CHAPTER 18
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TABLET FOR DEVELOPING HANDWRITING SKILLS

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INTRODUCTION

This device was designed for students who have difficulty developing handwriting skills. A number of children have difficulty forming letters of uniform height that touch the top and bottom lines on lined paper without crossing them. This includes students both with and without a diagnosed disability. As a result, teachers and therapists in elementary schools devote a significant amount of time and energy to help children develop their eye-hand coordination for improved handwriting.

SUMMARY OF IMPACT

This device helps children develop handwriting skills more independently. It presents students with positive and/or negative stimuli that encourage them to use accurately the lines on the page. They can receive additional reward stimuli if they consistently perform well. The teacher or therapist can configure different combinations of visual and audible stimulation, including: illuminating a smiley face, playing music, playing a recorded message (which cab be re-recorded anytime), sounding a buzzer, and flashing a message on the LCD display. Student may develop better eye-hand coordination by repeating handwriting exercises independently using this device. As a result, their teachers and therapists can be free to do other tasks.

TECHNICAL DESCRIPTION

The device consists of two units: the tablet and an interface box, as shown in Figure 18.1. The tablet is a Wacom 9 x 12 graphics tablet. It comes with a wireless ballpoint pen that does not contain a battery and has the look and feel of a standard ballpoint pen. The interface box acquires and analyzes the data from the tablet, presents the visual and audible stimulation for feedback to the student, and allows the teacher or therapist to change the device configuration. The box is connected to the tablet by a standard computer serial cable.

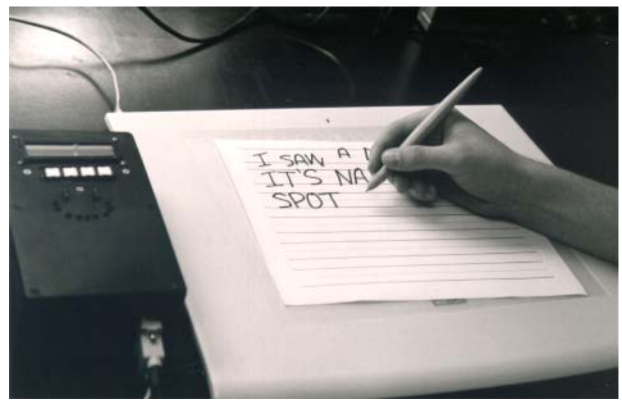

Figure 18.1. Interface Box (Left) with LCD display, Programmable Menu Switches, and LCD stimuli.

The Wacom graphics tablet has a slightly larger writing area than an 8 ½ x 11-inch piece of paper. The teacher or therapist places a standard piece of writing paper on the pad and calibrates the device by touching the pen to the top and bottom of the first and last writing spaces on the page. This is done on both the left and right side of the page. From this information, the device determines the orientation of the paper on the tablet, and the locations of the legal and illegal writing spaces, as shown in Figure 18.2. While the student is writing in a writing space the positive feedback is active, while in the non-writing spaces, the negative feedback is active. The ratio of cumulative time spent in the non-writing spaces to that spent in the writing spaces is used to determine if the reward can be activated.

The teacher then sets up the visual and audible stimuli will be used for positive and negative feedback to the student. This is done through a menu-driven system in which the different options are presented on an LCD display, and the user chooses the desired option by pressing one of four switches. This versatility accommodates the preferences of different students. For example, one student likes the sound of the buzzer, so it is programmed to be a positive stimulus. However, other students do not like the sound of the buzzer, so the teacher reprograms the device to make the buzzer a negative stimulus.

Once the system is set up, it starts analyzing the student's handwriting and presenting feedback. At any time, the teacher or therapist can press the "reward" button on the interface box, and if the student has been performing consistently well, he or she receives an extra reward stimulus.

The Wacom graphics tablet continuously streams data to the interface box. This data contains the x and y coordinates of the pen location, the amount of pressure that the user is applying to the tip of the pen, and the tilt angle of the pen. Currently, only the pen location and pressure information is used. A BasicX microcontroller collects this data continuously and determines whether the user is currently writing properly between the lines (the BasicX is similar to the Basic Stamp but more powerful). This information is then sent to a second BasicX microcontroller, which activates the appropriate positive or negative feedback.

With the versatility of this device and the power of microcontrollers, other features may be added in the future to provide more sophisticated evaluation of the student's handwriting.

The interface box prototype costs approximately $200. The Wacom graphics tablet and inking pen retails for $540, although it was obtained from the company at a significant discount for this project.

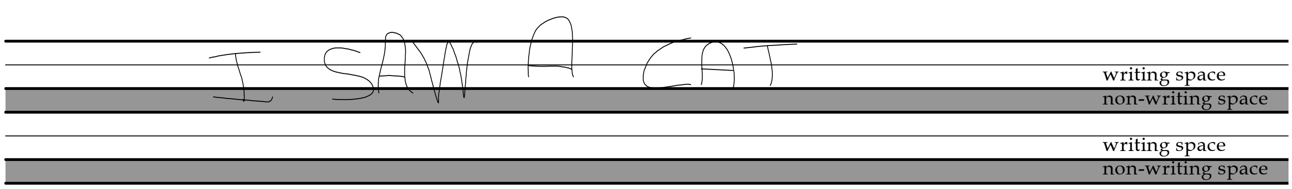

Figure 18.2. Writing and Non-Writing Spaces.

TRACKING DEVICE FOR PEOPLE WITH VISUAL IMPAIRMENTS

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INTRODUCTION

Visual tracking devices help stimulate and exercise the visual system. Currently, teachers and therapists engage students with tracking problems in exercises by manually moving light sources across the student's field of view.

SUMMARY OF IMPACT

This device is designed to improve the visual tracking of students with disabilities. It encourages them to track an object throughout their field of vision by providing visual stimuli (blinking lights) and auditory stimuli (music or recorded messages). The therapist uses a remote control to move the stimuli through the student's field of vision, and to turn the stimuli on and off.

This device has several improvements over current tracking techniques. Since the therapist controls the device remotely, positioned behind the student, the student can focus on the stimuli in front without being distracted. In addition, auditory stimuli supplement the visual stimuli to help engage the student's visual tracking abilities.

TECHNICAL DESCRIPTION

The block diagram in Figure 18.3 shows the system components. The prototype is shown in Figure 18.4. The tracking device consists of four parts: the transmitter, the receiver, the robotic arm, and the stimuli. The stimuli are attached to the end of the arm, and contain both visual and auditory components. LEDs are arranged around bright pictures on a card to provide the visual stimulation. The auditory stimuli consist of well-known songs. For the students with weaker vision, the songs are

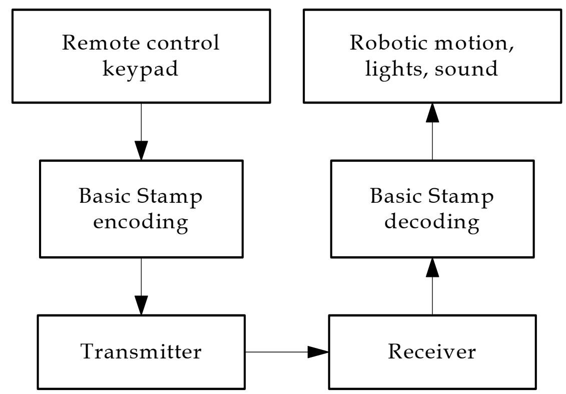

Figure 18.3. Block Diagram of Tracking Device.

the central stimuli used to attract their attention. For others, the songs are used to reward the students after successfully tracking an object.

The cards are removable, and the bright pictures are attached with Velcro for variety. Two stationary arms can also be attached so that multiple cards are visible. This allows the teacher or therapist to have the student choose among cards.

The robotic arm has motion in three directions: vertical, horizontal along an arc, and horizontal along a radius (towards and away from the student). Motion in the vertical and horizontal dimensions is controlled remotely by the therapist, and it moves the stimuli across the student's field of vision. Radial position is adjusted manually, allowing the teacher to decide how close the card(s) are to the student.

The mechanical design of the robotic arm consists mainly of two vertical shafts and one horizontal telescoping pole. The tall vertical shaft allows for gross movement (up to six feet) through a rack and pinion system, which the user controls manually. This is to incorporate students who are sitting in wheelchairs or standing up, strapped in the standers. The shorter vertical shaft allows for vertical movement via the remote control. The range of vertical motion for this shaft is one foot. A DC motor, obtained from an auto junk yard, drives this movement by turning a screw, which then raises or lowers the shaft. The horizontal movement is controlled by a second DC motor using a pulley system (Figure 18.5). When the motor is activated it rotates the shorter vertical shaft to create right and left movement. The telescoping pole is attached to the end of the vertical shaft. The object card is attached to the end of the pole, and the teacher can manually control the distance from the card to the student.

Figure 18.4. Tracking Device with Sensory Stimulation Card, Long (Far Left) and Short Vertical Shafts, and Enclosures (Center Left) Containing Power Supply, Circuitry, and Second DC motor.

The transmitter circuitry is contained within the hand-held remote control. When a key is pressed on the keypad, a Basic Stamp microcontroller sends out a code containing information about the row and column of the key pressed. A Linx transmitter chip amplitude modulates this signal at 300MHz.

The receiver demodulates the 300 MHz signal from the remote control. A Basic Stamp microcontroller (Parallax) interprets the received code and activates the appropriate secondary circuits. The DC motors are controlled through relays, and additional circuitry activates the playing and recording of messages and music.

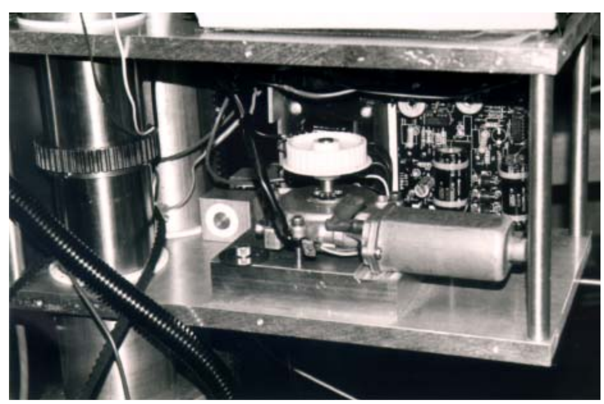

Figure 18.5. Enclosure with DC Motor in Foreground and Power Supply Behind.

The device cost approximately $500 in electrical and mechanical parts.

HEARING LOSS SIMULATOR

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INTRODUCTION

The hearing loss simulator is a computer program that modifies a sound clip based on a child's audiogram. The therapist enters the audiogram data into the program, characterizing the child's hearing loss. The program then records, modifies and replays a voice or a music clip as the child would hear it.

SUMMARY OF IMPACT

This program will provide a means by which parents of a child with hearing loss can understand what their child is capable of hearing. It demonstrates the severity of hearing loss through the comparison of the original sound clip with a sound clip based on the child's audiogram. This program will help the audiologist and parents have realistic expectations of the child's future performance. Additionally, the program will aid in the formation of individualized education plans through providing a more accurate representation of hearing loss. Currently, hearing loss is classified as profound, severe, moderate and mild. Most individuals have difficulty in applying these generalized terms to what a child can hear. Current audio examples of hearing loss are not specific to the child and may give only an approximate idea of the type of sounds that a child is able to hear. This program gives a more exact, personal replication of the child's audio environment.

TECHNICAL DESCRIPTION

The Hearing Loss Simulator consists of five primary components: a microphone, a PC, a sound card, a software program, and a speaker system.

The audiologist must first enter data from the child's audiogram into the simulator. A polynomial function is matched to the data points, then used to apply the appropriate attenuation at selected frequencies to the recorded audio signal. The PC receives input from the microphone via the sound card. Contained within the sound card is an analog to digital converter that transforms information from the microphone into a form usable by a software program on the PC. Based upon information taken from a patient's audiogram, the program processes the recorded audio. This altered digital signal is then transformed back into analog format by a digital to analog converter housed on the sound card and ultimately played by a speaker.

The programming is in Visual Basic 6 and requires a computer running windows 9x or NT at 266MHz or higher. To hear the modified sound clip, a 16-bit A/D sound card, a microphone, and speakers are needed. Components of the device are shown in Figure 18.6. Audio is recorded via a microphone and converter into a digital form. Data from an audiogram is entered into the PC. The digital signal is modified, then converted back into an analog signal, which is then played through a pair of speakers.

Initial testing of the simulator has proven that it is qualitatively accurate. Several simple scenarios, such as filtering all high frequencies or all low frequencies, have generated the expected results. The initial impression by people in the audiology field is very optimistic. Although further testing is needed to prove that the simulator is quantitatively accurate and clinically useful, the outlook is promising.

The current limitations of the device are that only up to seven data points may be entered from an audiogram and that audio must be recorded and modified before being played back. One major possible enhancement might be to allow the audio to be modified and played as it is being sampled, thus allowing for a real-time system. As it stands, the Hearing Loss Simulator appears that it could prove to be very beneficial in communicating the level of hearing loss in a child to a parent. The total cost of this project was $505.

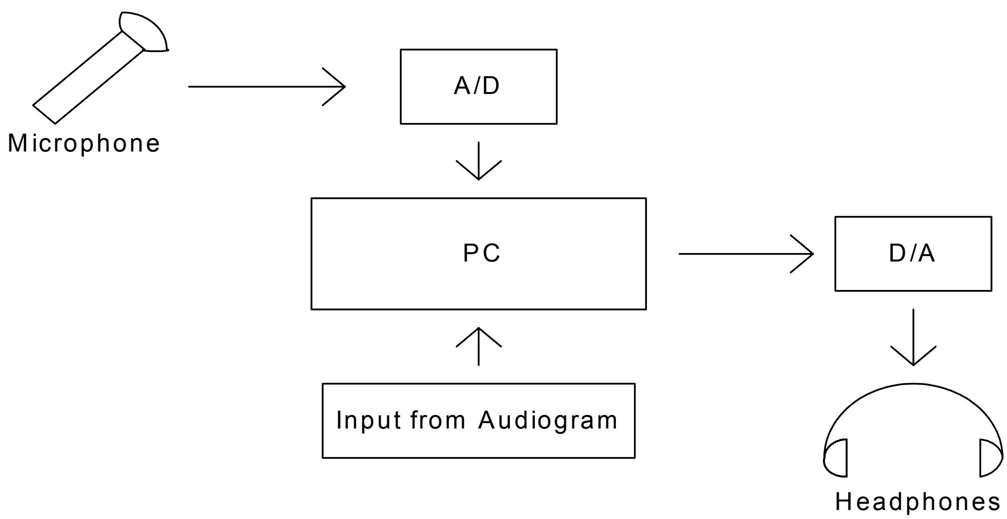

Figure 18.6. Hardware for Hearing Loss Simulator.

INFANT PATTING DEVICE

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INTRODUCTION:

An infant patting device was developed to simulate a hand patting motion during bottle-feeding in a neonatal intensive care unit (NICU). A hand patting motion calms the baby to facilitate bottle-feeding. It may also decrease the probability of food aspiration into the lungs during feeding. This device provides an easy, safe way to comfort patients in the NICU, while providing relief to their caregivers.

SUMMARY OF IMPACT:

Some NICU infants require two nurses to feed them: one to hold the infant and the bottle, and another to pat the infant's back. This device performs the patting task, allowing a single nurse to manage all feeding tasks in a safe and timely manner. The patting, used independently of feeding, may allow the infant to remain calmer during a stay in the NICU. Currently the device is waiting for clinical approval.

TECHNICAL DESCRIPTION:

The system works by providing puffs of compressed air to an inflatable bladder that is held up to the infant. Compressed air sources are available throughout the NICU. An air input hose connects this air source to the system. A timer circuit turns a solenoid valve on and off to provide puffs of air. These puffs flow along the air output hose (25 ft. long, ½″ inner diameter) to the inflatable bladder that provides the patting motion. The bladder can be suspended in foam padding or placed directly on the infant. An escape hose attaches to the bladder to direct the airflow out of the bladder and away from the baby.

The system is encased in an aluminum project box (12″ x 12″ x 8″) equipped with wheels to facilitate movement. A power switch and large knobs allow the user to control the air pressure and patting rate. A commercial 24V wall transformer provides electrical power. Throughout the system, ½″ diameter tubing, large enough so that it does not restrict air flow, is used.

Figure 18.7. Infant Patting Device.

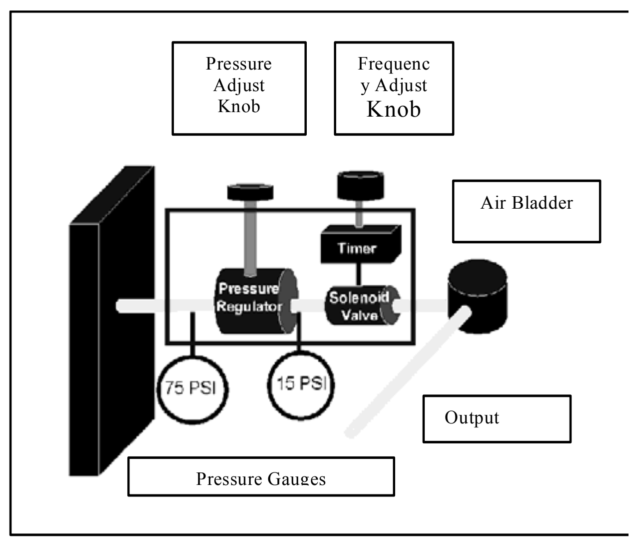

Figure 18.8. System Block Diagram.

The puffs of air are provided by a pressure regulator, timer circuit, and solenoid valve. Since the compressed air source has a pressure of 60-85 pounds per square inch (psi), a regulator is necessary to lower the pressure. The user can adjust the regulator output pressure to the range of 2 to 60 psi. A solenoid valve opens and closes to provide puffs of air to the inflatable bladder. The solenoid has a large 5/8″ aperture to maximize the flow of air, and runs off a standard 24V plug in power supply. To switch the solenoid on and off, a 556 timer circuit is used. This timer uses a 5V power supply, which is provided using a 24VDC to 5VDC voltage regulator. The frequency at which the timer operates is controlled by a potentiometer, which can be adjusted using the frequency knob on the box.

The patting motion is provided using a custom neoprene bladder. The bladder is circular, with a 3 ½″ diameter, and has connections for an air supply hose and air escape hose.

When the valve is open, the puff of air from the solenoid causes the bladder to expand. The air leaves the bladder passively through an open tube. The tubing is 25 ft long to enable the nurses to freely move with the device, and to ensure that the air released from the bladder flows away from the infant.

Safety was the most important feature to address. The system needed to be safe for use with infants, and easy to clean and sterilize. The metal box provides an effective casing for the electrical equipment, and effectively separates the infant and the caregiver from the electrical circuits. Neoprene was chosen for the bladder to avoid any possible side effects from latex allergies.

Aesthetic concerns were addressed by decorating the plain aluminum box with child friendly, decorative Sesame Street® stickers.

The total cost of this project was $667.

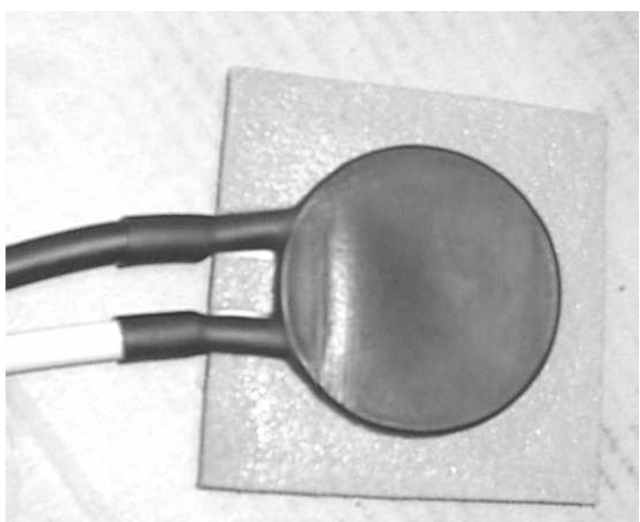

Figure 18.9. Neoprene Bladder.

JOYSTICK-CONTROLLED POWER WHEELS JEEP

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INTRODUCTION

Commercial Power Wheels vehicles cannot be easily controlled by children with poor muscle control. This project involved the modification of a Barbie Jeep for use by an 8-year-old girl with cerebral palsy. A joystick control and supportive seat were added to facilitate use and promote independence.

SUMMARY OF IMPACT:

The modified Barbie Jeep will allow the client to gain experience for future operation of joystick-controlled wheelchairs and provides client increased independence. The modifications allow the client to practice her fine motor control skills and visual-spatial skills, and encourage active play and outdoor activity. The joystick controls allow forward/reverse motion, with future additions to include left/right control. The modified seat provides leg and torso support and a seat belt to ensure child safety.

TECHNICAL DESCRIPTION:

Analog based circuitry was chosen to provide a comparable driving experience when operating the car. The original 12-volt battery that comes with the car is maintained to operate the original propulsion motors, which require high currents. Two 9V batteries are used to power the joysticks and circuit components in the modified design. The batteries are located under the hood and have a power switch to turn the system on and off to preserve the batteries.

The joystick outputs a speed signal corresponding to the position of the lever. The signal range of the joystick is +2.6V to –3.0V as it moves along the y-axis. A comparator checks whether the signal is positive (forward motion) or negative (reverse motion), then relays number one and two are triggered to set the selected direction of motion for the motors.

Figure 18.10. Modified Barbie Jeep with Supportive Seat and Joystick Control.

The maximum speed of the modified car is slightly less than before the alterations. The speed is distributed evenly over the range of the joystick, and seems to be a safe velocity for both forward and reverse movement. The proportionality of the control will eliminate any jerky motions from the motors and provide for a smoother ride and acceleration.

The main limitation of the car is that the joystick does not control the left/right motion of the car. Because of the inability of the client to use the manual steering wheel, a parent or therapist must control the steering.

The seat of the car is specifically designed to provide torso support and hip support. A 6″ semicircle used to separate the client's knees and an armrest is positioned on the left side to enable better joystick control. 1/8′ plywood is used as a base and back, and 1" x 6" quadrilateral pieces of wood were used for the hip supports.

Comfort and aesthetic value were important when incorporating the seat. Two layers of foam were added to each surface that contacts the client and the foam covered with pink vinyl to match the color of the jeep. This redesigned seat has the same dimensions as the original seat and will meet the client's needs.

The approximate cost of the modifications to the car was $110. This excludes the price of the car itself.

Figure 18.12. Modified Seat.

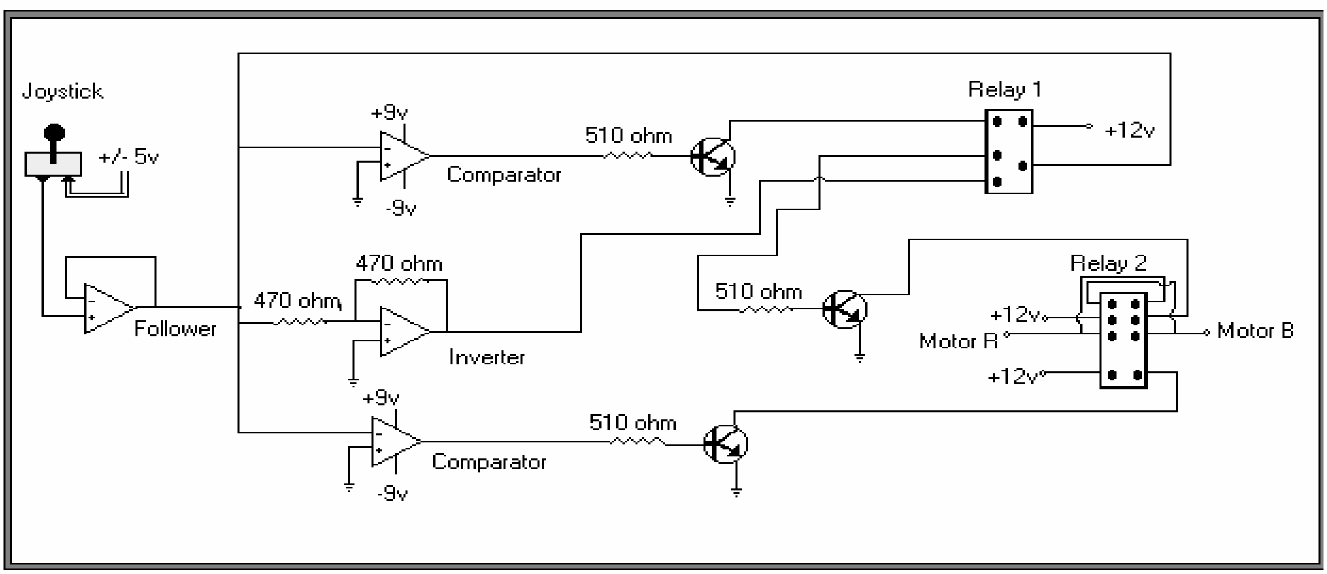

Figure 18.11. Wheel Propulsion Circuitry Located Under the Vehicle Seat.