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CHAPTER 8

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Motorized Wheelchair Trainer

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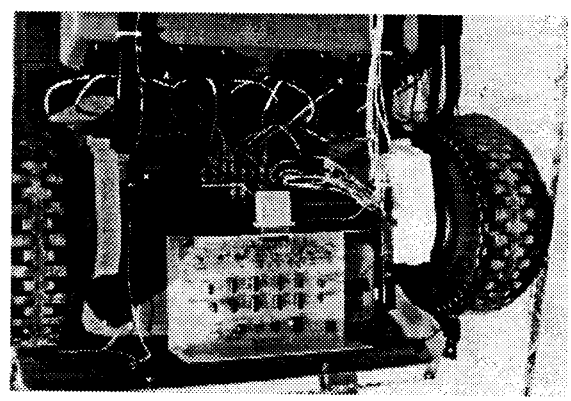
INTRODUCTION

A number of children at the Anne Carlson School for the handicapped in Jamestown, ND are physically disabled and will have to use a motorized wheelchair for independent mobility. Wheelchair training at an early age is desirable while the purchase of a wheelchair for the child is best delayed until a proper evaluation of which wheelchair and options would be proper. Adult motorized wheelchairs are commonly used for wheelchair training because of cost constraints. These large wheelchairs appear intimidating to the child making the first experiences with motorized mobility very difficult. To adequately prepare them for using a motorized wheelchair, it was suggested that an inexpensive alternative be built around a child's electric sidewalk car.

The design of the wheelchair trainer is presented. Both electrical and mechanical systems are discussed with schematics and diagrams given where appropriate. Specifically, this paper covers the controls used by the user, the controls available to the supervisor, and the two operating modes, Start/Stop and Continuous. The design of the new electronic control system is explained, and the addition of new mechanical systems as well as all modifications to the original toy car are discussed.

SUMMARY OF IMPACT

The equipment that we received from NDSU is a motorized wheelchair trainer. This is a battery-operated riding car that has been adapted for switch use. This car has been very useful for smaller children who are having their first experience with



independent mobility. The small size is less intimidating than a large power wheelchair. Also, because that they are riding in a car, it is easier to relate to than a wheelchair.

While the child is playing and having fun, he is gaining skills in cause and effect, following directions, simple language concepts (i.e. go, stop, bump, etc.), as well as developing skills in social interaction, control of his environment and readiness for power mobility. Overall, the motorized wheelchair trainer has been valuable.

TECHNICAL DESCRIPTION

The Motorized Wheelchair Trainer consists of a Fisher Price Sport car that has been modified to enable a handicapped child to drive it by switches. It is 51" long, has a 29" wheelbase, and is 20" high. It has a maximum carrying capacity of 90 lbs.

Motive power is provided by two DC permanent magnet motors, one on each rear wheel. The motors are driven by four pairs of power MOSFETs mounted on heat sinks bolted beneath the car. Power for the motors is provided by two 6 volt rechargeable batteries located underneath the hood. Also located there are three 6 volt lantern-type batteries that provide power to the control circuitry. The control circuitry itself is in an enclosure bolted underneath the car behind the rear wheels. The car's steering wheel has been removed. Turning is accomplished by driving one motor at a time, the right motor to turn left and the left motor to turn right. A caster has been mounted between the front wheels of the car, and the wheels have been locked in position. This was done so that the car could turn easier.

The car's original seat was also removed and replaced with a platform and railing assembly. A second adjustable platform was installed behind the dashboard for the placement of switches. These switches plug into four 1/8 in. phono jacks located on the right side of the dash.

There are four controls located on the dash, two switches located on either side of the original steering wheel shaft, and two knobs on the lower left area of the dash. The switch on the left is the on/off switch. The switch on the right switches the trainer from Continuous to Start/Stop mode (see below). The knob on the right is the speed control for the car, and the knob on the left sets the time for the Start/Stop mode of operation.

There are two operating modes available for the motorized wheelchair trainer. The Continuous Mode allows the trainer to move as long as the appropriate button is pressed by the user. The Start/Stop Mode allows the supervisor to select a maximum time span that the trainer will be in motion. For example, the supervisor could select a two second time span and the trainer would go forward and then stop after two seconds, even if the forward control is still being held down. To go forward again the user would have to release the forward control momentarily and then depress it again. This mode could be used as a training mode to let the user get familiar with the operation of the device.

The design of the motorized wheelchair trainer can be broken down into two major sections, electrical systems and mechanical systems. Electrical systems consist of timing and control circuitry for the mechanical systems. Mechanical systems consist of systems designed to do some physical task. Each is described below.

ELECTRICAL SYSTEMS

The electrical systems can be further divided into four subsystems. The pulse width modulator circuitry generates a pulse width modulated (PWM) signal that is used to drive the motors on the trainer. The mode control circuitry selects the current operating mode. The control logic circuitry enables the left motor, right motor, or both motors for forward or reverse motion depending upon what switches are being pressed. The motor drive circuitry drives the electric motors that provide motive power to the car. Each is detailed below.

PULSE WIDTH MODULATOR CIRCUITRY

The pulse width modulator circuitry consists of three stages, a square wave generator[1], an integrator[2], and a comparator[3] as shown in Figure 1. Each stage is utilized using a LM358 operational amplifier and passive components. The square wave generator outputs a 12 volts peak to peak square wave. The frequency of the square wave generator can be found by using the following

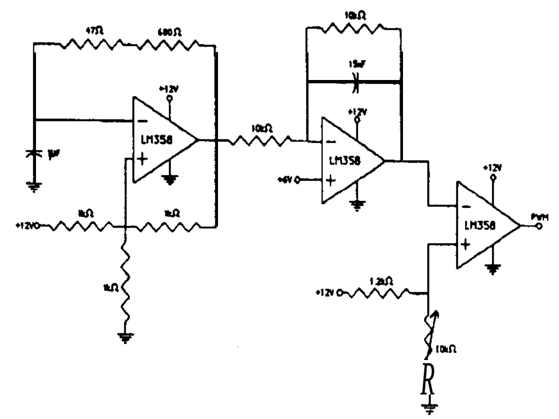


Fig. 1. Pulse width modulation circuitry.

formula

$$f = 1/T = 1/(2RC\ln 2) = 992 \text{ Hz}.$$

This signal is then input to the integrator stage.
The integrator stage integrates the square wave input and outputs a triangle wave. This is accomplished by applying +6 volts to the noninverting terminal of the operational amplifier. Therefore, any voltage above +6 volts will be positive with respect to the noninverting terminal, and any voltage lower than +6 volts will be negative with respect to the noninverting terminal. Therefore, the integrator circuit sees a square wave with amplitudes of +6 volts and -6 volts instead of one with amplitudes of 0 volts and 12 volts.
The comparator stage compares the triangle wave generated by the integrator to a reference voltage provided by the voltage divider circuit connected to the noninverting input of the operational amplifier. When the triangle wave voltage is greater than the reference voltage, the output of the comparator is zero. When the triangle wave voltage is less than the reference voltage, the output of the comparator is +12 volts By adjusting the resistance of the 10 Kohm potentiometer, the reference voltage can be adjusted up and down, thereby changing the output pulse width.

MODE CONTROL CIRCUITRY

The mode control circuitry consists of an EX-OR gate network, a monostable multivibrator, an OR gate, and a single-pole double-throw switch as shown in Figure 2. The switch is used to select the operating mode. With the switch in the upper position the car is in continuous mode, +12 volts are applied to the input of the OR gate, and the ENABLE line is always high. When the switch is in the lower position, the car is in Start/Stop mode, and the state of the ENABLE line is determined by the monostable multivibrator. Whenever the monostable multivibrator input goes high (i.e., someone presses Forward, Reverse, etc.), the output of the monostable multivibrator goes high for a certain time period, causing the ENABLE line to go high. The maximum time that the monostable multivibrator output can stay high is found by

$$T = RC = 9.5 \text{ seconds}$$ [4]

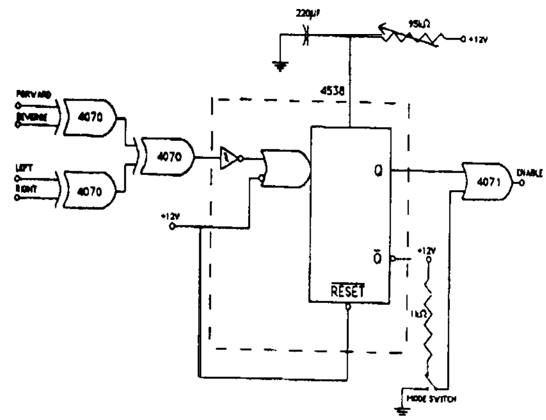


FIGURE 2 - MODE CONTROL CIRCUITRY

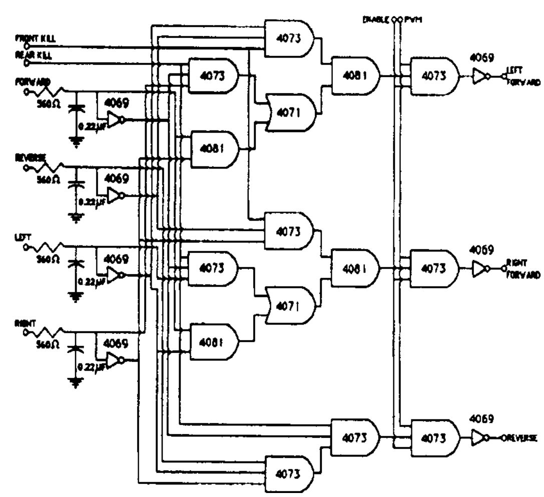


Fig. 2. *Mode Control Circuitry.*

The EX-OR gate network insures that the monostable multivibrator will be triggered when one and only one switch has been pressed, and will be disabled otherwise.

CONTROL LOGIC CIRCUITRY

The purpose of the control logic circuitry is to enable the correct motor drive line when a switch is pressed. The circuitry has eight input lines and three output lines as in Figure 3. The input lines consist of the PWM, ENABLE, FRONT KILL, REAR KILL, FORWARD, REVERSE, LEFT, and RIGHT lines. The PWM line is the output of the pulse width modulator circuitry. The ENABLE line is the output of the mode control circuitry, and enables or disables all output lines. The FRONT KILL and REAR KILL lines come from the collision detection System (see below). The FORWARD, REVERSE, LEFT, and RIGHT lines come from the user operated switches. The last four lines each has a low-pass filter on the line to debounce them. The output lines consist of the LEFT FORWARD, RIGHT FORWARD, and REVERSE lines. The LEFT FORWARD and RIGHT FORWARD lines are the forward control lines for each motor, while the REVERSE line controls both motors. The high conditions for each output line are as follows

LEFT FORWARD - **Will be enabled if the ENABLE, PWM, FRONT KILL, REAR KILL, and RIGHT lines are high, and the REVERSE, LEFT, and FORWARD lines are low, or if the ENABLE, PWM, FRONT KILL and FORWARD lines are high, and the REVERSE, LEFT, and RIGHT lines are low. In other words, the left motor will provide forward motion if only the RIGHT control switch is pressed and there is nothing against both the front and rear collision detectors, or if only the FORWARD control switch is pressed and there is nothing against the front collision detector.**

RIGHT FORWARD - **Will be enabled if the ENABLE, PWM, FRONT KILL, REAR KILL, and LEFT lines are high, and the REVERSE, RIGHT, and FORWARD lines are low, or if the ENABLE, PWM, FRONT KILL and FORWARD lines are high, and the REVERSE, LEFT, and RIGHT lines are low. In other words, the right motor will provide forward motion if only the LEFT control switch is pressed and there is nothing against both the front and rear collision detectors, or if only the FORWARD control switch is pressed and there is nothing against the front collision detector.**

REVERSE - **Will be enabled if the ENABLE, PWM, REAR KILL and REVERSE lines are high, and the FORWARD, LEFT, and RIGHT limes are low. In other words, both motors will provide reverse motion only if the REVERSE control switch is pressed and there is nothing against the rear collision detector.**

The FRONT KILL and REAR KILL lines provide a special function. Each line is tied to a pair of lever switches, mounted on the front and rear bumpers. If for example, one of the switches on the front is pressed (i.e., by the car hitting an obstacle), the FRONT KILL line will go low, disabling all attempts at forward motion. Conversely, if *one* of the lever switches on the back is pressed, the REAR KILL line will go low, disabling all attempts at reverse motion.

MOTOR DRIVE CIRCUITRY

The purpose of the motor drive circuitry is to provide power to the two motors that drive the car. There are two identical circuits, each with the schematic shown in Figure 4.

The motors consist of small DC permanent magnet motors with a run current of approximately 6.5 amps at 12 volts DC. No other specifications for the motors are known.

The main portion of this circuit consists of what is known as an H circuit[5,6] composed of the 4 MOSFETs. Since this is a 'switching type of application, the MOSFETS are not biased to operate in the linear region of operation.' Each MOSFET in turn has a npn BJT to drive it. There is a 24 volt varistor[8] across the motor to prevent any large voltage spikes. The bases of the diagonal BJT's are tied to the same control line.

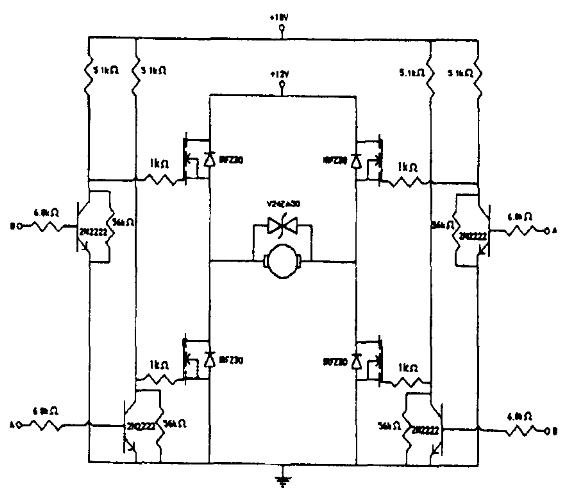


Fig. 4. Motor Drive circuitry.

The circuit operates as follows: Let control line A be inactive and control line B be active (lines are active low). Control line A will be high, saturating the two BJT's and turning off the two MOSFETs connected to them. With control line B having a PWM signal applied, its MOSFETs also will be in this state during the high period of the signal. However, when the signal goes low, the BJT's will be cut off, causing the gates of the MOSFETs to rise toward +18 volts turning them on. This will apply +12 volts across the motor and cause current to flow through the motor. The diodes on the MOSFETs controlled by line A will sink the motor current during the off period of line B, since the current through the motor (an inductive load) cannot change instantaneously. To reverse the motor direction, the current direction has to be reversed. This is done by setting control line B inactive and applying the PWM signal to control line A.

MECHANICAL SYSTEMS

The mechanical systems can be divided into three subsystems. The first subsystem is a collision detection system designed to stop the vehicle if it runs into something. The second subsystem is the switch platform upon which the switch controls rest. The third subsystem is the seating/restraint platform that replaces the original seats that were on the car. Each is detailed below.

COLLISION DETECTION SYSTEM

The collision detection system consists of two galvanized steel strips, one on each bumper. The strips are mounted using two bolts, each of which has a spring encircling it. This enables the strip to spring back after being pushed in by contacting an object. The end of each strip is bent 90 degrees so that the strip wraps around the edge of the car. Mounted near the ends of the strips are two lever switches connected in series to +12 volts. The switch is also connected to either the FRONT KILL or REAR KILL line. Whenever one of the strips encounters an object, forcing it back, it will close a contact on one or both of the lever switches. This will ground the control line, which in turn will stop the motor and prevent any further motion in that direction.

SWITCH PLATFORM

The switch platform consists of an 8" by 20" piece of plywood mounted on two adjustable slide assemblies behind the dashboard. Each assembly consists of two bars, one of which fits inside the other. Both-bars have a 5” slot cut down the middle of them. The platform can be adjusted up and down by loosening the wing nuts holding the bars together and repositioning the platform. The top of the slide assembly is bolted to an angle iron with another slot cut in it. By loosening the wing nut holding the platform in place here, the platform can be moved backward and forward also. This enables the teacher to find the optimum placement for each child.

SEATING/RESTRAINT PLATFORM

The seating/restraint platform consists of a roughly rectangular 18"&3/4" by 15” piece of plywood inserted where the old seat used to be. The original seat had to be replaced since each child has their custom-made seating insert. This meant that a general seating platform had to be designed. The platform has a railing around three sides, which can be used to secure each child's seating insert.

CONCLUSION

The motorized wheelchair trainer fulfils a need for an inexpensive method of teaching disabled children about independent mobility. The component cost of the trainer was $475.

The trainer consists of four electrical systems and three mechanical systems. The electrical systems consist of the pulse width modulator circuitry, the mode control circuitry, the control logic circuitry, and the motor drive circuitry. The mechanical systems consist of the collision detection system, the switch platform, and the seating/restraint platform.

There are two operating modes available - Continuous and Start/Stop. In Continuous mode, the motorized wheelchair trainer will move as long as a switch is held down. In Start/Stop mode the motorized wheelchair trainer will move for a preset time that can be adjusted by the therapist.

The Motorized Wheelchair Trainer has four user-operated controls and four supervisor-operated controls. The user-operated controls consist of four switches for directional control - Left, Right, Forward, and Reverse. The supervisor-operated controls consist of an on/off switch, a mode control switch, a variable speed control, and a timer adjustment for the Start/Stop mode of operation.

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APPENDIX A. PARTS LIST

Part	Count	Description
LM358	2	Dual Differential operational amp.
4069	2	CMOS hex inverter
4070	1	CMOS quad 2 input EX-OR gate
4071	1	CMOS quad 2 input OR gate
4073	3	CMOS triple 3 input AND gate
4081	1	CMOS quad 2 input AND gate
4538	1	CMOS dual monostable multivibrator
IRFZ30	8	N-channel power MOSFET
V242A50	2	24 V varistor, General Electric
2N2222	8	NPN transistor
47 ohm	1	Resistor, 1/4 W
560 ohm	4	Resistor, 1/4 W
680 ohm	1	Resistor, 1/4 W
1 kohm	12	Resistor, 1/4 W
1.2 kohm	1	Resistor, 1/4 W
5.1 kohm	8	Resistor, 1/4 W
6.8 kohm	8	Resistor, 1/4 W
10 kohm	2	Resistor, 1/4 W
56 kohm	8	Resistor, 1/4 W
4.7 Mohm	4	Resistor, 1/4 W
10 kohm	1	Potentiometer
95 kohm	1	Potentiometer
15nF	1	Capacitor, PC mount
0.22 uF	4	Capacitor PC mount
1 uF	1	Capacitor, electrolytic, 50V
100 uF	1	Capacitor, electrolytic, 50V
RS274-248	2	1/8" 2 conductor phono jacks
RS275-016	4	Subminiature SPST lever switch
RS274-415	4	3/4" molded knobs
LMB 784	1	Tite-Fit chassis (10" X 6" X 3&1/2")

A Microprocessor Controlled Placemarker for Reading

Designer: Robert M. Farrell
Disabled Coordinator: Sue Baumgardner, PT/OT Associates
Supervising Professor: Dr. Daniel Krause
Electrical and Electronics Engineering Department
North Dakota State University
Fargo, ND 58105

INTRODUCTION

The Microprocessor Controlled Placemarker is a book holder equipped with an arm extending horizontally across the page. The arm can move up a line, down a line, up to the top of the page, or down to the bottom of a page all by the push of a button. The size of the line movement can be adjusted by the user.

The line up/line down and page up/page down push-buttons are located on a wired remote control with a three foot cord. The power switch and the line size adjust dial are located on the front panel. Also located on the front panel is the power-on indicator and the page limit indicator (indicates that the arm is at the top or the bottom and cannot travel any further in that direction).

SUMMARY OF IMPACT

The Placemarker was designed and built for a young girl in the second grade learning to read. The girl has Cerebral Palsy, a disease which is characterized by involuntary motions and difficulty in controlling voluntary muscle movement. In this girl's case, difficulty arises while trying to read. As she reads, her head (and eyes) will stray to the side and when her eyes return to the page, it is difficult for her to find her place on the page. To aid in the girl's reading, her teacher usually points to the words on the page as she reads. The purpose of the Placemarker is to allow the girl to read with less reliance on her teacher.

When the Placemarker was delivered, the girl picked up on the controls right away and seemed to enjoy using it. The girl's physical therapist and mother were also pleased to have such a device.

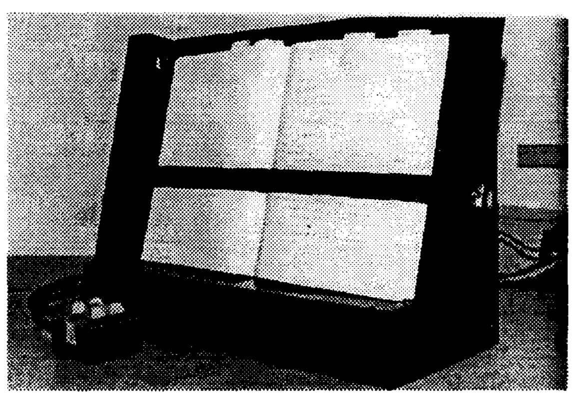
TECHNICAL DESCRIPTION

A stepping motor is connected by a belt and pulleys to a lead screw, to which the arm is attached. The stepping motor is controlled by a Motorola 68HC11 microprocessor, which is the heart of the Macemarker. The main parts of the Placemarker include the microprocessor, the motor driver circuits, the stepping motor, and the input switches (see diagram).

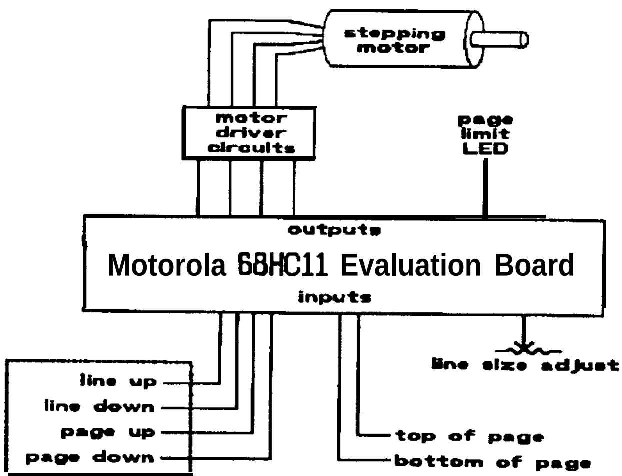
Because of it's relatively low price ($68.11) and it's completeness, the microprocessor Evaluation Board, the 68HCllEVB or just EVB for short, was used in the final assembly of the Placemarker. The EVB was designed by Motorola for 68HC11 testing and contains everything needed to operate the microprocessor (except the power supplies: +5 and ±12 volts are required).

The operating program for the Placemarker is located in an EPROM chip on the EVB. All inputs and outputs are simple zero or +5 volt signals with the exception of the line size adjust, which is read by the microprocessor's A/D converter. The line size adjust is a voltage between zero and +5 volts and is converted to a digital quantity used to determine the number of steps to move the motor.

The motor driver circuitry isolates the microprocessor from the motor. A high to one of the motor drivers excites that particular winding of the motor. HEXFETs are used as high current switches. HEXFETs are able to withstand a much higher drain current than conventional FETs



and are thus ideally suited for such applications. The advantage in using HEXFETs rather than power transistors is that the HEXFETs have an infinite input impedance and therefore draw no current from the microprocessor. Selecting a motor stepping rate involved tradeoffs. Ideally, it would be preferred to step the motor as fast as possible. In practice, however, as the motor speed is increased, the time that each winding is excited is decreased, the amount of current buildup through each winding is decreased, the maximum magnetic flux is decreased, and hence, the torque delivered to the load is decreased. If the controller is sending out pulses too fast, the motor will not be able to keep up and will stall. It was found that accelerating the motor up to a rate of about 1850 steps per second yielded a fast enough speed while consistently delivering enough torque to move the arm.



Easy-Read Indoor/Outdoor Thermometer

Designer: Timothy A. Bigelow
Supervisors: Mr. Antonine Rouphael and Mr. Larry Baczkowski
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North Dakota State University
Fargo, ND 58105

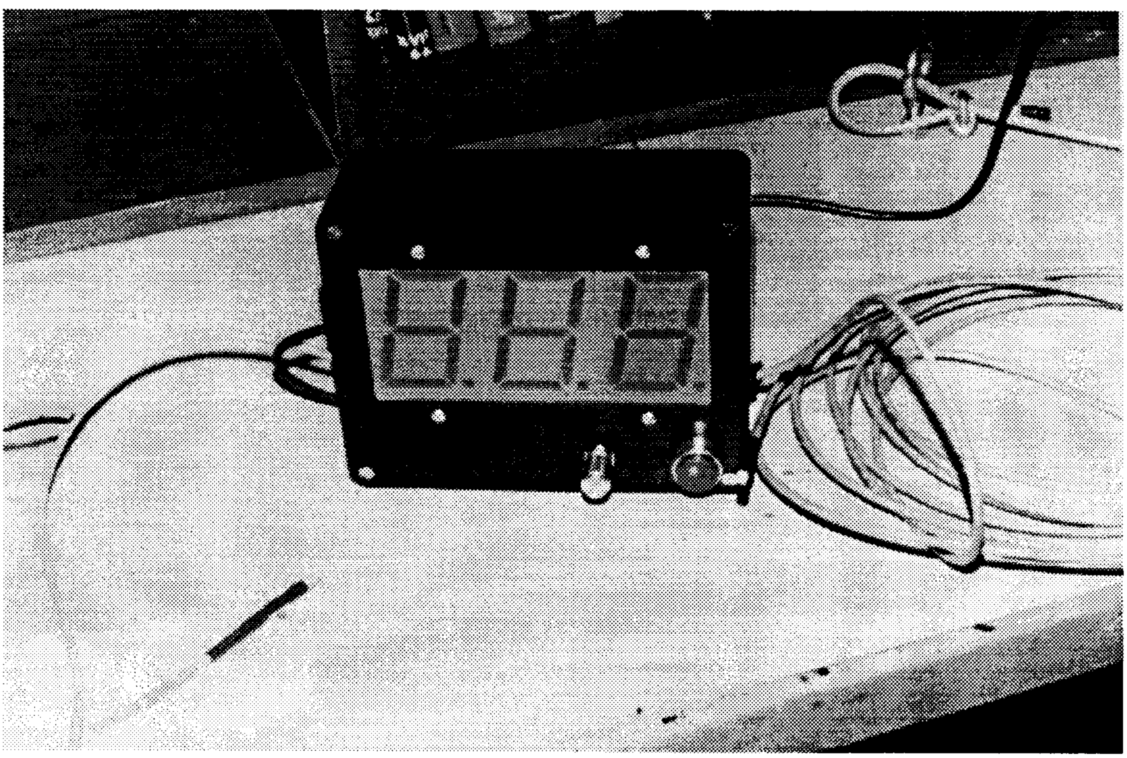
INTRODUCTION

The Easy-Read Indoor/Outdoor thermometer is an instrument that enables the visually impaired to accurately measure and read inside and outside temperatures. It overcomes the problem of hard-to-read thermometers (such as- conventional bar thermometers) by its large (2 inch) digital LCD display of both inside and outside temperatures. The display is extremely bright so that it can be clearly seen in a sunlit room, since brightness is a factor that will allow a visually handicapped person to read the temperature easier. Moreover, there is a brightness control dial that will allow the user to adjust the brightness depending on the room lighting.

The temperature is measured using external sensors that are at the end of a 4' and 15' cable. The outdoor probe is designed to be placed outdoors in a shaded area for accuracy year round.

SUMMARY OF IMPACT

"I use my digital thermometer every day. I am unable to read most bar thermometers. Now with a glance I know what the outside temperature is and I don't have to listen several minutes to the radio to find out. This helps me greatly as a Mother in knowing how to dress my children for school as to what kind of jacket they should wear, etc. Its easy to press a button and find out what the indoor temperature is too."



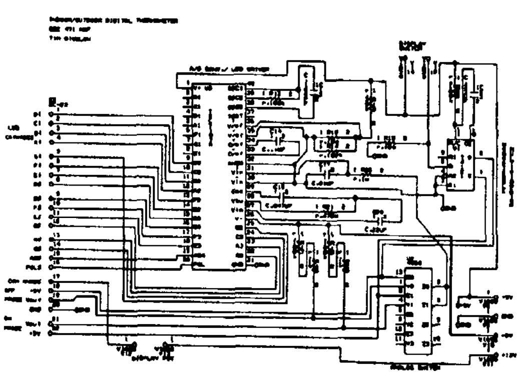
TECHNICAL DESCRIPTION

The design of the easy-read thermometer is best described if it is broken down into 5 distinct modules with each having their own function. These five modules are the temperature sensors, monostable multivibrator, analog switch, analog to digital (A/D) converter, and miscellaneous hardware.

The temperature sensor for this device is an integrated circuit type sensor. This selection was made because of the high accuracy and linearity of an I.C. sensor. The particular I.C. sensor chosen for this design is the National Semiconductor's LM34 - precision Fahrenheit temperature 'sensor. The LM34 is powered by +5 volts and its output is 10mv/F. The LM34 also has a 100 Kohm variable resistor connected between its output and -5 volts so that at 0 degrees the output will be 0 volts.

A monostable multivibrator is used to provide an 8 second pulse to display the inside temperature. The specific multivibrator used was the Texas Instruments SN54121.

An analog switch is used to gate the appropriate analog output of one of the sensors to the A/D converter. By using an analog switch the indoor/outdoor thermometer only has to use one A/D converter to convert signals from two sensors. The analog switch picked is the Texas Instruments TLC4066 silicon-gate CMOS quadruple bilateral analog switch. It is powered by +5 volts and is bidirectional. The TLC4066 becomes a two line analog multiplexer.



An analog to digital converter is needed to convert the analog voltage of the temperature sensors to a digital signal so they eventually can be displayed on 7-Segment LEDs. For this function a specialized I.C. chip is used that not only converts it to digital, but to BCD with an on chip segment driver. The I.C. is Teledyne Semiconductor's TSC7107A 3 1/2 digit A/D converter.

This chip directly drives 7-Segment LEDs, so the thermometer display can be directly wired to this chip. This chip is driven by a +5 and -5 voltage supply and has a fairly complicated outside circuitry for proper operation. This circuitry is shown on the right side of the chip in the schematic to the left.

Since four digits can be hooked up to this chip, the least significant digit lines are left unconnected to anything and only the three upper digits are used. The scale is then set so that 10mV equals an output of 10 that shows up as a 1 F on the thermometers display (since there is no LSD). This setting will allow both the display of temperatures over 100 and of below zero (negative).

The miscellaneous hardware for the Easy-Read thermometer is the output LEDs, power supply, and the display potentiometer and switch.
The 7-Segment output LEDs are two inch red LEDs from AND Corp. (AND4107SAL). These are common anode 7-Segment LEDs that are within the power limits of the A/D converter (it is also common anode).

Lastly, the display pot and switch are used to control the unit's display. The pot is used to control the voltage to the LEDs which in turn controls their brightness. The max voltage the displays receive from the pot is the full 12 volts. The switch is used to send 5 volts to trigger the monostable multivibrator. This in turn displays the indoor temperature for 8 seconds.

The Easy-Read Indoor/Outdoor thermometer cost $90 to assemble; the LED display was the most expensive component ($40).

A Head Movement Environmental Control

Designer: Chris Cain
Disabled Contact: Carol Anderson, Anne Carlson School
Supervising Professor: Dr. Daniel Krause
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INTRODUCTION

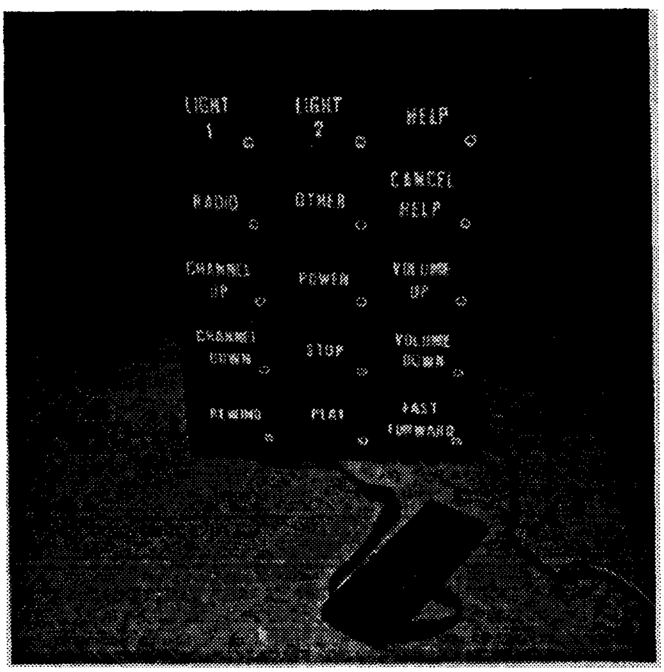
The head movement environmental control was designed to aid handicapped people that can not use switches or buttons. This device will help them have more control over their environment. By using a red light beam as a pointer, the user can point to a square on a control board to activate various functions. They can control lights, a TV, VCR, radio, fan, a help signal, and other electrical appliances.

The Environmental Control is made up of three basic types of units: power control, remote control interface, and the help signal. Each square on the control board contains one of these three types of units. The environmental control is made up of four power control units, nine remote control interface units, and two help signal units for a total of fifteen units or squares.

SUMMARY OF IMPACT

The equipment we received from NDSU is an environmental control unit that is accessed by a light that also accesses an Epson Real Voice communication system.

This unit can be helpful in training clients in the use of environmental control. This is especially helpful for clients that display severe motor impairment and may only have voluntary motor control of their head as the light is typically worn on the client's head. It also may help the client to develop some control over their environment that could lead to greater independence and feeling of self-worth.



TECHNICAL DESCRIPTION

The control unit is broken into four parts, the light detector, the power control unit, the remote control interface unit, and the help signal unit. Each is explained separately.

Light Detector

The light, used as the pointer, is modulated at 46 KHZ. A TIL-81 photodetector is used to detect this light. The signal from the photodetector is then applied to a **bandpass** filter with a center frequency of 46 KHZ. The filter will remove all other light interference that may be present, and the output will be a 46 KHZ sine wave, when the light is shining on it. The output of the filter will be fed into an envelope detector. This converts the sine wave into a constant DC voltage. That voltage is then compared to a constant reference voltage, Vr, and it if is greater then the comparator output goes low (active), otherwise it goes high (inactive). A feedback LED is used to notify the user that a function is activated.

Power Control Unit

To allow the power to be switched by a low power circuit, the 120 V power line must be isolated from the switching circuit. To accomplish this, an optocoupled isolator is used (MOX3011). When the current through the optocoupler LED reaches 15 milliamps, the phototransistor controlled triac will conduct. Since the current rating of the optocoupled triac is small (100 milliamps), this triac is used to trigger another triac with a higher current rating (4 Amps). This will totally isolate the 120 V power line from the 5 volt power supply.

When the user shines the light on a LED detector, a delay circuit is activated. Following the delay, a signal is then sent to the state toggling device (if the current state is high it will be toggled low and vice-versa). If the new state is high, then a signal is sent to a power switching device and the power is applied to that outlet and finally to the appliance connected to it. If the new state is low, the power is then removed from the outlet by the power switching device.

Remote Control Interface

A quad bilateral switch, CMOS 4016, was used to control the switching for the remote control. When the user activates one of the remote control detectors and the delay is processed, a digital signal will activate one of switches on the 4016. This will allow current to flow through the switch which then activates the remote switch. The remote will then send the appropriate infrared signal to the TV or VCR.

Help Signal Unit

The LED detector detects the light and the signal is delayed as in the previous two units. Next, the state of the help signal (stored in a D-Flip Flop) is either enabled or disabled depending on which help square was activated. If the help signal is activated, a signal light on the environmental control is turned on so the user knows the help signal has been activated. A signal is then sent to the alarm outside the user's room. If the signal were active and is canceled, then the signal light and external alarm is shut off. A manual override was provided so that a user entering the room can shut off the alarm if necessary. The environmental control unit cost $250.

Voiced Amplifier for the Conversational Use

Designer: Monte Dematteis
Disabled Contact: Vicki Riedinger, Human Communication Associates
Supervising Professor: Prof. Jenny Rawson
Electrical and Electronics Engineering Department
North Dakota State University
Fargo, ND 58105

INTRODUCTION

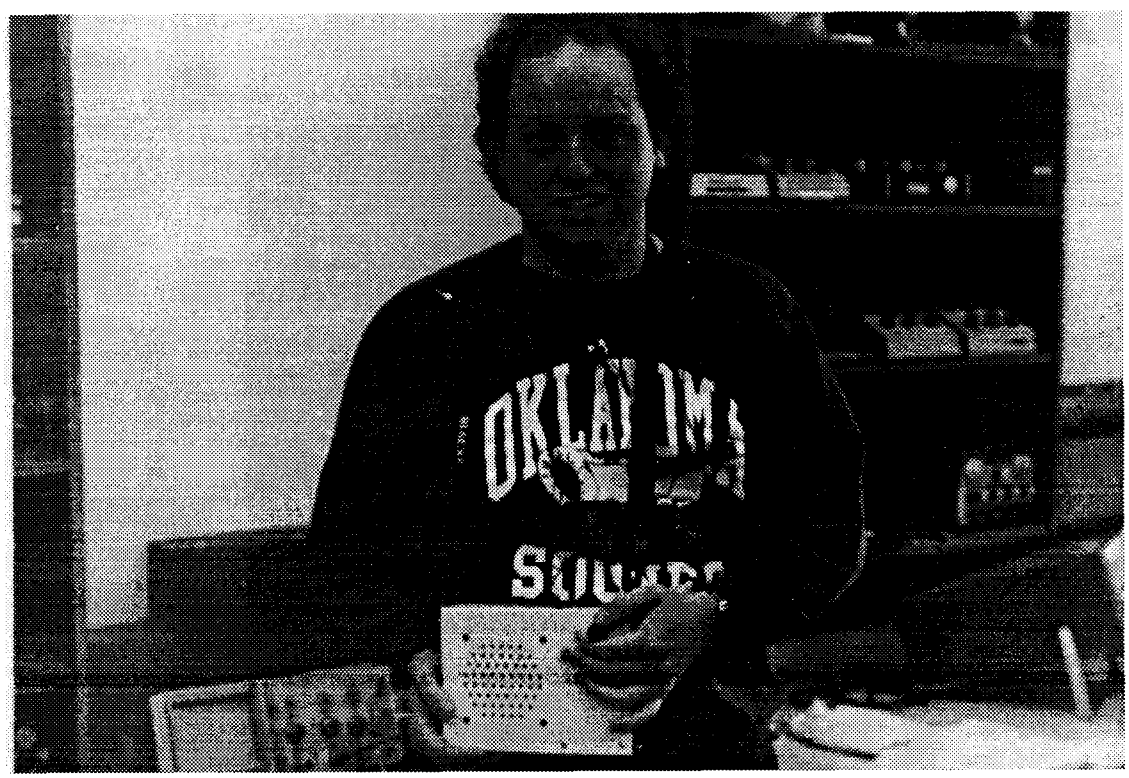
The voice amplifier was designed to amplify a voice that is barely audible from normal conversational distance to a volume that can be heard clearly. The man whom this voice amplifier is being designed for suffered a stroke. He has limited motion with his hands and is unable to speak very loudly.

The chief consideration in this design was to accommodate to the limitations of the patient. Since the patient cannot move his arms below the level of his chest, the switches had to be located up near the microphone for easy access. Since the voice amplifier is to be used in many different settings, it was also important to design the amplifier to be powered by batteries so that it is portable. The size of the amplifier also had to be small so it will be easy to carry around.

SUMMARY OF IMPACT

The voice amplifier has been used successfully by a stroke victim whose voice was affected. The voice amplifier allows him to carry on more normal conversations.

The only difficulty encountered with the device is that the lapel microphone does not do the best job of picking up his voice. This can be alleviated by providing a device to hold the microphone in front of his mouth.



TECHNICAL DESCRIPTION

The design is divided into two parts: the electrical design and the mechanical design, The electrical design involved designing a circuit that will receive a voice through a microphone, amplify the voice, and deliver the amplified voice through a speaker. The mechanical design involved packaging the circuit, microphone, and speaker in a way that allows easy use and transportation of the device.

The amplifying element used in the voice amplifier is the LM 386 linear audio amplifier. This amplifier is powered by four "AA" batteries to provide a source voltage of 6 volts. The gain of this amplifier was set to 200 (46 dB) to allow for a maximum sound intensity level of 75-80 dB from the speaker, the output device. The input device to the amplifier is a tie-clip microphone with an impedance of 800 Ohms. Since the microphone had an impedance of less than 10 Kohm, the bypass of the LM 386 had to be connected to ground across a 0.1uF capacitor to avoid distortion. The microphone is powered by a 1.5 V battery that was included with the microphone.

The output device from the amplifier is a wide-range speaker with a diameter of four inches. The impedance of the speaker is 8 Ohms. The LM 386 has an output impedance that matches either 4 Ohm or 8 Ohm speakers. A 0.05 uF capacitor and 10 Ohm resistor placed in parallel with the speaker were used as a low pass filter and a 220 uF capacitor placed in series with the speaker is used to eliminate the DC component of the output.

The level of the sound intensity is controlled by a 10 Kohm potentiometer connected between the microphone and the LM 386 amplifier.

Two switches are used to control the amplifier: one is used to control the power to the microphone and one is used to control the power to the LM 386 amplifier.

The amplifier circuit and speaker are contained in a case that has a size of 8.25" x 6.125" x 1 .9375". The speaker fits into the left side of the case and the circuit board, batteries, and volume control (potentiometer) fit into the right side of the case. The circuit board is suspended one inch from the speaker side of the case by one-inch spacers. The battery is placed between the side of the case and the circuit board underneath the potentiometer.

To make the device portable and easy to use for the patient, the following modifications were made: 1) a neck-strap was connected to the case so it can be carried around similar to a "Walk-Man", 2) the switches for both the microphone and the amplifier were placed at a level high on the chest to accommodate the limitations of the patient, and 3) a microphone was selected that can be clipped onto a shirt or pinned to a tie. The cost of the device was $60.

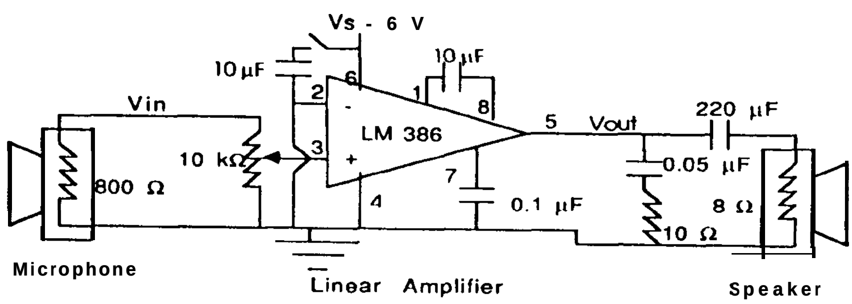


Figure 1 - Amplifier Circuit

Pin Description:

- **1.6 - Gain Control**
- **2 - Negative Input Connector (Ground)**
- **3 - Positive Input Connector (Vin)**
- **4 - Ground**
- **5 - output (Vout)**
- **6 - Source Voltage (Vs = 6 V)**
- **7 - Bypass (Used to match impedance)**

Electronic Programmable Word Recognition Flashcard

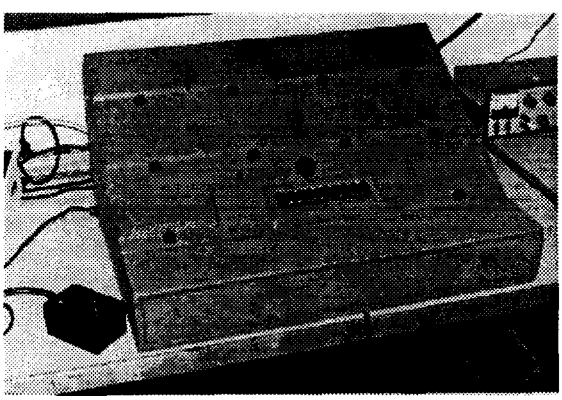
Designer: Doug Feist
Disabled Contact: Sherry Johnson, Fargo Public Schools
Supervising Professor: Dr. Daniel Krause
Electrical and Electronics Engineering Department
North Dakota State University
Fargo, ND 58105

INTRODUCTION

The Electronic Programmable Word Recognition Flashcard (EPWRF) is a device to develop the reading skills and vocabulary of mentally handicapped individuals with IQ's of 50 or less. The device features a word display and ten flashcard slots to represent different words in a vocabulary list. The object of the EPWRF is to correctly match the displayed word with a flashcard. Positive and negative feedback signals are implemented to inform the user of their correctness in choice. The EPWRF is a dynamic tool to improve the word recognition and overall learning capability of a mentally handicapped individual. The flexibility of operation and programming of the EPWRF allows for use by a variety of mentally handicapped individuals.

SUMMARY OF IMPACT

The programmable word recognition flashcard device was completed after Summer break for elementary school started. Therefore, the device has not been tested in the classroom as a learning tool. The trainable mentally handicapped children the flashcard device was designed for have a successful school year if they can add ten words to their vocabulary. The vocabulary training has to be very repetitious and can occupy many hours of the teacher's time. This programmable flashcard device will reduce the teacher's time and still give quality vocabulary training to the students.



TECHNICAL DESCRIPTION

There are two modes operation for the EPWRF: the program mode and the flashcard mode. Program mode allows input of a vocabulary list, up to ten words, from a keyboard. Flashcard mode enhances a handicapped individual word recognition by displaying a word momentarily from the input list and allowing the user to match the word to the word flashcard on the display panel. Operation of the two modes is described below. Run-time options of the EPWRF include: choice of word display times, buzzer enable/disable, type of user response, feedback, and mode of operation(Program or Flashcard). These options are controlled by external DIP switches located on the right side of the EPWRF.

Program Mode

As stated above, program mode allows input of vocabulary lists, up to ten words, from the keyboard. These ten words are stored in the microcontroller EEPROM for permanent storage. Each change of the vocabulary list will overwrite the previously stored list. Input of each character is echoed to the LCD display. A string of characters, a maximum of 20, forming a word is terminated by a carriage return. Any mistake in a string of characters can be resolved by hitting the ERASE key on the keyboard, although this will erase the complete string of displayed characters, and retype in the complete string. After the instructor has completed the vocabulary list entries, the QUIT key is pressed, allowing the vocabulary list to be written to EEPROM memory. To exit Program mode, change DIP switch #7 TO 'OFF' position. The RESET pushbutton is now pressed to change to FLASHCARD mode.

Flashcard Mode

Flashcard mode tests the handicapped person's word recognition by displaying a word from the stored vocabulary list and checking the word-to-flashcard selection by the user. Each selection is caused by a pressing of a button, located under each word flashcard. The correct selection is indicated momentarily by a green LED, prompting another word to be displayed on the LCD screen. An incorrect selection is indicated by a red LED and optional buzzer, but the same word is displayed allowing the user one more chance. The only way to exit Flashcard mode is to change the mode switch, DIP switch #7, on right side of the EPWRF to 'ON' position and press RESET pushbutton to enter Program mode.

Hardware and Software Implementation

The hardware for the EPWRF is microcontroller based and is implemented in HCMOS and CMOS digital logic. The software is M68HC11 assembly language and is interrupt driven. Brief explanations of hardware and software interfaces and implementation strategy are given in sections below.

Microcontroller

The main controller unit of the EPWRF is a Motorola M68HC11 microcontroller mounted on a Motorola Evaluation Board. The M68HC11 contains 512 bytes of EEPROM memory and can access 8K bytes of EPROM and 8K bytes of RAM mounted on the Motorola Evaluation Board. The M68HC11 consists of 8-bit Ports A, B, C, D,, and E. The ports are either output, input, or combination input/output.

Keyboard

The keyboard consists of a 6x8 grid of 48 keys. The encoding strategy is to detect a valid key strike caused by any two `x' and `y' lines of the grid being connected, caused by pressing a key. This causes an ASCII value to be read from a lookup table and displayed on the LCD display.

Feedback Signals

Feedback signals were incorporated in the design to give the user a response after a flashcard selection. The positive feedback signal consists of a green LED driven by a NPN transistor. The LED is activated by driving the transistor into saturation and allowing current to pass to the LED. A logic 1 output from a port will drive the transistor into saturation. The negative feedback is a red LED driven again by a NPN transistor. An optional buzzer can accompany the red LED and is driven the same way. The feedback signal is immediate after a user responds with a pushbutton selection or the display time delay is up. If the display time delay is up, a negative feedback is sent.

User Input Interface

The front panel of the EPWRF contains 10 word flashcard slots, with one pushbutton below each slot. Each pushbutton represents a flashcard selection for the user. A pushbutton press causes an interrupt to the microcontroller which reads Port E to determine which pushbutton has been pressed.

LCD Display Interface

All display output is sent to a single 20 alphanumeric LCD display. The LCD display is interfaced through Ports B & C. Control signals are output over Port B and actual word output, in ASCII code, is over Port C.

DIP Switch Options

The EPWRF offers many varieties of operation during flashcard mode. These include variable word display times, buzzer enable/disable, user response/feedback, and current operating mode (program or flashcard). These options can be set by setting the proper DIP switches to 'OFF' or 'ON' position. The parts cost of the EPWRF was about $250.

Car Horn Directional Finder

Designer: *Joseph F.* Moore *IV*
Disabled Contact: Peter Bower, Counseling and Personal Growth Center, NDSU
Supervisors: Dr. Daniel Krause and Mr. Larry Baczkowski
Electrical and Electronics Engineering Department
North Dakota State University
Fargo, ND 58105

INTRODUCTION

In the United States more than 21 million people suffer from hearing impairments and 80 percent of these people have been issued a drivers license. It is estimated that 5 million drivers are completely deaf in one or both ears [1]. The inability to hear surrounding noises can hamper the ability to drive. To give hearing impaired drivers a sense of driving noises, the need arises to electronically sense noises and display their directions.

The car horn directional finder is one alternate device to help hearing impaired drivers “see” traffic noises.

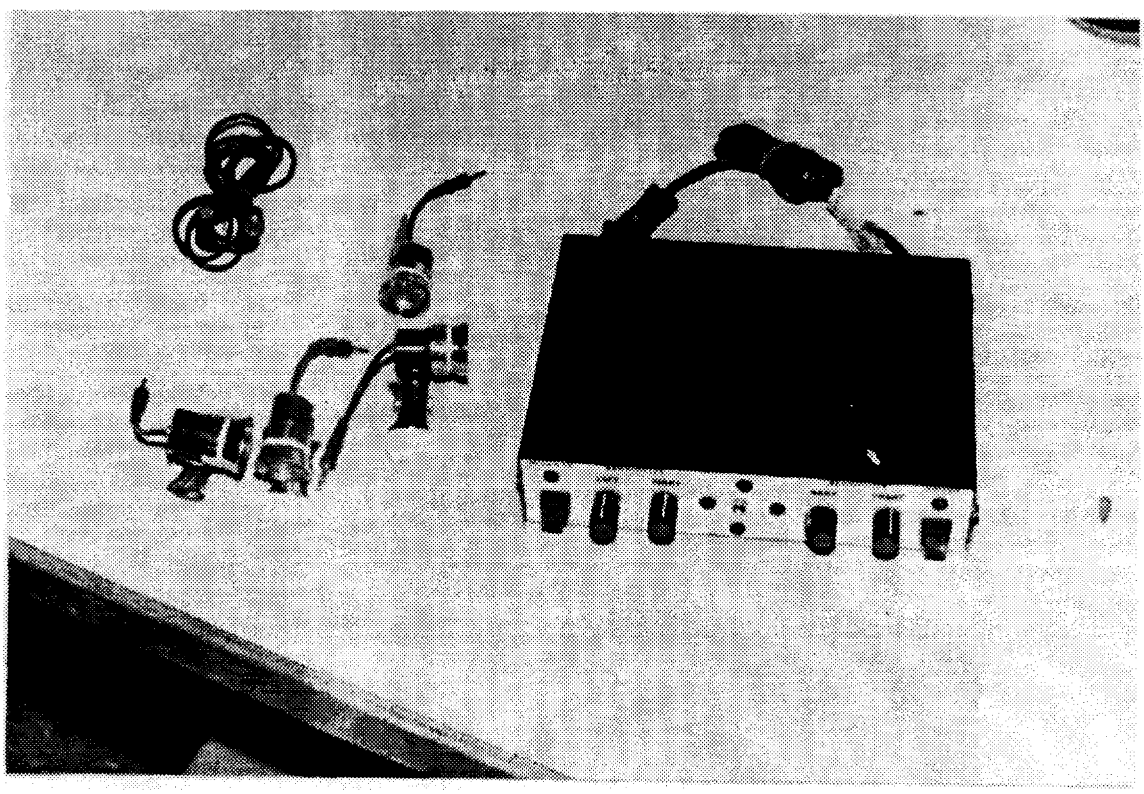
This device senses noises from around the vehicle to which it is attached and processes this information, distinguishing horns and sirens from background noises. Once the device senses a horn or siren it displays its direction with directional lights mounted on the dash of the vehicle.

SUMMARY OF IMPACT

The device is a wonderful instrument for the deaf people. Some things that need to be improved:

1. The box face should be darker. It is hard to see it in daylight.
2. The lights on the display should be larger to be easier to see.

Although the device has been installed and is currently in use, it has not yet detected any emergency sounds.

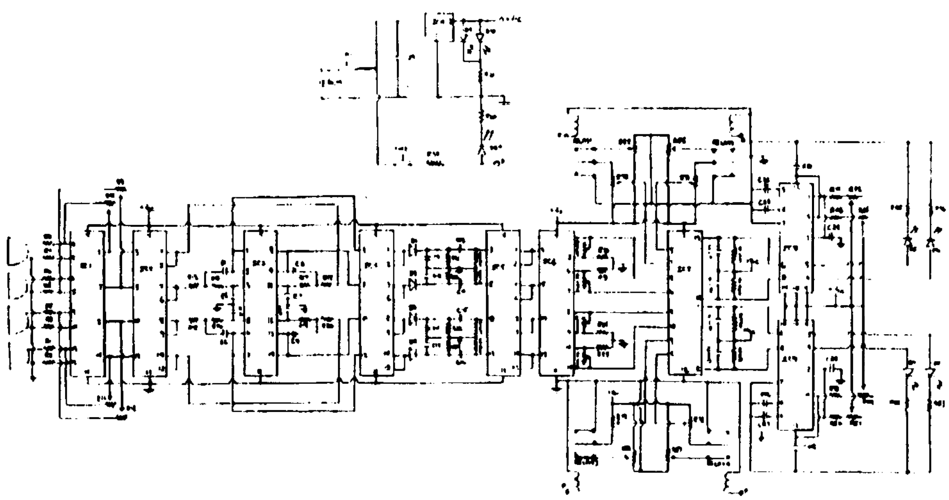


TECHNICAL DESCRIPTION

The device was designed to handle four separate channels of information, independent of one another, at any given time; the front, the back, and both sides of the car. Each channel consists of analog input preamplification, low pass filter, envelope detector, high pass filter differentiator, gain stage level comparator, and lighting delay. The audio input preamplification stage consists of microphones that are located around the car and a gain stage built from operational amplifiers. The microphones used have a frequency response from 100Hz to 8kHz, which when coupled with the low pass filter section set at 4kHz, gives a system bandwidth from 100Hz to 4kHz. The envelope detector is used to follow the envelope of the incoming audio signal and the high pass filter section picks out fast changes. From the high pass filter the gain stage amplifies the signal for interfacing with the level comparator. When the incoming signal is higher than the reference voltage, set by the user, the comparator changes states from high to low. This high to low transition then triggers timers set up as one shot timers that blink the directional LEDs on the face of the unit for 1.1 to 6.6 seconds. The power supply is based around the 7805 chip that supplies 5 volts to the boards.

The unit, besides having sensitivity controls, has a highway switch for when the unit is used outside the city. The highway switch decreases the sensitivity of the unit by a preset amount to counteract wind noise. With the type of circuitry used, the user can adjust up or down from the preset sensitivity on the highway without having to turn up or turn down all the sensitivities as the user enters or leaves freeway conditions.

Also, for nighttime use, a LED was placed in the middle of the directional LEDs to give a reference point when one of the directional LEDs blinks. The parts cost for the device was about $200.



Electronic Flashcard/Responder

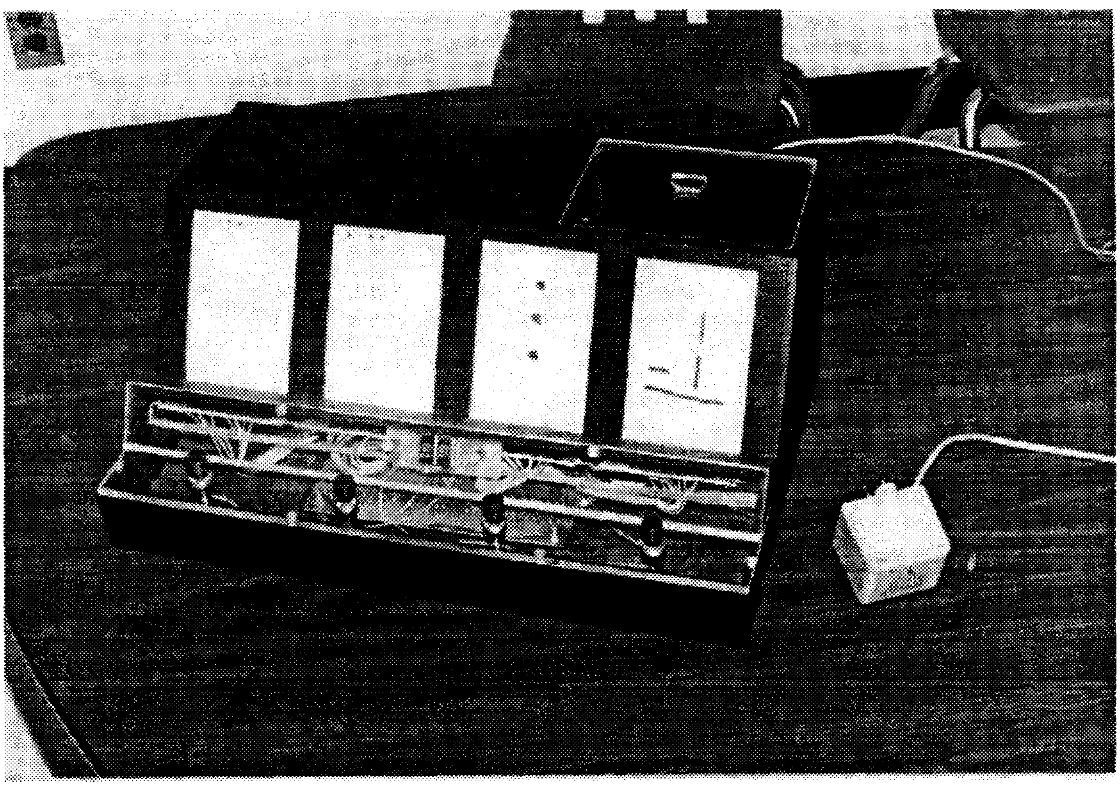
Designer: Jerry Neidlinger
Disabled Coordinator: Sherry Johnson, Fargo Public Schools
Supervising Professor: Dr. Daniel Krause
Electrical and Electronics Engineering Department
North Dakota State University
Fargo, ND 58105

INTRODUCTION

The electronic flashcard/responder is an educational tool that will help in the area of mathematics and numerical counting. The responder will consist of four slots, with 3x5 inch cards slipping in these slots. The responder will randomly pick one of these slots, display the numerical value of the card in the slot, with the numerical value being between 0 and 99. The participant will then have the task of choosing which card corresponds to the numerical display. This will be done by four buttons, one in front of each slot. A green LED will light if the correct choice was made, otherwise a red LED will continue to be lit.

SUMMARY OF IMPACT

The flashcard/responder was devised to assist a TMH (trainable mentally handicapped) student practice number skills independently with a binary system. The student can do addition, subtraction, etc. The teacher can individually program the cards with an endless array of number problems. Immediate reinforcement is made possible by visual red and green lights. It's extremely functional for a TMH student to learn to work independently rather than rely on adult one to one supervision.



TECHNICAL DESCRIPTION

The hardware involved in the design is standard TTL, therefore the design incorporated a five volt power supply. The power was supplied via a plug in transformer rated at sixteen volt-amps and 120/18 voltage ratio. The AC voltage was rectified by a full bridge rectifier and this voltage was the input to a 7805 voltage regulator. A large 1000uF capacitor was shunted across the ground and the output of the regulator, thereby acquiring a fairly level DC voltage of +5v. The current necessary for the responder was .42 amps, therefore a heat sink was needed for the regulator as a great deal of heat was produced.

The differentiation of the cards being used will be by holes punched in the bottom of them. The code used in the identification of the cards is the binary code. A zero will be a hole and a one will be a no hole. There will be up to eight possible positions for holes to be punched. With the left four most holes for the higher value digit, rightmost for the lower value digit. The cards will be placed between eight infrared LED's and eight phototransistors. Where there is a hole the infrared light will strike the phototransistor and will act like a base current. The collector of phototransistor is connected to +5v through 15 k resistors. The output is taken from this point. With no base current the output will be +5v but with a base current, the output will be effectively grounded.

The outputs of the phototransistors will be the inputs to four 74245 three-state octal bus transceivers. The panel selected will come about by the enabling of one of the transceivers.

The outputs of the transceivers are the inputs to two 7447 BCD to seven segment display drivers. The outputs of the 7447's are to the two seven segment LED displays with 220 ohm resistors between them to limit the current.

The enabling of the 74245's is accomplished through a 74155 two to four demultiplexer. The two inputs to the 74155 will decide which one of the outputs is enabled. The four outputs are to the enabling lines of the 74245's, with a zero voltage level being the enabling logic level.

The two inputs of the 74155 are the outputs of a 7475 quad-latch. The latch's input comes from a 74107 J-K master/slave flip flop set up as a two bit counter. The clock input to the 74107 comes from a 555 timer. The 74107 continuously counts from 00 to 11 and resets back to 00.

The selection of a panel is by four momentary contact switches that form a contact between ground and the input to half a 74221 dual monostable multivibrator. The oneshot is set up to be on for seven seconds, enough time for the participant to recognize the correctness of his decision. The outputs of the monostables are the inputs to a 7408 quad two input AND corresponding panel for the switch, these were inverted by a 7404 hex inverter as the enabling value is low. The outputs of the 7408 are ORed together by a 7432 quad two input OR gate. The output of the 7432 is inverted thereby allowing either the red or green LED to be on according to the correctness of choice.

If the correct button is pushed, the output will be a logical one level on the OR gate and this will enable the 7475. With the 74107 continuously clocking, the enabling of the 7475 would change the conditions for the correctness of the decision. Therefore the 7475 is set up with the outputs of half the latch being the inputs to the other half of the latch. The side of the latch that is connected to the 74107 is enabled first, then the other side is enabled when the monostable returns to the quiescent level. This allows the correct conditions to remain for the on time of the monostable.

The display case was made out of Plexiglass with dimension of 17 x 11.375 x 7 inches. There is a 4 x 6 x 4.4375 inch container for the cards contained in the display case.

The total cost for the project was about $120, which included the part mentioned, the pc board they were mounted on and the case that was used.

Inside-Outside Intercom

Designer: *Mark Schroeder*
Supervising Professor: Dr. Daniel Krause
Electrical and Electronics Engineering Department
North Dakota State University
Fargo, ND 58105

INTRODUCTION

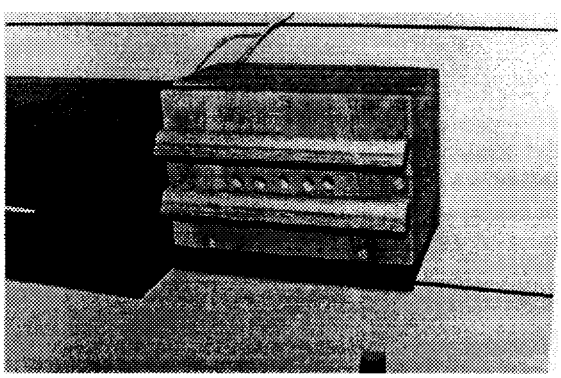
The disabled person whom this design is intended for has very limited vision. She is unable to see through one of her eyes and the other has severe tunnel vision. This situation makes it very difficult for her to identify a stranger who comes to her door due to her lack of vision through a window or peek-hole.

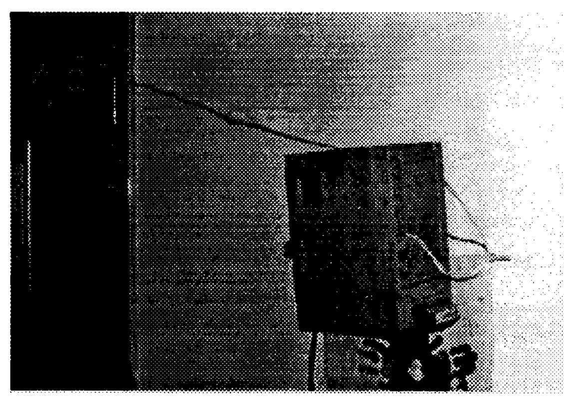
To aid her in identifying someone at her door some sort of communication device was needed. The goal of this design is to make an intercom that will help in identifying people at the user's door. Besides having a high quality of voice reproduction the intercom also will be easily controlled by a blind person. This will be done by having few and large user controllable devices.

Operation of the Inside-Outside Intercom is controlled only by the inside user. There is one switch for the power and one push button used for direction of transmission.

SUMMARY OF IMPACT

"I can now identify people who come to my door without having to open the door. I feel safer in my own home. Other people can simply look out the window or use a peephole, but I can't see well enough to use those means of identifying callers. The intercom is just what I needed."





TECHNICAL DESCRIPTION

The inside-outside intercom consists of four basic parts: the AC power supply, the battery back-up, the basic intercom circuitry and the LED. Together these make up the bulk of the design. The schematic should be reviewed with the descriptions.

The power supply consists of a transformer, a bridge rectifier, a filtering capacitor and a voltage regulator. Transform, T1, steps down the normal 115 VAC household voltage to 18 volts rms. D1 is a four diode full wave bridge rectifier available as a single discrete component. A 47 uF capacitor is used to filter the rectified wave and give a smoother voltage level. To regulate the power supply and give a constant voltage of 12 Volts the LM 340 T-12 voltage regulator was used. The LM 340 T-12 requires a nominal +19V input with a minimum of 14.6 V. to maintain +12V line voltage. A capacitor of .1 uF is recommended at the output of the voltage regulator for stability and to help the transient response. D1 and IC2 are grounded together first and then to the ground of the 47uF capacitor to eliminate hum in the output speaker.

The battery back-up part of the circuit is simply a diode and a 9 V battery. The diode conducts if there is no AC power and therefore the battery is used. Otherwise, the AC power is used since it is supplying 12 volts that is greater than the 9 volts.

The core of the intercom is the LM 386 Audio Power Amplifier. It has a supply voltage range of 4 - 12 volts and the gain is internally set at approximately 20 (36dB.). However, with a 10 uF capacitor and a resistor connected from pins 1 to 8 a gain from 20 to 200 can be obtained. This circuit uses just the capacitor therefore giving a gain of 200. The volume of the intercom will be set by using a 15 Kohm resistor from the non-inverted input to ground.

A 10uF polarized capacitor is placed in series with the speaker to block the DC output of the amplifier and to provide low impedance to voice frequencies. R3 is used to lower the voltage to drive the microphones between 2 to 10 Volts. The two speakers (8 ohms) and two microphones (1 Kohm) are connected as shown through a DPDT switch. The switch will be held down to close the appropriate switches needed so that the person inside can speak and the person outside can listen. Upon letting go of the button the person inside listens and the person outside can speak.

To tell if the intercom's power was left on a LED was added to the design. This LED must be very bright in order for a vision impaired person to see it from a fair distance away.

The cost for the components was $40. All of the intercom was fabricated by the designer.

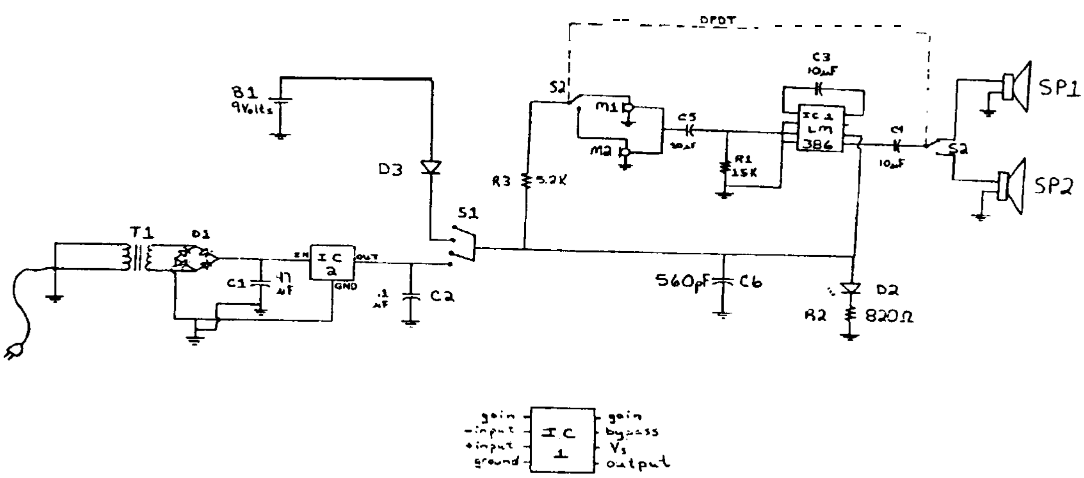


Fig. 1. Circuit *diagram.*

Foot Operated TV Remote For The Disabled

Designer: Vince Segal
Disabled Contact: Bruce Kolding
Supervisor: Mr. Larry Baczkowski
Electrical and Electronics Engineering Department
North Dakota State University
Fargo, ND 58102

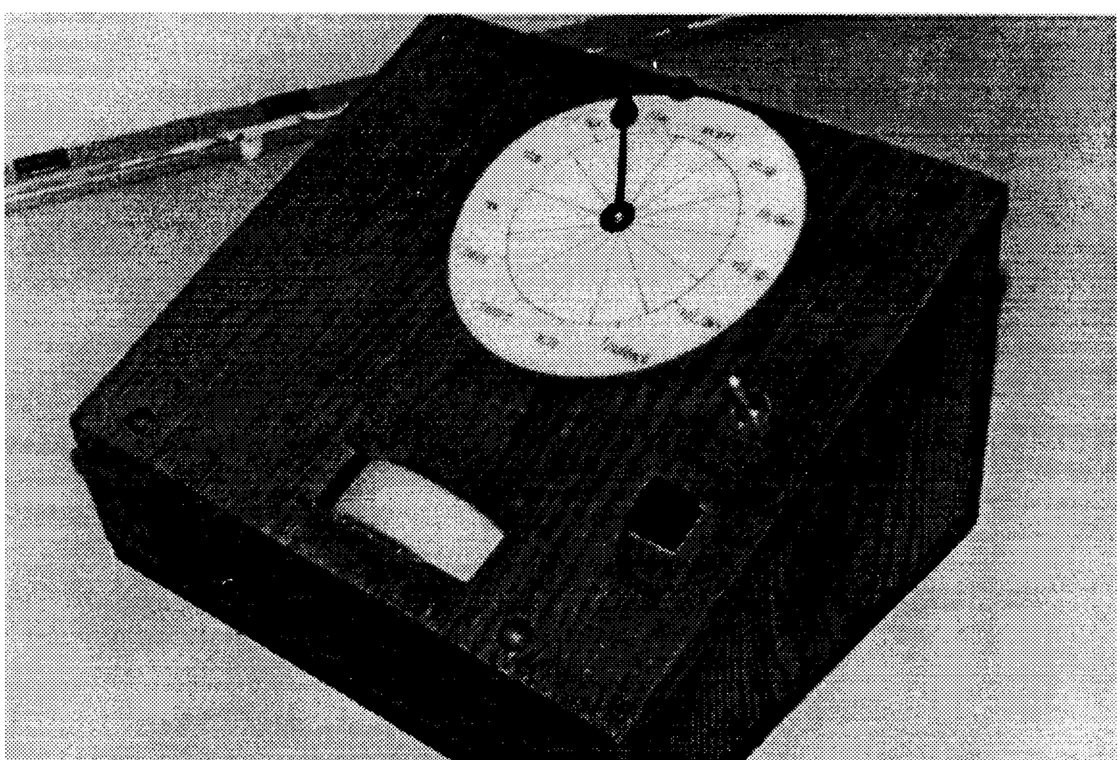
INTRODUCTION

The foot operated TV remote is simply an adaptation of a hand operated Zenith Allegro to foot controls. The purpose of the foot remote is to allow an individual with cerebral palsy to independently operate his TV and VCR. The recipient of the foot remote, is confined to a wheelchair and has no use of his arms or hands. Although not strong enough for standing or walking, his lower legs and feet have a fairly large range of motion and made the decision to implement foot controls the most reasonable. The final product rests on the floor and is housed in a 11.5 x 9" oak enclosure with a control surface that slopes from 6.5 to 3.5 inches front to back. On the control surface is a large momentary push button, a three position toggle switch, a clock-like display with thirteen TV/VCR options, and a nylon roller that, when rotated, positions an arrow around the display.

SUMMARY OF IMPACT

The remote control device works well. The recipient now can operate his TV and VCR by himself.

When TVs or VCRs are changed he still can use the foot operated remote. This is because the Zenith Allegro used in the design of the foot remote is programmable to virtually any brand name TVs and VCRs, so the foot remote should accommodate his needs for years to come.



TECHNICAL DESCRIPTION

The foot operated TV/VCR remote is an adaptation of a hand operated Zenith Allegro to foot controls. This modification is accomplished using slotted optical switches and a bevel gear drive assembly to interface the Allegro's controls.

Thirteen slotted optical switches are used and are mounted in a four inch circular pattern on the underside of the control surface. These optical switches are composed of a LED side and a phototransistor side. Each phototransistor has two leads, collector and emitter, which are soldered to the contacts of a single function on the Zenith Allegro. The Allegro itself is mounted on a hinge with its emitter end protruding a nominal distance through the front of the oak enclosure. Each LED is tied between the momentary "ENABLE" push button and ground. The complete circuit is shown in Fig. 1 and is the identical circuit used for each optical switch.

The function of the bevel gear drive assembly is to rotate an opaque disk between the slots of all the optical switches and in essence block the LED's from the phototransistors. One single hole will be removed from this opaque disk that will allow for the selection of one function at a time on the Zenith Allegro. The display arrow and the removed section of the opaque disk are aligned and rotate together. Therefore when the arrow is pointed at the desired TV/VCR function the removed section of the opaque disk will line up with the single optical switch that controls that function on the Zenith. Pressing the momentary push button now will power all thirteen LED's and they will emit infrared signals in the direction of their paired phototransistor. Only the single phototransistor not being blocked by the opaque disk will be affected. The base of this phototransistor is now opened and the phototransistor acts just like a short across the contacts in the Zenith Allegro.

The Zenith Allegro uses CMOS logic so very little current is needed during operation. This caused a little problem initially because the leakage current that would run through an unbiased phototransistor was sufficient to activate the Allegro. By inserting an 82 Kohm resistor in series with the collector this leakage current was attenuated enough to allow proper operation.

A twelve key keypad was used in the design of the foot remote to provide the necessary programming of the Zenith Allegro. Ten of the twelve keys on the pad are labelled O-9 while the other two are blank. The numbered keys are hooked in parallel to the identically numbered keys found on the Zenith Allegro while both the two blank keys are wired in parallel with the "enter" key found on the Allegro. Reprogramming of the Zenith Allegro is necessary any time a change in batteries is needed or if a different TV, VCR, or cable box is implemented. The parts cost was $105.

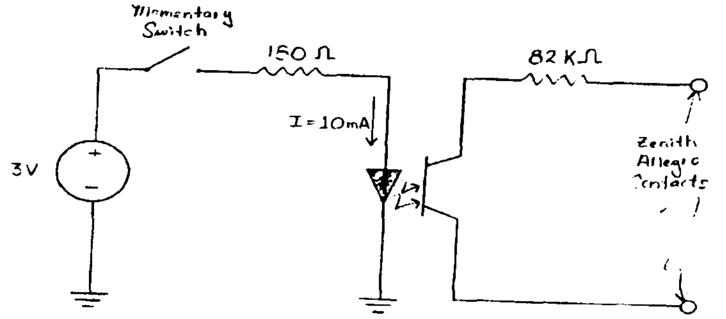


fig. 7. Optical Switch Circuit

Remote Controlled Emergency 911 Telephone Dialer

Designer: Ken Strand
Disabled Coordinator: Adelene Knutson
Supervising Professor: Dr. Daniel Krause
Electrical and Electronics Engineering Department
North Dakota State University
Fargo, ND 58105

INTRODUCTION

The remote controlled emergency "911" phone dialer is a device that will enable elderly/handicapped persons to live life easier knowing that if they should need emergency help it is only as far away as the switch on their wrist.

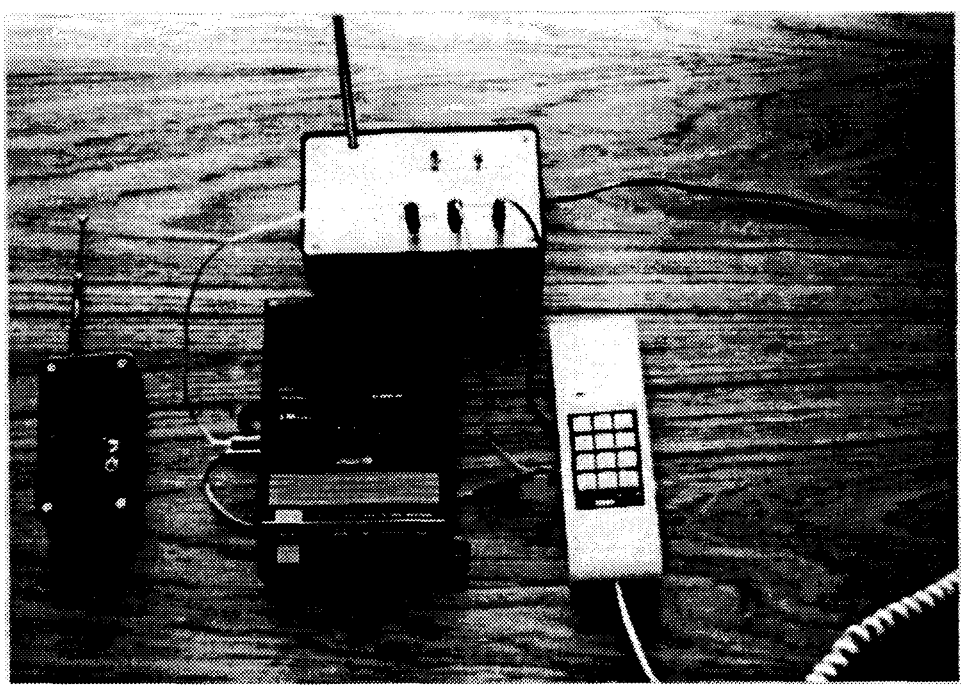
A simplified explanation of how the emergency telephone dialer works is as follows. The transmitting unit (similar to a garage door opener remote) will be with the user at all times. If some sort of an emergency (police, fire, or medical) the person will simply push the button on the unit thereby activating the remainder of the system. The rest is completely automatic. The phone will be taken off the hook, the emergency "911" number will be dialed, and finally a tape recorder will begin playing a pre-recorded message asking the authorities to send help to that address.

SUMMARY OF IMPACT

The remote controlled emergency "911" phone dialer was put to use in the home of the designer's 80 year old grandmother. Fortunately, the phone dialer has not been put to test in a true emergency but the device has gone through several practice emergencies to check the range and proper operation of the unit. Recently the grandmother, who incidentally lives alone, tripped and fell off her outdoor steps. Luckily, she was not injured badly enough to require emergency medical assistance but now she realizes how important the phone dialer can be to her in any emergency.

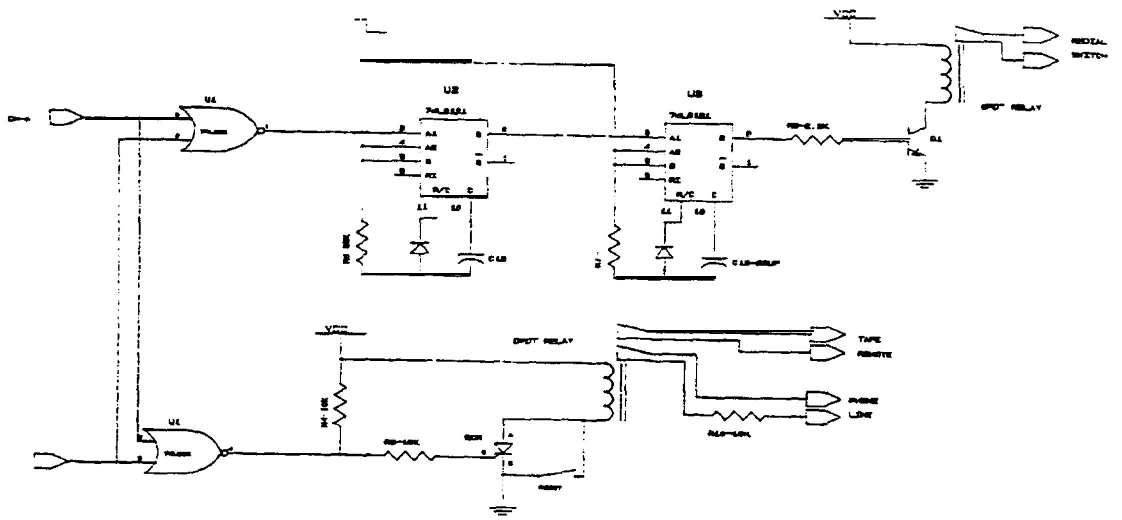
TECHNICAL DESCRIPTION

The remote controlled emergency "911" phone dialer is broken down into three parts, the transmitter unit, the receiver, and the switching circuitry.



The transmitting or remote unit is housed in a small plastic box about the size of a pack of cigarettes. This box will be carried by the user. The transmitter operates on a 9 volt battery. The circuit is based on the LM 1871 integrated circuit. The first section of the circuit is that of an encoder. To avoid an accidental "911" call being placed the receiver must receive a coded signal, which the transmitter sends. This signal consists of six channels (or pulses) in a fixed time frame. The actual transmitting section uses a 49.89Mhz 3rd overtone parallel mode crystal. To activate the transmitter the user must flip two small switches. The reason for two switches is to prevent an accidental activation of the dialing system. The transmitter remote does not use any power while in the standby mode and has the range of a small house or apartment.

The receiver unit and switching circuitry are housed in another plastic box and are non-portable. There is a reset switch on the box. All the circuitry in the base unit runs off a regulated 5 volt power supply. When activated, the transmitted signal is received through a small antenna on the base. The receiver is based around the LM1872 integrated circuit that is a companion to the transmitting chip. The received signal is detected leaving the encoded six channel signal to be sent to the decoding section of the chip. The decoder sends two digital outputs to the switching circuit, which is shown in the figure.
Two channels A and B from the receiver are sent to a NOR gate. The output of this gate goes to a SCR and to a monostable multivibrator. The SCR, which stays latched until a reset is done, activates a DPDT relay. One pole on the relay completes the circuit that goes to the telephone switch. Once closed (the telephone line connection will be made) and a dial tone is present. The second pole on the relay closes the circuit on the remote function of a tape recorder, this starts the tape recorder playing. The tape player would already be in the play mode with a pre-recorded message such as "A handicapped woman needs emergency assistance at 3448 Johnson St. in Fargo. Please send help immediately." This message would be repeated several times to be sure that it was heard. A safety feature is that if the tape player did not function properly, the address of where the phone call was made would still be received at the "911" center.
The purpose of the monostable multivibrator is to cause a small delay after the dial tone is present and then to make a connection to the redial switch on the phone. This is accomplished using two monostables. The first one causes a 0.5 second delay and then triggers a second monostable that gives a 0.1 second pulse to a SPDT relay. This relay connects the redial switch for a brief second. The phone must be previously loaded with the "911" number. To reset the circuit an externally located normally closed switch is pressed. This switch will break both the tape recorder remote circuit and the dial tone circuit. The cost of the parts for the emergency system was about $95.



Telephone Dialing Aid

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INTRODUCTION

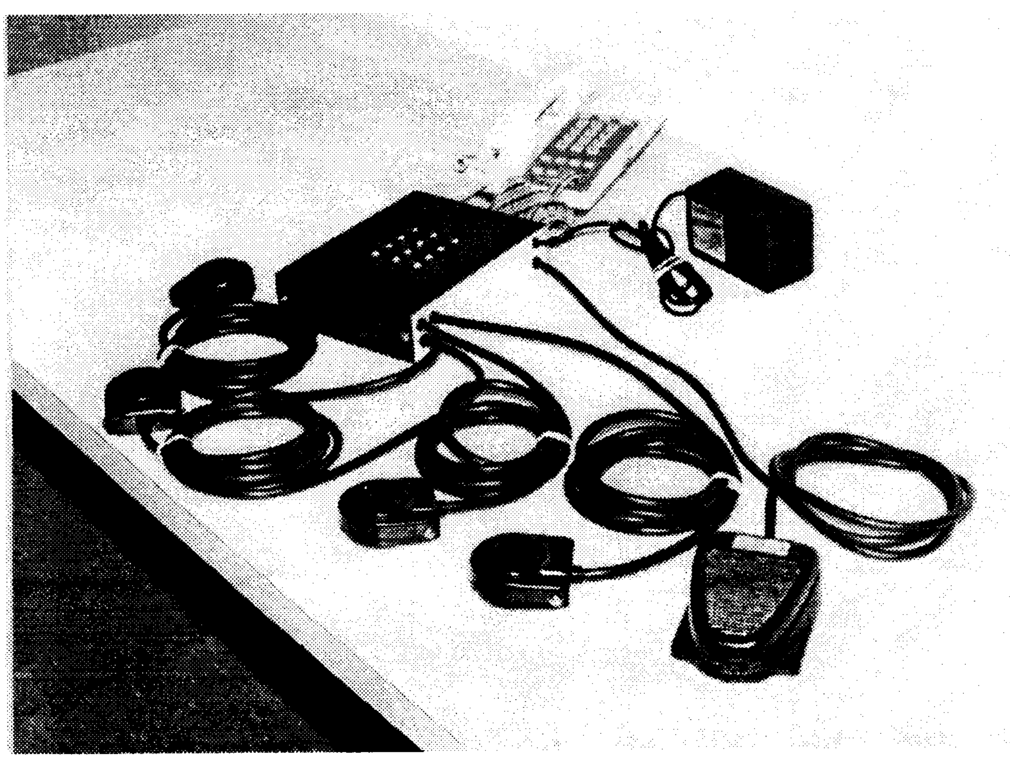
The telephone dialing aid was designed to aid a handicapped person in placing and receiving telephone calls by assisting them in the dialing and answering process. The handicapped person for whom the telephone dialing aid was designed has lost a substantial amount of motor skills in his arms, hands, and fingers. He is unable to lift the telephone receiver off the cradle, hold the receiver up to his head, or manually dial the telephone number. In order for the design to be an effective tool, it was necessary to allow its operation to be controlled by his feet, thus, eliminating the need to rely on his hands to do the work. Four foot pedals were employed for the user to control the device. It was also necessary to integrate the device with a telephone that has speakerphone capabilities. These considerations allow the user the maximum amount of freedom when operating the device.

SUMMARY OF IMPACT

The telephone dialer is useful but should be a little faster. The dialer does allow the foot to be used to dial the telephone. The buttons could be smaller so the foot could be moved on a pad instead of to each button, such as up-down, dial or reset.

TECHNICAL DESCRIPTION

The operation of the Telephone Dialing Aid begins with the use of the control pedals to select a number to be dialed. The user has four control pedals. The DOWN pedal is used to control the vertical movement of the row selection and the RIGHT pedal is used to control the horizontal movement of the column selection. A RESET pedal is also available for the user to reset the selector network so that the first row and first column are selected. A standard touch tone keypad configuration is used for ease of the design and the familiarity of the



keypad to the user. When a control pedal is pressed and released, a clock pulse is created. This clock pulse is necessary to allow the output values of the J-K flip-flop control networks to be altered.

When operating this device, it is necessary to have a visual display that allows the user to determine the present state of the dialing device. This is accomplished by constructing a display of LEDs that are placed in a similar configuration as the keys on the keypad. The LEDs are controlled by the outputs of the J-K control networks. The three LEDs in each row are connected to the row outputs of the J-K control network. Similarly, the four LEDs in each column are connected to the column outputs of the J-K control network. When a row and column value is being selected by the control networks, the corresponding LED will turn on. Since only one row and column value will be selected, only one LED will be on at any given time.

The outputs of the J-K flip-flop control networks are necessary not only to control the LED display but also to generate the proper tone from the dual tone multi-frequency generator chip. The tone generator chip used is the CMOS chip found in the Radio Shack speakerphone with which this design is integrated. The chip generates a tone for a key when the row and column pins for that key are short circuited. Therefore, it was necessary to simulate a short circuit by using a bilateral switch.

The need to operate the device using the speakerphone is evident when considering the type of handicap for which this device was designed. A speakerphone enable switch was inserted in order for the user to operate the telephone. The existing switch was a four pole-double throw switch, meaning that it switches 4 circuits from the normal operating mode to the speakerphone mode. Thus, a four pole-double throw relay and a pedal that has push-on push-off characteristics was used to switch the telephone to the speakerphone mode. A 12 volt regulated power supply was used to power the relay. The Telephone Dialing Aid cost approximately $230 to build.