CHAPTER 2

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Force Sensing Resistor Switch

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INTRODUCTION

Singles switches are often used by handicapped children to operate communication and educational aids, computers, environmental controls and mobility aids. Severe motor impaired students often have difficulty controling the amount of force that is applied to such a switch. The results is a "wearing down" of the sensitivity of the switch. Other students, however, may not elicit an adequate amount of pressure to activate the switch. This points out the need for a pressure sensing switch which can be adjusted to control the threshold force necessary to activate the switch. In this study we have used a commercially available force sensing resistor (FSR) to build such a switch.

SUMMARY OF IMPACT,

Figure 1 shows the first force sensing rsistor switch that was built with a small (15 mm diameter) FSR element. This has been used by a few normal volunteers and will soon be used by several motor impaired students at the Caddo School for Exceptional Children.

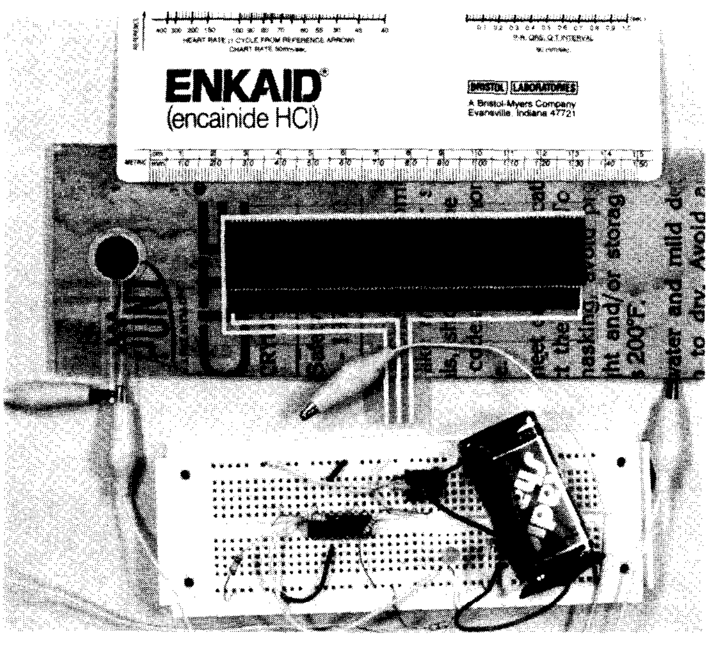

Figure 1: The Force Sensing Resistor Switch.

TECHNICAL DESCRIPTION

The Force Sensing Resistor™ (FSR) is a polymer film device that exhibits a decreasing resistance with increasing force which has been developed for several applications, one being human touch control. Due to the FSR's various characteristics as well as its small thickness (<0.5 mm), these devices made by Intertink Electronics are available in a variety of shapes and sizes. Figure 2 shows the circuit that allows the FSR to be used as a simple force adjustable switch. The comparator circuit allows for the sensitivity of the switch to be adjusted to accommodate the specific needs of the child. This adjustment is done by adjusting the 20 K ohm potentiometer. As force is applied to the surface of the FSR the voltage at pin 9 of the comparator decreases and when the voltage at pin 9 reaches a value equal to or less than the voltage at pin 8, the relay is activated turning the device on. Additional devices (such as a timer device) can be connected or additional circuitry can be included in the device to facilitate added capabilities. The device including the FSR device costs approximately $15.00 per switch; however, the cost will depend on the size and shape of the particular FSR device sed as the active element.

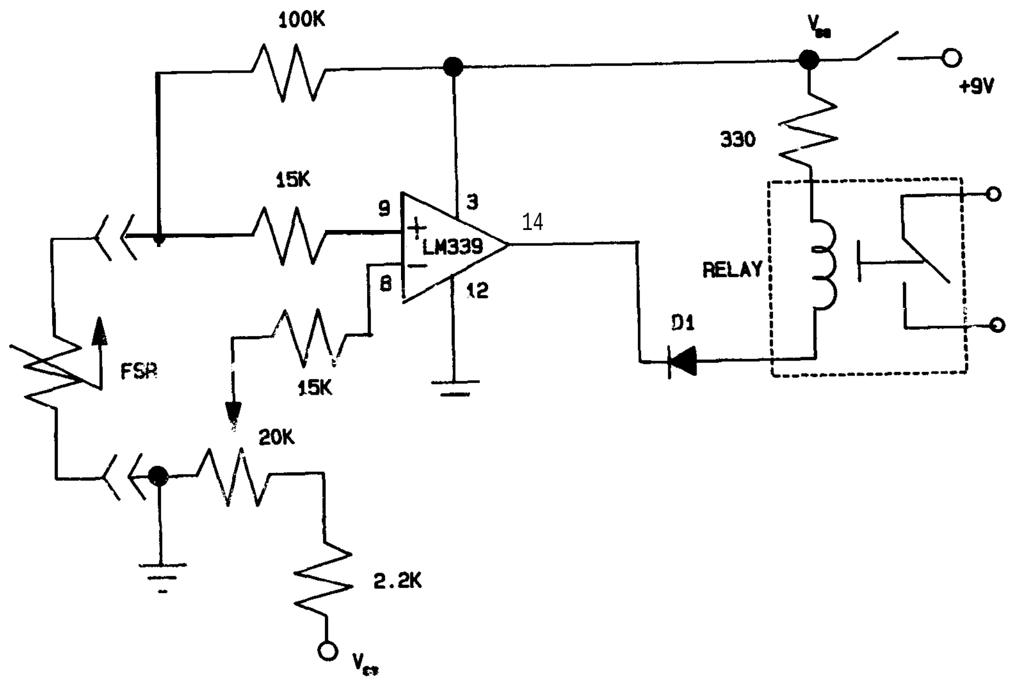

Figure 2. Scematic design of circuit for the FSR switch. The FSR device at left is connected to the circuit and the relay output is connected to the toy or reinforcement.

ACKNOWLEDGEMENT

This work was partially supported by U.S. National Science Foundation Grant EET-8807522.

Visual Scanning Training Device

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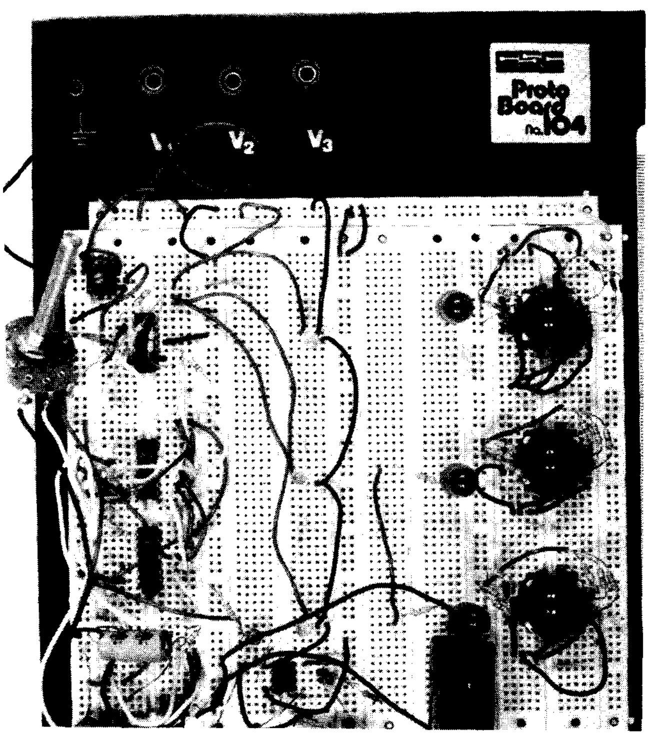
INTRODUCTION

Many electronic assistive devices for handicapped children use LEDs in the scanning mode for feedback action to the children. However, visually impaired students often find it difficult to recognize the LEDs, particulary those of low intensity, depending upon their degree of visual impairment (either perceptive or acquity), appropriate sized LEDs need to be selected for any visual feedback to succeed. In this project, we have attempted to design a visual scanning training device with four sets of different sized LEDs, so that a student using this device can identify a LED of appropriate brightness which he/she can see without any difficulty.

SUMMARY OF IMPACT

This device as not been field tested yet, as the design was modified several times to improve its function and reliability.

Figure 1: The visual scanning training device. The different sized LEDs *are* shown *at* the right.



TECHNICAL DESCRIPTION

Figure 2 shows the circuit used for the device. The three D-type flip-flops (SN7474) are configured in a ring-counter arrangement to sequentially cycle the LED display one LED at a time. The cycle is controlled by the clock which is a 555 timer circuit and be changed by adjusting the clock rate. The ring counter produces a logic high on each output channel sequentially which in turn activates one of the LED display elements. The LM324 is a quad-op-amp used to drive the LED display and the 330 ohm resistors are current limiters. The LED display elements can be extra-bright or jumbo size LED's which are available or they can be any of several special types of LED's available commercially. The 500K ohm variable resistor is used to set the reference voltage for the LM324 since the low and high states of the ring-counter outputs are not 0 and 5V, respectively. Although not yet complete, the physical device will be enclosed in a package with a plug-in slot for an LED display plug in module. This allows interchangeable LED displays to be used with the same controlling electronics thereby allowing newer displays to be utilized without rebuidling the circuit also reducing total cost. A connector would permit the display to be ocnnected to the circuit. The total price of one complete unit would be approximately $30.00 to $40.00 with each additional display module costing about $10.00 on up depending on the LED display element and the physical module design needed.

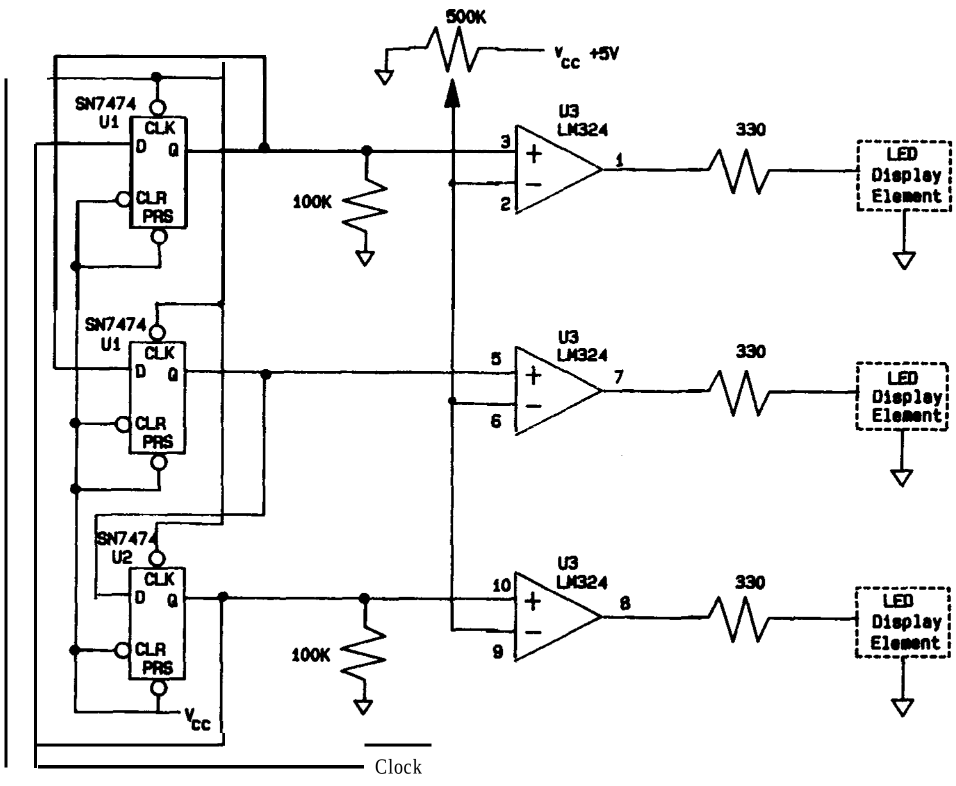


Figure 2: Schematic diagram of visual scanning training device. The LED display elements shown at right are connectors allowing for various different types of special LED's to be utilized.

ACKNOWLEDGEMENT

This work was partially supported by U.S. National Science Foundation Grant SET-8807522.

Upper Extremity Training Device

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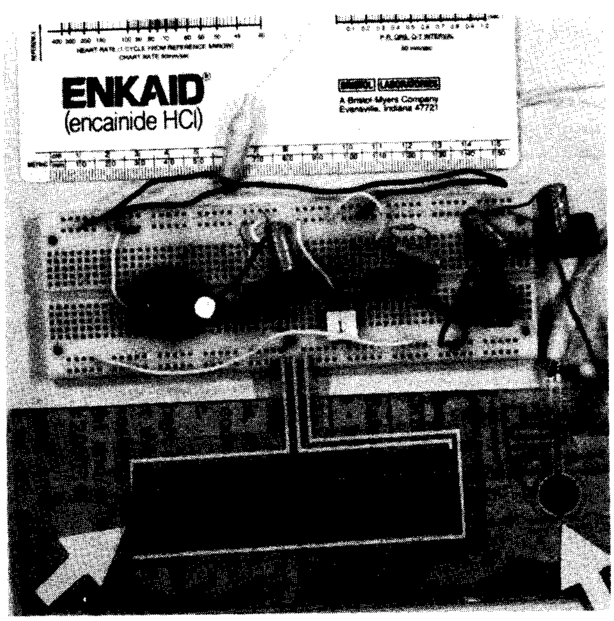
INTRODUCTION

Children with some cogenital deformities (e.g., spina bifida) often have difficulty in the use of their forearm and hand in bearing weight in their attempt to use walkers. Such children need training to improve their capacity to support their body weight by the use of their hand. In this project, we designed a device which provided an auditory feedback to the student as they applied more vertical force with their hand thus reinforcing their capacity to support themselves in the use of a walker.

SUMMARY OF IMPACT

As the device has only been built as a bread-board stage, it has not been field tested yet. However, discussion with the physical therapist indicates that it will be highly beneficial for handicapped children in the training of upper extremity assistive devices. Such training will allow these children to be mobile with the help of walkers and thus be more indepedent.



TECHNICAL DESCRIPTION

The Force Sensing Resistor (FSR™) made by Interlink Electronics, Inc. is a polymer film device that exhibits a decrease in resistance with increasing force. Figure 2 shows the electrical circuit for the device. The 74C14 is a Schmitt trigger inverter that functions as an oscillator. AS the resistance of the FSR changes (force is applied), the frequency of the output of the inverter increases proportional to the force aplied. The frequency range is determined by R and C. For the the circuit shown the frequency range is 150 Hz to approximately 5.5 Hz. The output of the variable oscillator stage is fed to an audio amplifier (LM 386) which drives an audio transducer that can be mounted on a PC board (Radio Shack cat. no. 273-090). Either a 9V transistor battery or a 9V AC adapter via an input jack can be used to supply power to the circuit. The 7805 voltage regulator provides 5V to the other two stages. The maximum current is about 19ma when a force is applied and 5ma when no force is applied. An output shown in the far right of figure 2 can be sed to connect an external device or additional circuitry to measure the force applied and/or to provide additional reinforcement such as visual or other. When no force is applied, there is no output to the audio amplifier and the amplitude of the audio output can be adjusted by adjusting the variable resistor. The addition of an external device or additional circuitry could increase the current reducing the battery life which may require the 9V AC adaptor to be used instead of making the device dependent on the availability of AC power outlets. The total cost of the device shown in figure 2 is about $25.00.

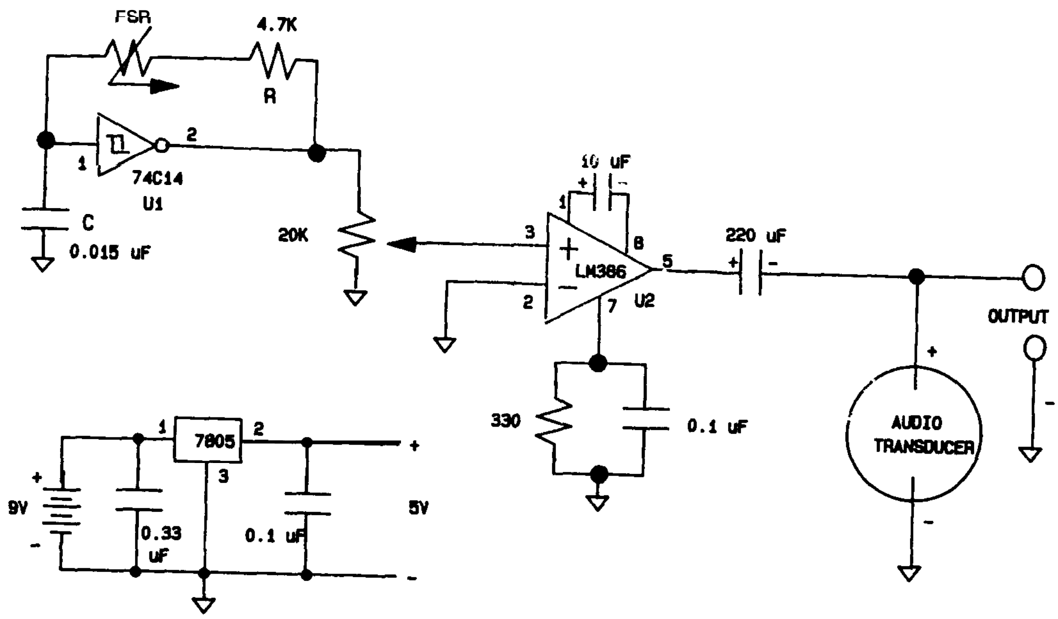


Figure 2: Schematic of the upper extremity training device. It should be noted that there are three stages shown, the power supply, the oscillator, and the audio amplifier. The output at right can be used of additional circuit or external devices for measurements or visual feedback.

ACKNOWLEDGEMENT

This work was partially supported by U.S. National Science Foundation Grant EET-8807522.

Portable Digital Communication and Control System

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INTRODUCTION

The purpose of this project is to provide a child with limited motor control and no speaking ability the means to communicate with other persons and the means to exercise some control over such activities as turning book pages, eating, turning devies on or off, etc. The oroiect is expected to involve a very small portable computer, a robot arm, voice generation electronics, and support software. It is a multi-year project with the initial concentration of effort being devoted to the portable computer and voice generation modules.

DESCRIPTION

A portable communication is in the process of being designed. This module will be built around a control computer that initially has a single input and outputs that drive a voice synthesizer and a display. The software will be a custom word processor that is stored in permanent memeory so that the system will boot and run independently. The separate hardware items that are required are 1) the computer, 2) the voice synthesizer, 3) the display, and 4) the power supply.

The Computer

The requirements for the computer are low power consumption, single voltage operation, EPROM software support, serial and parallel ports, and programming support. It must also be capable of operation with some type of low power consumption display, preferably a liquid crystal display. A low power consumption (CMOS) PC compatible computer made by AMPRO Computers of Synnyvale, California, meets these requirements and has been selected for use on the project. power consumption is less than five watts from a single five volt supply.

The Voice Synthesizer

The reauirements for the voice svnthesizer are 1) compatibility with the computer that was selected, 2) plus five volt operation, 3) low power consumption, 4) high speech quality, and 5) serial port (RS232C) operation.

A search revealed a doll with high quality speech. The doll was manufactured by Worlds of Wonder located in California. We have learned that they were using linear predictive encoding (LPC) chips to synthesize the human voice. These chips have been in widespread commercial sue since the days of the Texas Instruments Sneak and Spell toys and are readily available from Texas Instruments.

Another possiblity for the speech synthesizer is a phonetic processor. A speech board of this type is available and it also uses LPC technology but has lower quality speech output than its mathematically modeled counterpart. It offers an unlimited vocabulary (although pronunciation is not always correct) through ASCII text to speech processing. Phonetic speech is also possible with a digital to analog converter.

Dieitised speech was the last possiblity investigated. This type of speech has excellnt quality but requires large amounts of memory and high processing speed. The memory requirement ruled this technique out.

Display and Power Supply

A search is underway to locate a suitable liquid crystal display. Several manufacturers have been located but not enough information as been obtained to make a choice. The device should operate off the parallel port in order to simplify programming. More information will be obtained and a decision made as soon as possible.

The Control System

The portion of the system that allows the user to control his/her environment will consist of a robot arm with interchangeable grippers supported by software that will start out at a primitive level and evolve into an expert system that will be capable of carrying out commands without detailed instructions.

ACKNOWLEDGEMENT

This work was partially supported by U.S. National Science Foundation Grant EET-8807522.

Computer Input/Output Interface for Apple II and IIe Computers

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INTRODUCTION

Caddo School for Exceptional Children has a number of Apple II and IIe computers that they use for various learning tasks. However, there is a large variety of applications that the computers are not utilized for. The Apple **computer game input/output (I/O) connector** is a 16 pin DIP that provides for various switching inputs and outputs that could be used in a *variety* of applications dealing with evaluation, training, and instruction. *Yet,* the limited access of the game I/O connector becomes a difficulty in the realization of the full potential of the device. This can be solved by the proper external interface allowing easy access to the **I/O connector.** The objective of this project was to **design** and build such an interface.

SUMMARY OF IMPACT

This input/output (I/O) device has been used successfully at the C.S.E.C. and has been utilized by several students. This device has allowed for software design of applications to *meet* various needs using the Apple computers without being restricted by I/O hardware access.

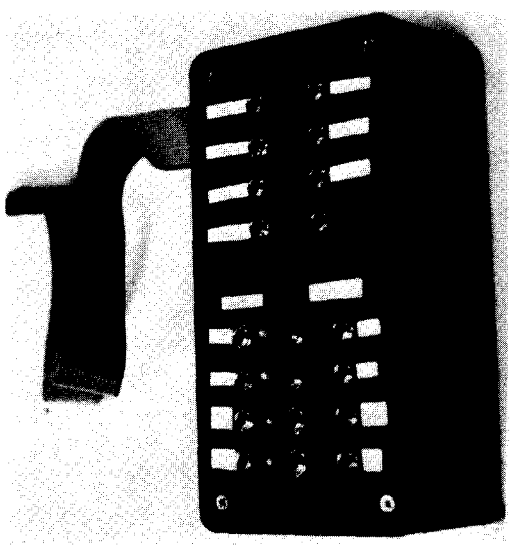

Figure 1. Computer Input/Output Interface for Apple II and IIe Computers

TECHNICAL DESCRIPTION

The Apple computer's game board has a 16 pin DIP connector by which a variety of inputs and outputs can be accessed. As shown in figure 2 the connector has 3 push-button inputs, 4 variable resistor inputs, and 4 annunciator outputs capable of 5 volt operation. Figure 2 diagrams the electrical connections and circuitry from the 16 pin DIP jumper cable for access to all inputs and outputs via 3.5 mm phone jacks. The 1K ohm resistors connected to the push-button inputs (PB) limit the current through the switch and provide a shunt for the input. The annunicator outputs can be used for turning a tape recorder or other device on or off, and the other mode is a 5 volt output. Both modes can be selected by a switch (shown in figure 1) and the annunciator can be turned on or off by use of peek and poke statements accessible within an Apple basic program. The SN74LS240 is an Octal buffer/driver for driving the 5 volt output to the reed relays or to another device. An additional 3.5 mm jack or appropriate connector (not shown in figure 1) allows a 9V AC adapter to be plugged into the device. This connection provides the 5V power supply via a regulator, shown in figure 2. By having all of the input and output capabilities of the game board's I/O connector outside the computer and the capabilities of Apple basic programming specific application software can be designed to aid in various needs of evaluation and training to assist the handicapped. The cost of the device completely assembled in about $50 maximum.

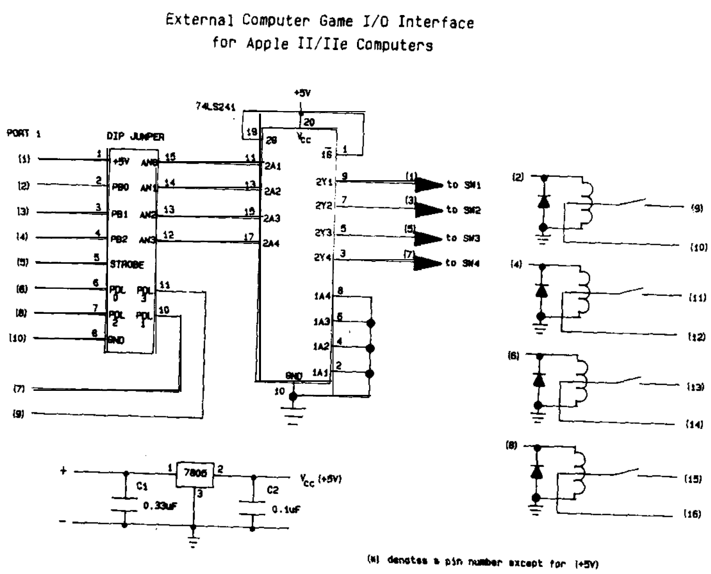

Figure 2. Schematic diagram of External Computer I/O interface for the Apple II/IIe game I/O connector.

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Knee Brace Alarm

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INTRODUCTION

Diseases that can affect the peripheral nervous sytem such as cerebral palsey may not effect the entire system, yet may only affect the sensory feedback pathways. For children in this situation an appropriate feedback device can assist in proper walking without constant observation by another person. A student at the Caddo School for Exceptional Children has such perceptual problems and he also has very weak muscles. He often does not know where his body is in space; thus when he bends his knee beyond a certain angle, he falls down. A knee f lexion alarm device was designed for this student.

This electronic device was built so that when attached to the long leg brace of the student it provided an audio signal when the knees are in excessive flexion when walking.

SUMMARY OF IMPACT

The student has used this device so that whenever he hears a beep from the black box attached to his belt he remembers to straighten his knee. This has allowed this student to be more mobile and independent. The gait. of this student also improved as the al arm system helped him to increase knee extension during stance phase and he learned to walk in a more erect fashion.

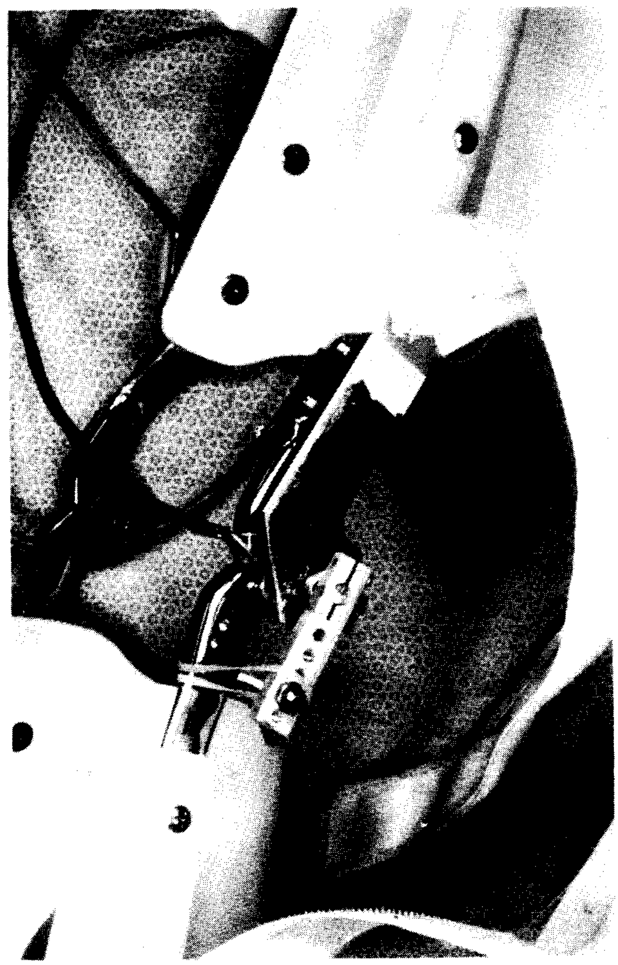

Figure 1. Knee flexion alarm attached to the knee brace.

TECHNICAL DESCRIPTION

The device requires two separate signals of which one is a reference and the other corresponds to the flexion angle of the knee brace. By comparing the two signals the device will signal the child when the proper condition is not present. With a variable reference the angle of flexion at which the device signals the child gradual training can be performed where the child learns at its own rate to maintain the proper knee position. The circuit for such a device is shown in figure 2. The positive input is the reference voltage which can be set by adjustment of the 20 Kohm potentiometer each voltage corresponds to a particular angle. The negative input to the LM339 is connected to the 10 Kohm potentiometer which is mounted to a knee brace that the child wears. This voltage changes with the angle of the knee brace which corresponds to the flexion angle of the child's knee. The 10 Kohm potentiometer is connected so that as the flexion angle of the knee increases so does the voltage. Depending on the setting of the 20 Kohm potentiometer, when the knee is flexed to an angle equal to or greater than necessary the output of the LM339 goes low enough to provide the required voltage across the piezoelectric buzzer to activate the buzzer and the child hears an audible sound signaling that the knee is flexed too much. A switch allows the device to be turned off when needed and an LED with current limiter resistor indicates whether the device is on or off.

The 10 Kohm potentioaeter is mounted to the knee brace with the jig shown in figure 1. One part holds the pot and clamps to the upper part of the brace. The other part clamps to the shaft of the pot and is strapped to the lower part of the brace. A cable runs from the pot and terminates in a small box worn on the child's belt that houses the circuitry. A belt clip mounted to the box allows the device to be worn without inconvience or discomfort, yet allowing for easy placement or removal.

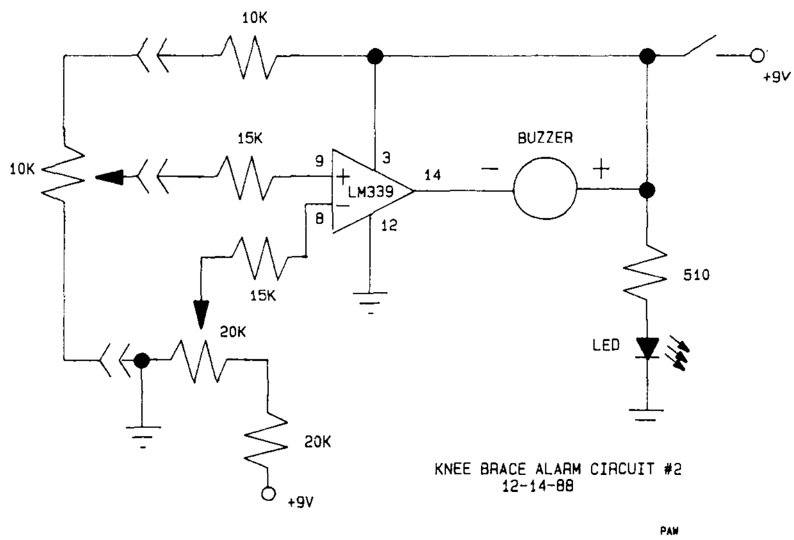

Figure 2. Schematic diagram of knee brace alarm circuit. The 10K Potentiometer at left is mounted on leg brace.

ACKNOWLEDGEMENT

This work was partially supported by U.S. National Science Foundation Grant EET-8807522.

Posture (Tilt) Alarm System

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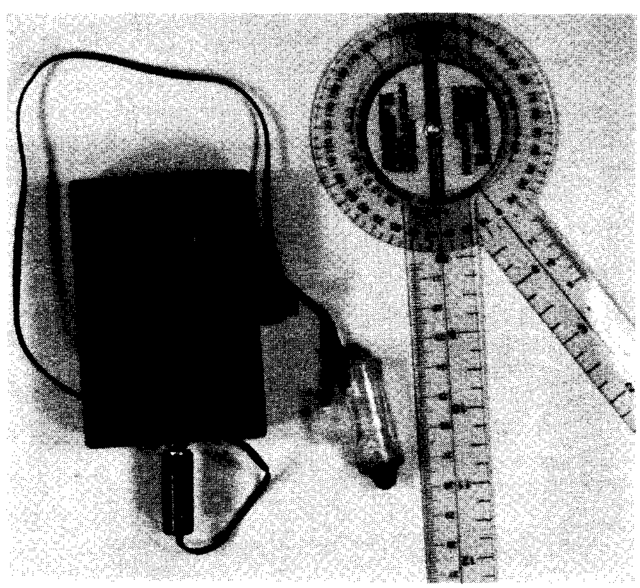
INTRODUCTION

Some children have difficulty in maintaining correct posture due to their tendency of leaning to one side. If this is not controlled, the child may fall. For some children, this requries strapping the child to a vertical support. An external device that would signal the child when he is leaning could aid in the maintaining of correct posture of a child and help the child to perform the task without the aid of another person. Such a device utilizing a mercury bulb as a switch to a buzzer was constructed. The mercury bulb was placed in a sealed tube of plexiglass for protection, and an on/off switch with an on light was included in the circuit. The device allows for other switching devices to be connected by way of a 3.5 mm connector. The mercury bulb is fastened to the child or the child's clothing at an angle so when the child reaches the angle of tilt the alarm buzzer is turned on signaling the child to straighten up.

SUMMARY OF IMPACT

This posture alarm has been used by one student. In the beginning the alarm had the mercury bulb switch only on one side; this prompted the student to overcorrect his tilting to the opposite side. This has been corrected by providing mercury bulbs for both right and left sides so that the student gets a warning signal for excessive flexion to either side.

Figure 1: Posture (Tilt) Alarm System.



TECHNICAL DESCRIPTION

Figure 2 shows the circuit schematic for the posture (Tilt) Alarm system. As shown in figure 1, a mercury switch is enclosed by a plastic tube which is sealed at both ends with silicone glue. Wires conncted to the mercury switch exit through the glue at one end of the plastic tube and connect to the circuit via 3.5 mm connectors. The plastic tube with the mercury switches are fastened either to the child's clothing or can be fastened directly to the child with the proper adhesive tape such as some type of medical tape. The mercury switches are fasted such that when the child leans too far to one side or the other one of the mercury switches is clsoed thereby activating the buzzer. Instead of only one buzzer, two buzzers of different frequencies (pitches) of sound can be used to indicate the direction in which the child is leaning too far. The total cost of this device is $10.00 as shown in figure 2.

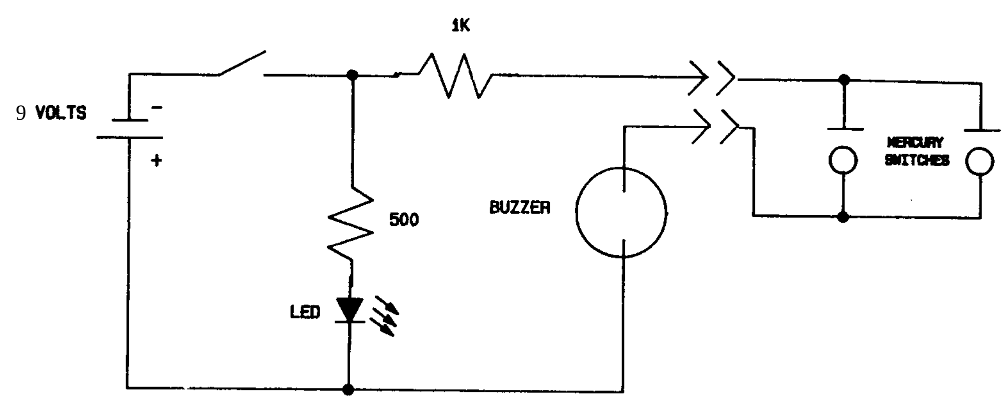


Figure 2: Schematic of posture tilt alarm. The LED indicates the device is on when the power switch is closed.

ACKNOWLEDGEMENT

This work was partially supported by U.S. National Science Foundation Grant EET-8807522.

Timer Switch

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INTRODUCTION

The importance of toys in the development and learning process is well known to educators who work with physically disahled children. It has been shown by many investigators that through purposeful play a child develops physically, emotionally, cognitively, and socially. Such developmentally appropriate play can often he provided by low cost, battery-operated toys and commercially available games. With modifications, often in the switching unit, the children at C.S.F.C. can benefit from this technique. However, modified battery-operated toys with single switch input requires a child to apply constant contact on the switch to activate the toy. Severe motor impaired students have difficulty maintaining contact on a switch, therefore, disabling them from controlling their environment during play situations. Therefore the objective of this project was to design and build a suitable timer switch.

SUMMARY OF IMPACT

Severe multi-handicapped students now have independence in controlling their battery-operated toys during play situations. It provides the student with an opportunity to be able to activate and enjoy playing with their toys. At the same time it provides the teacher/therapist with an objective measure of the student's ability to understand cause-and-effect relationship.

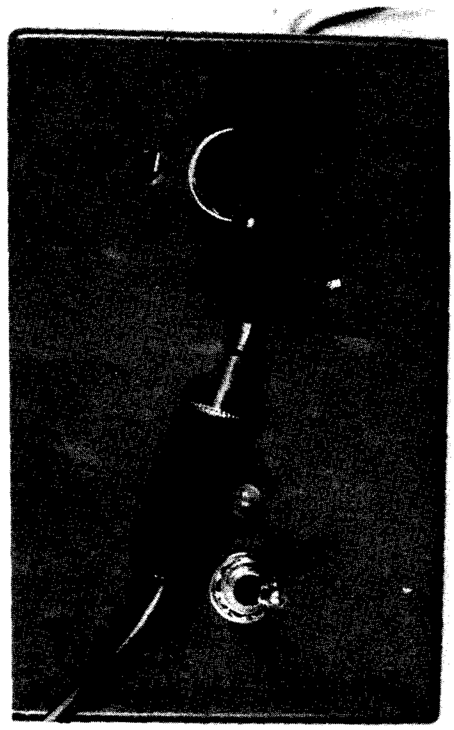

Figure 1: Timer Switch.

TECHNICAL DESCRIPTION

Figure 2 diagrams the electrical circuit for the timer switch. Any switch with a 3.5 mm connector that the child can utilize is plugged into the input (SWI on the schematic). The circuit takes advantage of a very simple, yet reliable configuration using a 555 integrated circuit device. As the child depresses the switch (SWI), the circuit closes the relay which is connected to a toy or type recorder's remote that will activate the device for a predetermined period of time, then deactivate the device. The 22 Kohm resistor, 1 mega ohm potentiometer, and 45 micro farad capacitor determine the range of time periods that can bet set. By adjusting the potentiometer, specific time period can be set.

The present circuit shown in figure 2 has a time range of about 5 seconds to approximatel y 50 seconds. The diode between the 555 timer and relay is to protect the timer from back current resulting from the behavior of relays. The completed device costs about $15.00.

TIMER SWITCH

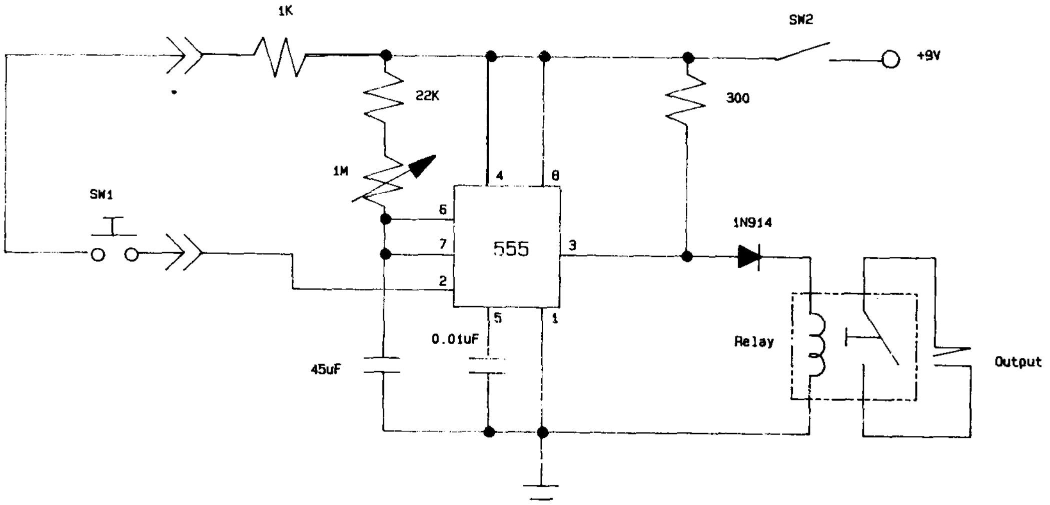

Figure 2. Schematic drawing for timer switch. The switch at the left (SWI) is the switch the child operates. The toy or other device is connected to the "output" at the right.

ACKNOWLEDGEMENT

This work was partially supported by U.S. National Science Foundation Grant EET-3807522.

A DYNAMIC FORCE EVALUATION DEVICE

Designer: Trey Rosenthal
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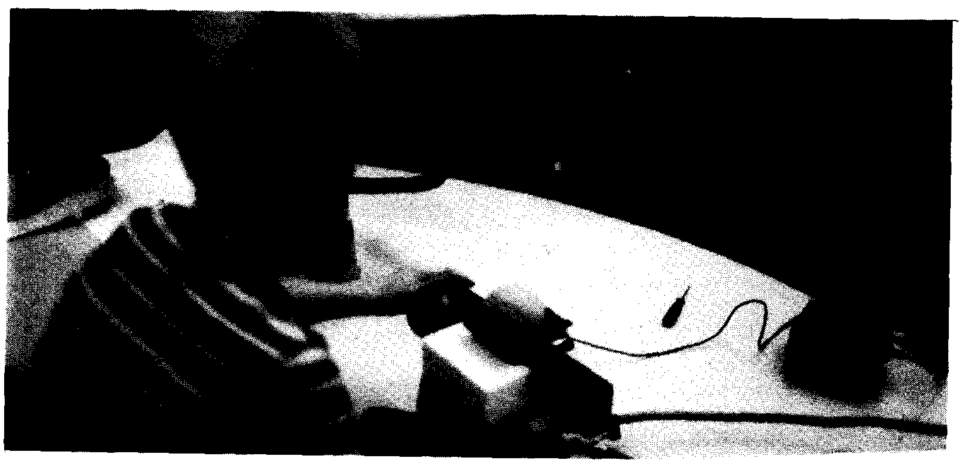
INTRODUCTION

A variety of communications/learning aids for severely handicapped rely on their ability to operate microswsitches to actuate different control devices. As different handicaps involve varying degrees of limitations on the motor skills, the successful use of microswitches by the handicapped is possible only if the most controlled movement of the individual can be used to operate the switch. Thus, to enable use by the handicapped, modification of the standard switches by use of suitable levers, gripping devices and proper placement, etc. is essential. Depending upon the individual abilities/disabilities, these switches can be adapted for operation by moving a hand, a finger, an arm, a foot, or the body trunk. Also, the head, chin or mouth movement can be used to operate the switch. It should be realized that all these adaptations have to be "tailor-made" for each individual depending upon his needs and abilities. We need data on the magnitude and nature of the force that a handicapped student can apply before an appropriate custom made switch can be designed. Presently no such force measurement device is commercially available. Therefore we have designed and built a special dynamic force evaluation unit and this unit has been used to measure the thrust forces and torques that normal and handicapped students can apply with their hand.

SUMMARY OF IMFACT

This unit (Fig. 1) has been used to measure forces and torques applied by fifteen handicapped students. As expected, a wide variation in the magnitude and duration of the exerted forces and torques were recorded. This information will be utilized in the future design of microswitches for these students.

Figure 1: The dynamic force evaluation device. Child is hitting target area on top of load cell.



TECHNICAL DESCRIPTION

A block diagram of the load cell and set up is shown in Figure 2. A Kistler biaxial load cell, Type 9271A, is utilized to measure an axial force in the z direction and a moment about the z axis (as shown in figure 2a). The biaxial load cell is also used so that two measurements may be recorded for each hit. The target area, consisting of a wooden beam clamped to the top of the load cell and two semispherical targest, tennis ball halves filled with a hard resin, proved to be very inexpensive while making directions for the children simplistic. Only forces directed near the very center axis of the load cell provide acceptable measurements, yet an easily identified target area must be utilized, thus the use of the filled tennis ball halves provided appropriate target areas.

To provide positive reinforcement, a capacitor switch is connected to the targets. The switch is then connected to a timer which is in turn connected to a toy. When enough area of the hand covers the tennis ball, the capacitor switch is activated and the toy operates for five to ten seconds. The purpose of the positive reinforcement is obviously to give a reward for the child's effort, to keep the child's interest as long as the experiment is taking place, and to provide time for the researcher to record data. It also can be a determinate or criteria in deciding which hits are valid and which are to be rejected.

Once a force has been applied, a charge representing the force and another the moment are sent form the load cell to the charge amplifiers. The charge amplifier (Kistler, Type 5001) receives the charge and proportionately converts it to a voltage. The particular models used had an output range of 0 to 10 volts. All settings were made according to the manuals provided by the manufacturer (Kistler). The range of the sensitivity could vary form one Newton per volt to five hundred Newtons per volt depending on each child's individual characteristics.

From the charge amplifier, the voltage is directed into a signal analyzer (Data 6000 manufactured by Data Precision). Two channel s are monitored and recorded, one being the force and the other the moment. This allows for both force and moment measurements after each hit incurred by a child. The range of both channels is + or - five volts. A remote terminal was connected to the signal analyzer so that tasks such as recording data could be made more efficient, thereby reducing experimentation time. The disk operating hardware is also provided by Data Precision and is used for recording data which may be needed at a later time. Lastly, a plotter (Hewlett-Packard 7470A) is connected to the signal analyzer allowing for hard copies of the waveforms to be made. The cost of the supplies needed for this setup is approximately $25.00 excluding, of course, the load cell (two to three thousand dollars), amplifiers, and data analyzing and recording equipment. It may be noted that any oscilloscope of x-y plotter could be used for data recording and signal analyzing, provided the instrument used has the proper ranges and performance needed.

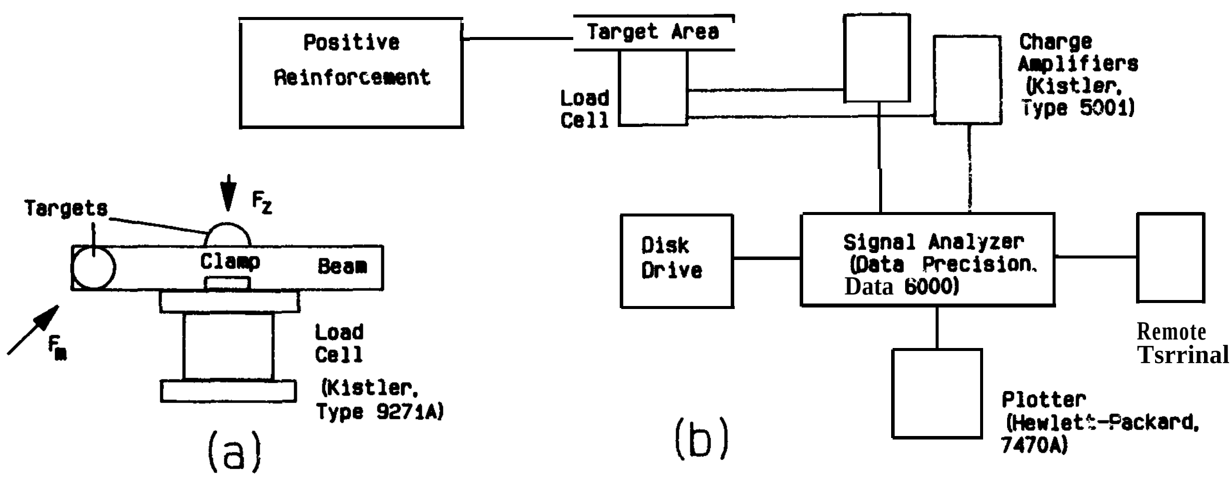


Figure 2: a) diagram of load cell and target area, b) block diagram of signal analyzing and data recording instrumentation.

ACKNOWLEDGEMENT

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A Non-Contacting Capacitive Switch

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INTRODUCTION

During the last decade, microcomputers have become more readily available for use of the disabled population and this has provided a more convenient means of communication and an increased level of independency for them. However, due to severe motor deficiency many children at the Caddo School for Exceptional Children (C.S.E.C.) cannot directly access computers and other electronic augmentative devices. For such students, there is a definite need for an economical, durable switch that a child can operate easily and which can act as an interface between the child and the computer or any other electronic device. In some cases the switch is required to be low force or even zero force activated. Small size and easy handling with little or no risk of damage of injury to the child is also required. A capacitive switch designed and sold for level control (Delta Controls model 104) with minor modifications, has been found to meet these needs.

SUMMARY OF IMPACT

This device has been used by a severely physically disabled student with cerebral palsey. Previously this student communicated through a computer via a microswitch which was activated by her head movement. This switch often needed repair due to constant impact from the head movement. This microswitch was replaced by the non-contacting capacitive switch and it has performed efficiently without any breakdown. Some of the advantages of this device are 1) the probe is connected by cable to the electronics allowing for the activation area to be custom designed and changeable to meet a specific need, 2) the sensitivity of the device is adjustable, and 3) on board delay capability al lows for different types of conditions such as minimum time for activation and time-off. There are some features that need to be altered, such as the device is currently AC powered instead of DC battery powered.

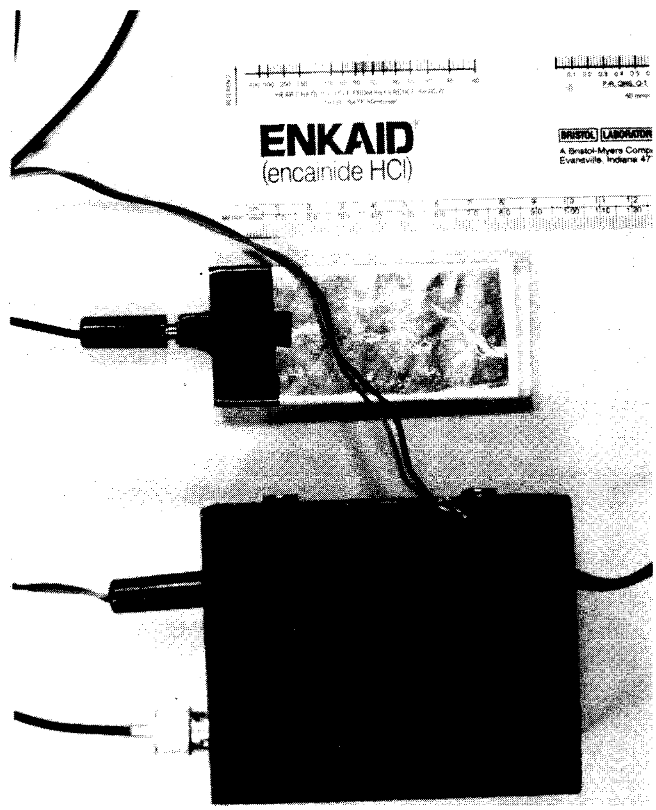

Figure 1: Non-Contacting Capacitive Switch.

TECHNICAL DESCRIPTION

The non-contacting capacitive switch is an adaptation of a circuit used in level control (Delta Controls Corporation, Model 104). Figure 2 illustrates the use of the device where the probe is some type of metal surface (i.e., aluminum, copper) covered with some type of insulative material (such as plastic, plexiglass, or spoxy). The probe can be almost any shape or thickness desired, however, the surface area needs to be as large as is practical. This is because the change in capacitance is dependent on surface area and the distance from the probe necessary for activating the switch. This change in capacitance of the probe is the mechanism by which the switch operates. Using a wire in contact with or connected to the metal surface of the probe a coaxial cable should be used to connect the probe wire to the circuitry via a post located on the circuit board. As shown in figure 1, connectors can be used to allow for different probes to be interchanged. Connectors attached to the circuit board allow for between the device and the toy or other reinforcement to be used. The circuitry (circuit board) costs approximately $100 with the total cost of the device being about $110 on up depending on the probe design. In constructing probes, we have found that aluminum foil and laminating sheets can be used to construct several effective and inexpensive probes.

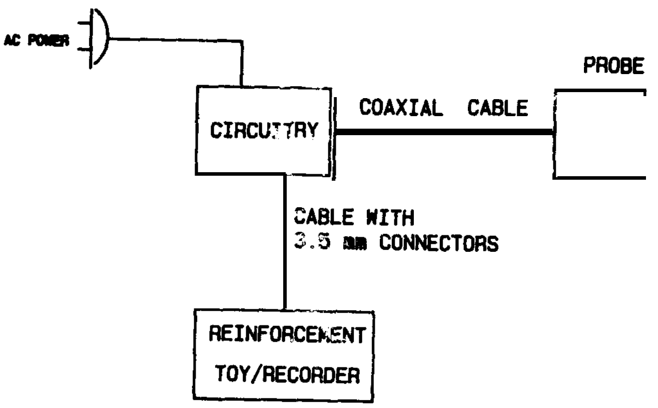

Figure 2. Block diagram of non-contacting capacitive switch with probe and reinforcement which can be any device that can be switched on and off.

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Limited Communication Device

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INTRODUCTION

Severe physically handicapped students are limited in the amount of social interaction they can have with their environment. Communication skills of older profound speech-motor impaired students *as* well as very *young severe* speech-motor impaired students are limited to eye gases, unintelligible vocalizations, and gross motor gestures. Devices such as a limited communication device will allow the student to begin training with a tool that adequately matches their cognitive and functional language skills.

The preliminary setup (Fig. 1) contains the use of one to three electronic switches which are individually connected to separate, corresponding messages recorded on loop tapes on miniatrue, portable tape players. The human recorded voice provides immediate reinforcement as well as changeable, recorded messages that *can* be easily accessed by single switch contact via direct select or scanning methods of input. The direct select mode requires the placement of the switches with its corresponding picture/symbol *onto* the wheelchair tray itself. The student directly touches the picture/symbol to indicate his/her desired item. The mounting of the short message communicator device would be located under the wheelchair tray. The scan mode requires a pane 1 with three LED lights connected to a single switch with standard miniature photo plug. The student presses the switch on the desired item that is highlighted as it scans across the panel. The selection resutls in the pre-recorded message corresponding to that particular switch.

SUMMARY OF IMPACT

Although only limited time was spent field testing the bread-board version of the Limited Communication Device, our results indicated that a variety of representational symbols, or icons, could be easily interchanged according to the student's cognitive abilities. The assortment of inter-changeable, textured switch contact points allows for flexibility in matching the site of activation to the student's limited motor abilities. These features adequately meet the needs of speech-motor impaired students as they begin to control their environment *via* their social communication skills.

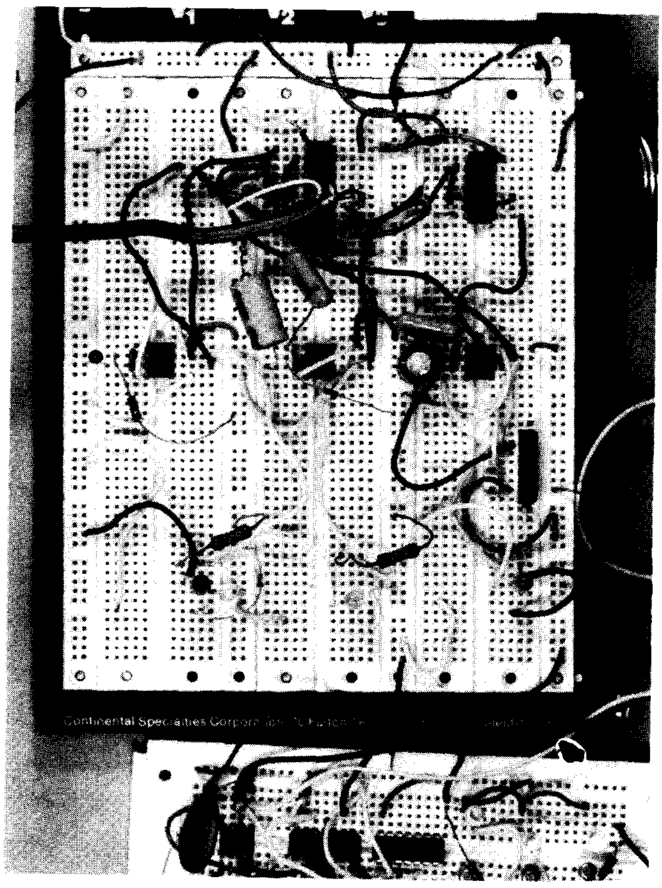

Figure 1: The limited communication device. The scanning element with LEDs are shown at the bottom.

TECHNICAL DESCRIPTION

Figure 2 shows the circuitry for the Limited Communication Device. The D-type flip-flops shown at left are connected in a ring-counter configuration. The counter sequentiallya ctivates each LED cycling at a rate determined by a 555 timer (U4) configured as a clock. When the LED corresponding to the desired action is active (turned on) depressing a switch (PBI) will cause a logical high to be present on one input of the three NAND gates (7400). Only the gate that also has the logic high from the ring-counter will have a logic low at the output. This one channel will be active causing a 555 timer circuit to activate a relay which ill be capable of turning on a tape recorder other switchable device connected to the output. As the relay circuit is activated, a voltage is sent back via an interter (7406) which is connected to the reset pin of the 555-clock circuit. When the output of any of the inverters goes low the clock stops thereby leaning the selected LED on. This locking out, because any further depressing of the switch (PBI) will not effect the operation, is maintained until the activated 555 timer circuit turns off. Since each channel is independent with respect to the timer circuits and relay circuits the time on period for each timer can be set to the period required for that channel /device adding flexibility. The initial application was to allow the child to turn on one of three tape recorders with prerecorded messages to allow the child to socially interact (messages such as "Hello, how are you?"). With additional work programmable digital audio devices could be incorporated into the circuitry to provide for a more portable, compact system which will be easier to set up for the needs of a particular child by software manipulation. The total price of the system shown in figure 2 including the tape recorders is approximately $200.00. Although the initial application was limited communication the device can be used for other uses by connecting other switchable devices to the output.

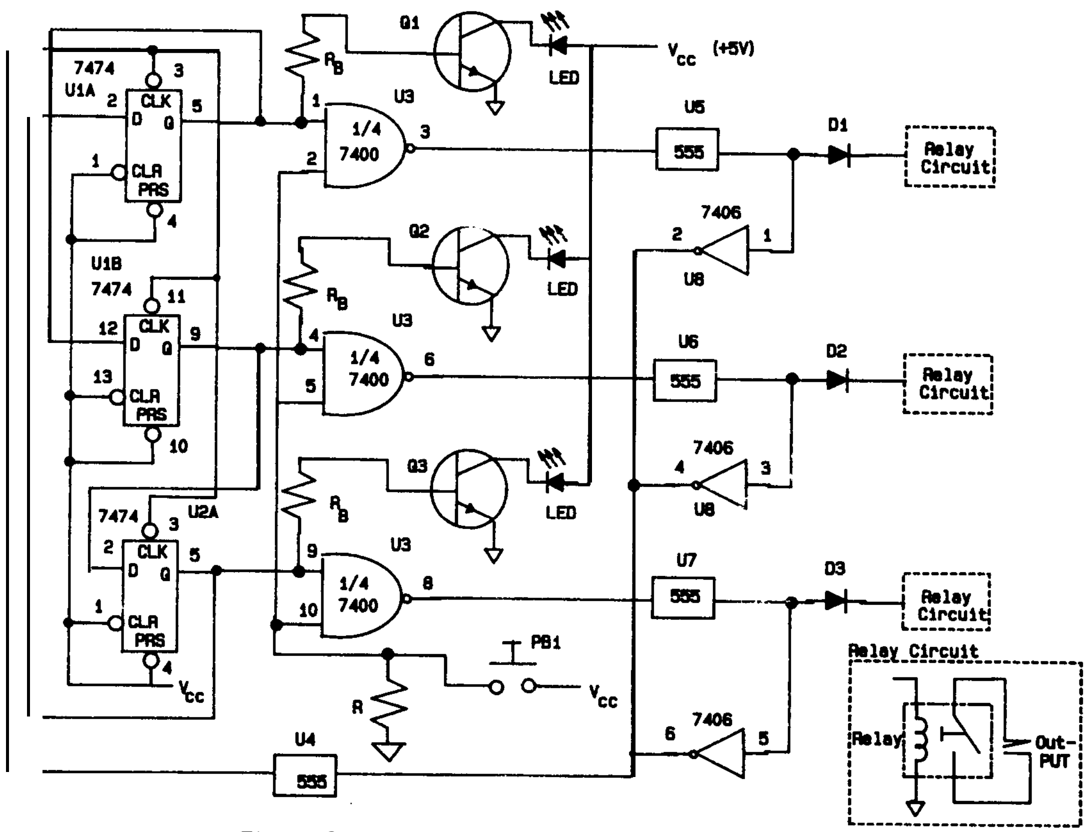

Figure 2: Circuit diagram of limited communication device. The isnert in the lower right hand corner of the figure shows the relax circuit with the output connection for the device (rape recorder).

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