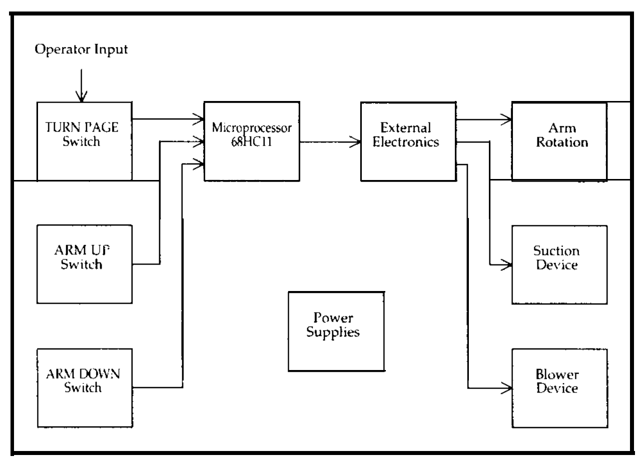

Figure 9.7. Block Diagram of the microprocessor controlled page turner.

The Turn Taker, A Behavior Modification Device

Designer: Ron David
Supervising Professor: Dr. Daniel Krause
Department of Electrical Engineering
North Dakota State University
Fargo, ND, 58105

INTRODUCTION

Behavior modification is the modification or change of a certain behavior or behaviors by various psychological tactics. Many children have behavior problems. One of the problems they haveis called behavioral excesses. Individuals with this condition cannot interact in a group of people, because they are impatient to wait for their turn in a group activity, so they become disruptive to that group. This is where the Turn Taker comes in to play.

This device will serve both as a game to the children and as the operant conditioner or behavior modification device for their excess behavioral problems.

The Turn Taker consists of the main unit and eight identical single units. The main unit depending on type and mode set, will select one of the eight single units and allocate a preset period to that unit. The selected single unit will then start the countdown timer on the main unit and wait until the time is up. When the time is up the active single unit will then select a different single unit and the process will start over.

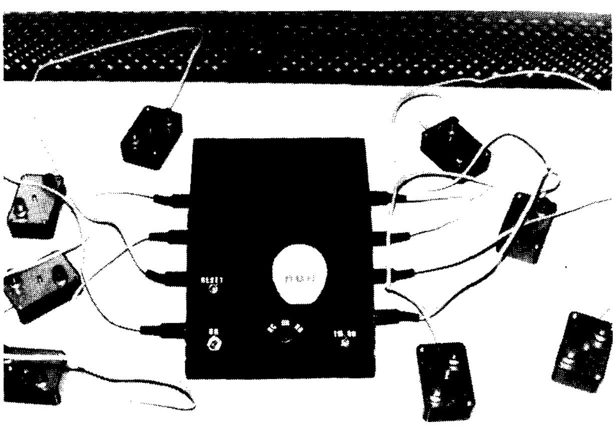

Figure 9.8. Picture of the Turn Taker, A Behavior Modification Device.

SUMMARY OF IMPACT

Many children when they are young do not realize what it means to respect other people. Therefore they do not listen when people are talking to them, or they try to be the center of attention in a group of people. The Turn Taker was therefore designed to help in the proper development of this area.

Because it is to be used with in a group, the device can be introduced to the children as a game. The rules are clear, who can stay quiet while John does something else. John does whatever the teacher has asked him to do and he will do it until the buzzer goes off, then it will be somebody else's turn.

With this device the children will learn patience and that everybody has a certain amount of time to be recognized in a group, while others devote their attention to that person.

TECHNICAL DESCRIPTION

The Turn Taker consists of the main unit and the eight single attached units. The main unit consists of four separate modules; the timer, the random board, the raced board, and the ordered board.

Because the Turn Taker uses at most .35 Amps of current at one time, the power supply required for this device will consist of 4 type "C" batteries. This will allow the device to have a power supply life of about 100 hours, An on/off switch will serve as the control switch for the power to the main unit.

The TYPE switch will be a two position switch that will either supply power to the timer, or it will not supply power to the timer. Hence the switch positions, Timer and No Timer.

The timer used for this device will be a Radio Shack Electronic LCD Digital Countdown Timer (CAT. NO. 63-879). This was used because of its compact size and limited power consumption. The buzzer on the timer will be a Piezo buzzer that operates at a frequency of 2800 Hz. The buzzer will provide an audible signal that the countdown cycle has been started and when it is finished, and it will last for approximately 8 seconds, which is determined internally by the timer.

Each of the eight single units will consist of one LED (green), two momentary push-buttons, and one 3.5' cable. The LED will light according to whether or not the unit is active. If active the green LED will be lit, if not active the LED will not be lit. The two momentary push-buttons will have separate functions; the top one will start/stop the timer and the bottom one will send a signal that will select a different single unit.

The 3.5' cable will be the connection between the main unit and the single unit. The cable will contain six wires, one for the LED, one for the timer, one for ground, one for the auto detection, one for main power, and one for the selection of a different single unit. The interfacing between the cable and the main unit will be a six pin DIN receptacle and plug.

The MODE selection will be done by a selector switch that will provide power to only one of three separate functions at a time. The functions (Raced, Ordered, Random) are individual modules located within the main unit. These functions determine how the selection of a single unit is executed.

Raced

The raced mode will use 8 J-K flip flops, 16 AND gates, 1 8-input NAND gate, and 8 OR gates. At first all the single units will be active. When the single unit who's bottom push-button is pressed first will deactivate all other single units while keeping itself active. This is realized by sending a high signal from a single unit to its corresponding AND gate. This signal is then ANDed with its active line. This is then sent to the J-K flip flop where it will then be set. When the flip flop is set it will send a low to the Dual-4 input AND gate and a high to the active line. The output of the DUAL-4 input AND gate will then send a low to the AND gates that control power going to the active lines of the single units and make them low. Thereby keeping the single unit who's bottom push-button was pressed first, active. To make another run in the Raced mode, one must press the reset button on the main unit. This will then reset the J-K flip flops and all active lines will go high.

Ordered

The Ordered mode will select single units in order by using a 4 bit counter and a BCD to DECIMAL decoder. The four bit counter will count from one to eight and start over. The BCD number it generates is then sent to a BCD to DECIMAL DECODER. The BCD number is then converted to decimal and the corresponding single unit will become active. When the timer goes off or when the bottom push-button on, the active single unit sends a signal to the 4 bit counter, which causes it to count to the next number.

Random

Random mode will consist of 1 DECADE COUNTER/DIVIDER, 2 2-input NAND gates, 16 2-input AND gates, 1 2-input OR gate, 8 D-Type flip flops, two resistors, and one capacitor. Here, two NAND gates will send a varying voltage to the DECADE COUNTER, where it will generate a random number because of the varying voltage. This in turn will then make the corresponding single unit active. When the bottom push-button of the active unit is pressed it will set the J-K flip flop and send a high to the OR gate where it will generate another number. The setting of the J-K flip flop acts as a memory device, so that when the corresponding active line goes low it will not be picked again until all other active lines have gone high. This is done so that one single unit will not get picked more than once in a single round. A round is completed when all single units have been selected.

The approximate cost of the project was $105.

A Voice Activated Thermostat for a Quadriplegic

Designer: Mark Schulz
Supervising Professor: Dr. Daniel Krause
Department of Electrical Engineering
North Dakota State University
Fargo, ND 58105

INTRODUCTION

This design project enables a quadriplegic who cannot physically control the temperature of his room to control the temperature through voice activated commands. The solution is a thermostat that requires no physical adjustment. Instead, the thermostat will regulate the temperature in the house through voice activated commands. The temperature will be able to be controlled between 65” F and 80" F.

There will be a microphone mounted near or on the bed of the user to receive voice commands. The microphone will then be hardwired directly into the voice recognition chip that amplifies and decodes the words. The voice recognition chip then sends out the correct information to adjust the thermostat to the desired setpoint.

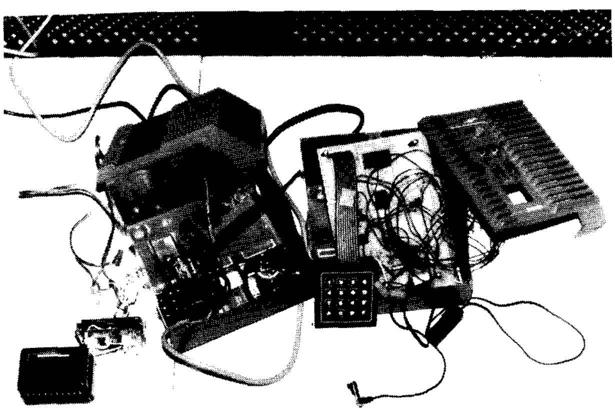

Figure 9.9. Picture of the Voice Activated Thermostat for a Quadriplegic.

SUMMARY OF IMPACT

Quadriplegics have no physical control of the temperature in their environment. The only possible form of control over the temperature of their environment is by telling the person that is caring for them. This may become very uncomfortable for a quadriplegic at night especially when no one is around to adjust the thermostat for them. One solution to this problem is a voice activated thermostat. The purpose of this design is to regulate the temperature in a room by means of voice commands. This gives the quadriplegic the ability to control the temperature of his surroundings, increasing his comfort and independence.

TECHNICAL DESCRIPTION

The voice activated thermostat is designed to adjust the setpoint of the thermostat to a desired temperature by means of a simple voice command. This section gives the details of the design.

Voice Recognition Chip

The Toshiba T6658A is a single chip voice recognition integrated circuit with an on-chip analog interface, voice analysis, recognition process and system control functions. It uses a speaker dependent isolated spoken word recognition that recognizes a maximum of 40 words. This enables the user to connect a microphone, keyboard, and memory to store up to 40 words. The chip is operated by manual control by the keyboard. The chip has three possible operating modes: Registration, Recognition and Standby modes. The three modes will now be discussed.

The registration mode is the mode to register words that are desired to be recognized and stored in an external RAM by use of the keyboard. This is the only mode in which the keyboard is used. It is necessary to execute the registration before actual recognition. There are four commands (BLK, ENT, CAN and ALLCAN) available for the registration mode of the T6658A.

The BLK command specifies BLOCK No. to which words are registered or canceled. There is a total of 4 blocks of ten words each, giving a total of 40 possible words to be recognized. This design will be concerned with only block 1, since only 10 words are needed for the design project.

The ENT command specifies the word number of an area in which words are registered. This command is given following a number (l-10) specifying word number. Thereafter, the chip waits for the voice input. The word spoken is then designated at that certain location word no. (l-lo).

The CAN command cancels the word that is registered to the word number specified. Similarly, the ALLCAN command cancels the registration of all words. It is recommended to execute the ALLCAN command at the beginning of the registration mode to clear all the areas in which words may be registered.

The recognition mode is used to recognize the words. The recognition mode starts automatically whenever a voice is input. The output is a digital word from 0001 to 1010. The words to be used to change the set point will be “one” through “ten” with ten = 80F and one = 65F. The range of the set point will be from 65F to 80F at increments of 1.5” F. After a word is said, the recognition process is over is when the EOR LED lights up. In stand-by mode, the operation of the T6658A is completely stopped but contents of words registered in the external RAM are kept unchanged. All the outputs remain unchanged.

Input* of *chip

There will be a microphone near the bed of the user. The microphone will have a switch on it to enable and disable it. The design calls for the switch to be off when others are present and normal conversation is going on. The only time the microphone is to be on is when the user is alone and especially late at night when there is no one around to regulate the temperature for him.

The microphone is directly wired into the voice chip. When a word has been said, the recognition process discussed earlier goes into progress.

Adjustment of the Thermostat

The thermostat being used has a remote setpoint. This means that by cutting into the remote setback loop, resistance values can be added into the loop to lower the actual setpoint of the thermostat. In reality all that happens is the setpoint is falsely adjusted from the actual setpoint. There will also be a digital display of the current temperature at bedside for a reference temperature when calling for a new setpoint.

For every 8.6 Ω of resistance added in the loop, the setpoint is lowered one degree!, For the design, 13 Ω of resistance is switched into the loop with relays depending on the digital output of the voice chip. This gives a change in temperature of 1.5” F. The remote setback loop initially travels through all the normally closed relays. When the relays are opened by the outputs of the voice chip the loop has resistance added to it. Consequently, the setpoint gets adjusted accordingly, one degree lower than what the setpoint of the thermostat is set at for every 8.6 Ω of resistance added in the loop.

As soon as the temperature reaches one degree above what the setpoint is set at, the thermostat puts out approximately 18 VDC that pulls in a relay. That relay in turn pulls in a bigger relay that can handle the power rating of the electric baseboard heating. This bigger relay, when pulled in, turns on the electric baseboard heating.

Test Results

Due to limited time available to work on this project, the project was not completed. The following are the test results as of May 17, 1992. The circuit from the thermostat to the electric baseboard heating meets specifications. The thermostat properly pulls in the 28VDC relay that then pulls the 120VAC relay which would then pull in the electric baseboard heating.

However, the voice recognition circuit has a few bugs in it. Input and output are accomplished by the Toshiba T6658A circuit, but the accuracy and dependability of the I/O need to be further tested and developed. The same output was received for a number of different input voice commands. Evidently, there may be some noise or distortion problems that should be examined in the future when more time is permitted.

The final cost of the voice activated thermostat is ***$250.***

Single Switch Telephone Dialer

Designer: Jeffrey Swanson
Supervising Professors: Dr. Daniel Krause and Prof. Val Tareski
Department of Electrical Engineering
North Dakota State University
Fargo, ND 58105

INTRODUCTION

The Single Switch Telephone Dialer is a device designed to help a disabled person dial a telephone by pressing only a single easily depressed button. It is useful to people with arthritis as well as those that have lost the use of their hands or fingers. The telephone dialer has a display that scans repetitively through the digits, O-9. To dial a number, one waits until the desired number appears on the display and presses the switch once to dial that number. The display scans again and the next number is dialed by pressing the switch again. This process continues until the entire telephone number has been dialed.

Long distance dialing and other special services are accessed in the usual manner simply by dialing the extended telephone numbers starting with a 1 and the area code, just as one would with any other telephone. The '*' and '#' keys on a standard telephone dial are not provided for on the single switch telephone dialer.

The telephone dialer is designed to work with a standard touch tone telephone. It is assumed that the person using the telephone dialer is able to lift the telephone receiver to his or her head or to turn on a speakerphone but has difficulty dialing a number using the standard touch tone keypad. The dialer turns on when the telephone receiver is taken OFF-HOOK and is off when the receiver is ON-HOOK. Therefore, the display is on and counting only when the telephone is not hung up.

To restart the dialer after a dialing error, one would simply hang up and start over like with any other telephone. The incoming telephone line is connected to the dialing device rather than going straight to the telephone. The device is then connected to the phone by a telephone cord extension. The Single Switch Telephone Dialer consists of three main parts: the display circuitry, the tone generator, and the telephone line interfacing.

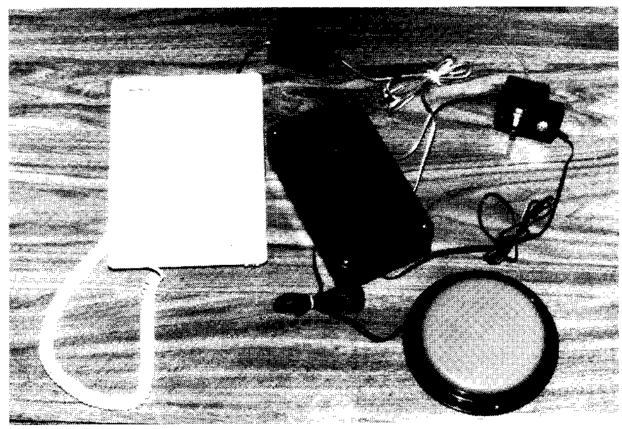

Figure 9.10. Picture of the Single Switch Telephone Dialer.

SUMMARY OF IMPACT

Many people with various handicaps including cerebral palsy, muscular dystrophy, arthritis and people that have lost the use of their fingers or arms have great difficulty dialing telephones using the standard touch tone keypad or rotary dialed telephones. This may hinder these people when it comes to staying in touch with friends and relatives as well as when an emergency phone call may need to be made. The Single Switch Telephone Dialer can be a tool that will allow these people to have access to a telephone and all the privileges that come with it.

TECHNICAL DESCRIPTION

The display circuitry consists of four parts. They are the clock, counter, decoder/driver and the seven-segment display. The system clock outputs a clock pulse approximately once per second and is therefore running at a frequency of 1 Hz. The counter is a decade counter that counts from 0 to 9, at one count per second. The Binary Coded Decimal (BCD) outputs of the counter are inputs for a seven-segment display decoder/driver that decodes the binary inputs and drives the appropriate segments of the seven-segment LED display so that it displays the current value of the counter. As the clock pulses, the counter increments its output that causes the display to scroll through each of the digits O-9 repeating continuously.

The tone generation section includes a tone generator and a push-button switch. The Dual Tone Multi-Frequency (DTMF) tone generator takes the binary outputs of the counter for its inputs. For each different combination of inputs the tone generator outputs a tone that is a combination of two signals at two different frequencies. Each row on a telephone keypad has a low frequency signal corresponding to it and each column has a higher frequency signal assigned to it. The tone output is a combination of the corresponding low and high frequency signals.

The tone is put on the telephone line to dial the specific number. The push-button switch is used to enable the DTMF tone generator. The tone generator sits idle and ignores its input until the button is pressed. Each time the button is pressed, the tone generator decodes its inputs and generates the appropriate tone. Since the enable is active high, an inverter is placed between the power supply and the tone generator's enable pin, to hold it low. Therefore, the tone generator will be enabled only when a positive edge is produced by pressing the push-button, and not at any other time.

A NOR gate and two OR gates are used to change the inputs to the tone generator for one specific case. When a zero is desired for dialing, the output '0000' from the counter is changed to a '1010' input for the tone generator. This is necessary to get the proper tone out for dialing a zero. The NOR gate gives a high output only when the counter outputs are all zeros. This high output causes the two OR gates to change the two appropriate output bits from zeros to ones.

The telephone line interfacing consists of the dialing interface and the power supply switching. The dialing interface is the process of putting the tone output from the DTMF tone generator onto the two telephone lines that are referred to as Tip and Ring. The DTMF tone output goes to a telephone line interface transformer that also connects to the Tip and Ring lines. Two zener diodes are placed back-to-back between the Tip and Ring lines to protect the device from unwanted voltage spikes.

The power supply ON/OFF switching is done by use of the A and Al leads coming from the A+A1 Light Control adapter, which is connected between the dialing device and the telephone. When the telephone is OFF-HOOK the A and Al lines are connected or shorted together inside the adapter, therefore the A and Al leads provide a low-current contact closure that is used for switching the power on and off to the circuitry of the device. When the phone is OFF-HOOK, the power will be on and when the phone is ON-HOOK, the power is off. The power comes in from an AC to DC adapter that plugs into a 120 VAC outlet and steps the voltage down to 5 VDC (Vcc). Vcc is connected to the A line and the Al line is connected to all the circuit components that use the Vcc power supply. When the telephone goes OFF-HOOK, A and Al are shorted and power is supplied to the circuit components.

The cost of the project was $95.

Ultrasonic Obstruction Detector for the Visually Impaired

Designer: Vaughn Thorstad
Supervising Professor: Dr. Daniel Krause
Department of Electrical Engineering
North Dakota State University
Fargo, ND 58105

INTRODUCTION

An ultrasonic obstruction detector has been designed in attempt to increase a visually impaired person's sense of independence and self confidence. This will enable them to attain increased mobility in unfamiliar surroundings by using an ultrasonic transducer to locate objects in their path. This design uses two transducers to provide object detection at both low heights and head height, as well as mid torso level detection. Existing similar designs have required the user to scan manually upwards and downward to detect objects, while this design will cover both locations automatically.

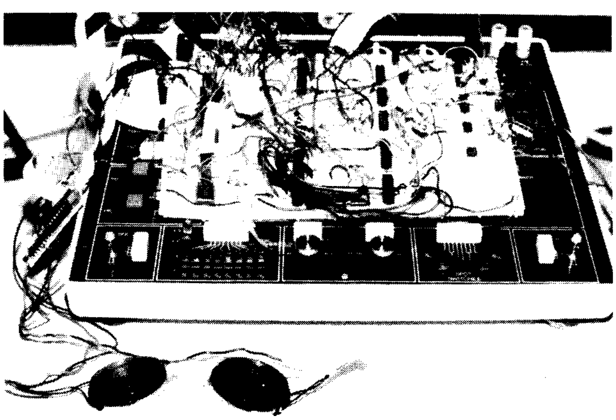

Figure 9.11. Picture of the Ultrasonic Obstruction Detector for the Visually Impaired.

SUMMARY OF IMPACT

Many visually impaired individuals may not achieve the sense of independence and self esteem they are entitled to achieve because of current mechanical canes. While necessary and useful, the canes do not enable them to ambulate comfortably in unfamiliar and/or noisy environments where the general surroundings are unknown. Also, in a noisy environment the auditory response from tapping the cane cannot be heard. This design should enable these individuals to become more independent and safely negotiate unfamiliar surroundings. Thus, the user should have a more fulfilling lifestyle.

TECHNICAL DESCRIPTION

The design incorporates two transducers, a Polaroid ultrasonic ranging board whose transmit/receive signal is multiplexed between the transducers, and the decoding and conversion circuits. High voltage hexfets were used to provide switching for the electrostatic transducers that require up to 400 volts during transmit and 150 volts continuous bias.

The drive signal originates from a 74C14 hex Schmitt trigger with symmetric output of 200 msec total period. This signal was used to toggle a 4013 D type flip-flop to direct the INIT (transmit trigger) to the proper transducer and ECHO signal to the appropriate bank of 4066 analog switches and proper Digital to Analog converter (DAC0830). It also provides the clear signal for the counter that is clocked by the output of the 12th stage of a 4060 counter that also provides two constant tones of 500 Hz and 250 Hz at the 13th and 14th stages respectively of the 4060.

A 4 MHz oscillator chip provides the input signal to the 4060 to assure that the counter "clock" pulse will yield an optimal count (O-255) for the effective range of the Polaroid ultrasonic board. The resultant count that has occurred between a transmitted burst and the received echo signal is switched to the appropriate D/A converter where it is latched into the converter via the action of a monostable multivibrator/Schmitt trigger (74121N). The inverted voltage output is then fed to an LM324 op amp where it is amplified before going to the precision voltage to frequency converter (LM331) which in turn gives a low frequency modulation of the two constant tones (500 Hz and 250 Hz)yielding a "beat" frequency of each tone due to the modulation signal. The beat frequency is the user's auditory feedback to enable determination of relative distances to a detected object; the closer the object, the faster the beat frequency generated.

The approximate cost of the parts used to build the project is $135.00.

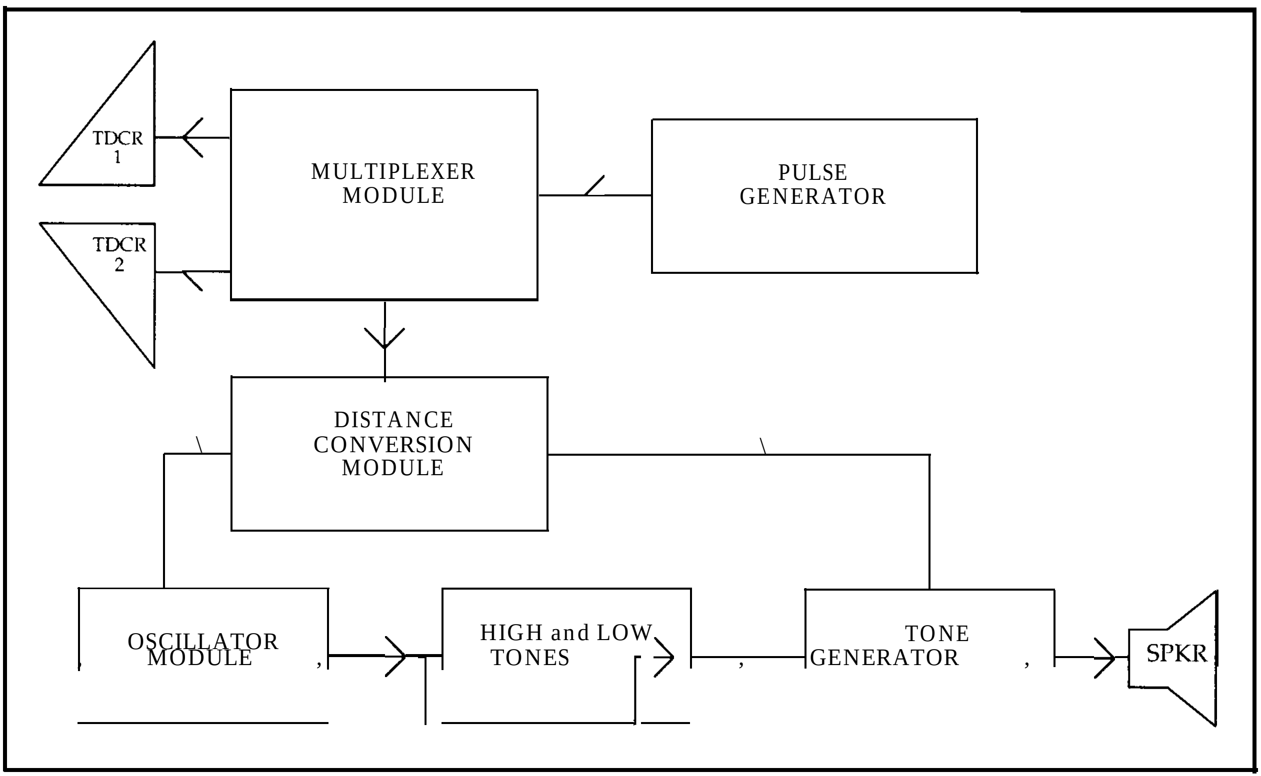

Figure 9.12. Ultrasonic Obstruction detector Block Diagram.

Printed Text Reader

Designer: Kenneth A. McIntyre
Supervising Professor: Dr. Daniel Krause
Department of Electrical Engineering
North Dakota State University
Fargo, ND 58105

INTRODUCTION

This device takes typed text and converts it into spoken words. It has been designed for individuals who are unable to read due to partial or complete blindness. Previous systems have complicated and sight-dependent controls, while this design uses only one button. Once the page is aligned on the scanner and the button pushed, the software takes over and makes all the control decisions.

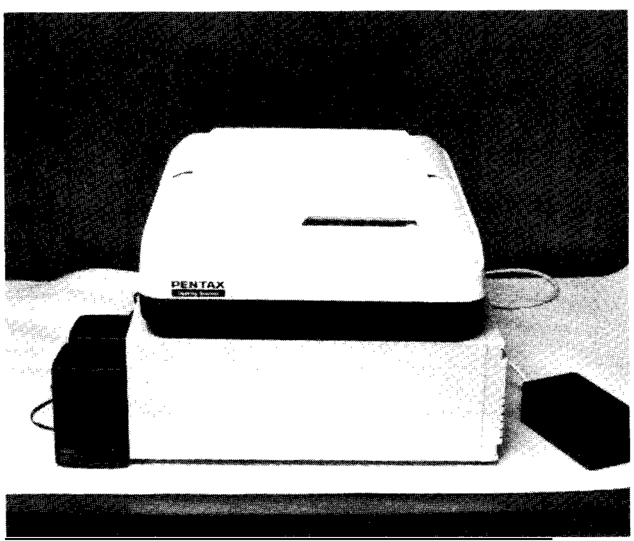

Figure 9.13. Printed Text Reader System.

SUMMARY OF IMPACT

Being able to get information from print is often taken for granted by many of us. For a partially or completely blind individual it can be frustrating not being able to read a book, newspaper, magazine, or letter. With the use of this system a plethora of new and exciting information is available, while allowing for a more independent and fulfilling life style.

TECHNICAL DESCRIPTION

The Printed Text Reader system consists of a box, flat-bed scanner, button, and speaker (shown in figure 1). After scanning a page, the device speaks the words aloud. There are six main parts: Scanner and Optical Character Recognition Software (OCR), Conversion Software, Speech Board, Controlling Software, Controlling Hardware, and IBM or compatible computer.

Scanner and Optical Character Recognition Software

The scanner used is the Pentax Desktop Scanner IQ Scan. This bed scanner can scan a legal size paper with a resolution of 300 dots per inch in about 10 seconds.

The scanner is complemented with Read Write OCR software. It has a rated accuracy of 99.5% on original typed print, and is capable of transferring a scanned image to text in excess of 500 words per minute. After running tests on several types of original typed print (paperback book, news paper, and magazine text), an average accuracy of 99.55% was obtained. Even though it scored above 99% in most cases, what is not obvious is that Read Write can make errors on critical letters. For example, “July 19” can become “July IB” so the entire meaning of a sentence may become obscured. After the typed text is scanned and converted to ASCII text, it is sent to a filter program.

Conversion Software

The Conversion Software takes the raw scanned ASCII text and filters it. The filter performs two basic functions. First, it removes the error symbols, so that the speech board will not speak them. Second, it does some simple statistical calculations on the text. If only spaces appear in the raw data, it assumes that the page is blank. If the raw text contains large numbers of errors, the program assumes the page is upside down or incorrectly rotated. In these cases, the appropriate message is spoken.

Speech Board

The speech board is an RC Systems V8600/1. It has its own microprocessor and memory. This allows multi-tasking. The computer can be scanning and converting a document while the 8600 is reading the last page. Consequently, the scanning, OCR, and filtering may seem instantaneous to the listener on the second page scan and beyond.

Controlling Softzuare

In order for all the above components to work together some type of controlling software was required. A simple batch file in DOS was used. This did not, however, address the problem of controlling the Read Write software that needs user keyboard input at various stages. To get around this, a TSR (terminate and stay resident) program was written that monitors Read Write, and places the appropriate characters in the keyboard buffer as needed. Before the batch file loops through the routine it requires a key-press to indicate the document is ready for processing, but it must not be affected by it at any other time. For example, if a key press was allowed while the Read Write program was running it could deviate from the path the TSR understands, locking the system up. To eliminate this problem, a program called LED was written to communicate with the keyboard. It simply changes the LED's on an AT keyboard indicating to the controlling hardware whether the key presses should be accepted.

Controlling Hardware

The hardware consists of a momentary switch (SPST) and a 4066 quad electronic relay. The schematic is shown in Fig. 9.14. The LED-scroll-lock output controls the 4066, and determines if the switch is allowed to register with the keyboard controller in an AND gate configuration.

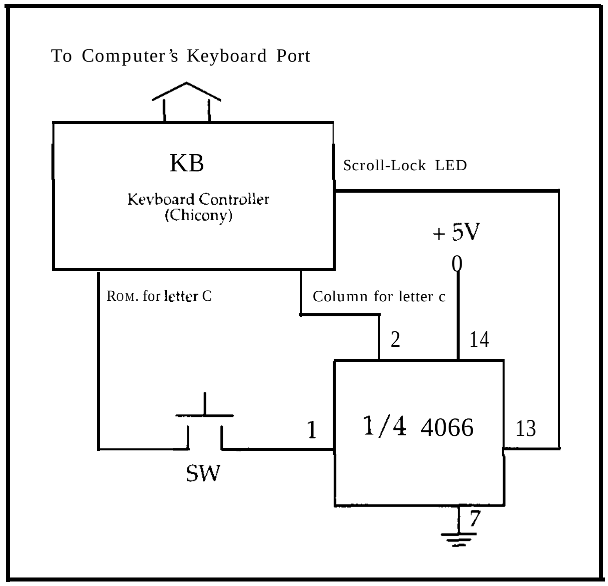

Fig. 9.14. Controlling Hardware.

IBM or Compatible Computer

The computer is the key component in the design, running the Optical Character Recognition (OCR) Software and Scanner, Conversion Software, Speech Board, Controlling Software, and Controlling Hardware as one unit. The minimum requirements are: 286 microprocessor, 640k RAM, 1 parallel port, and 10 MB hard drive.

The cost of this project was approximately $1150, excluding the cost of the computer.