

CHAPTER 19
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SOUND WALL FOR MUSCLE STRENGTHENING AND SENSORY STIMULATION

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INTRODUCTION

A physical therapist requested a device that will strengthen the upper arms and trunk muscles of a girl with cerebral palsy. Currently, toys are available in the market aimed at training muscles of children with disabilities using sensory stimulation as an encouragement. The problems with these toys are that: 1) they provide limited sensory stimulation and fixed stimulation mapping, 2) most of them cannot be mounted vertically, thus the children do not have to reach up to trigger those switches, and 3) for most commercial devices, all the sounds are already built in by the manufacturer, thus the child cannot be creative to make her own sounds. The Sound Wall, shown in Fig. 19.1, is an attempt at a treatment device that addresses these shortcomings.

SUMMARY OF IMPACT

The major advantages of this device are that: 1) it is vertically mounted, 2) it is expandable, 3) the client can be creative while playing with it, and 4) it is appropriate for use with supervision by any child.

TECHNICAL DESCRIPTION

The device consists of three major parts: a frame, five function blocks and the power supply. Any combination of four out of the five blocks can be mounted in the frame at a given time. Bright colors and simple shapes are applied for aesthetics. The base consists of two parts, the frame and the supporting structure, which are easily detachable. Composed of aluminum, the base is light but rigid, and the triangular design of the support makes it stable. All the edges are rounded for added safety. A commercial wall transformer is used to provide a 12-volt power supply, which meets safety standards. A project box with four jacks is located on the back of the frame to provide 12 volts to each block. The power connector of each block is screwed into the jacket, making the connection robust and safe. The

back panels containing circuit boards are all covered to prevent injury.

Five function blocks

Motorcycle driving block: This block can provide blowing air and flashing light stimulation. The client can stretch both her hands out to hold the motorcycle bar, which when turning can activate lights and fans on each side in response.

Recorder block: Two pulling switches are mounted on this block for recording and playback. By pulling the switch and holding it, the child will train and strengthen arm muscles. The child may also be creative by making up sounds to record and play back.

Telephone block: Installed in this block are nine push buttons, representing the nine digits on a telephone. When pushing a button, music or a message is emitted from the speaker. A three-way switch located just under the speaker is designed to be adjusted by the caregiver, allowing each digital button to play three distinct sounds. Another feature of this block is the phone bar. One set of magnetic stones with inverse magnetic polar are attached on the block and another set are attached on the phone bar. The phone bar can be hung on the block very easily in one direction, and impossibly in the other direction. To play with this block, the child is encouraged to push different buttons as well as feel the strength of repulsion and attraction of magnetic stones when hanging up the phone. All the materials of this block are from a commercial toy phone.

Rotating flower: On this block, two different melodies can be played by either simultaneously pulling two switches or pushing two buttons. A flower rotates, with controllable speed, when either set of switches is closed. This flower is specially

composed of very soft fabric with plastic materials inside, so when the flower is touched a paper sound can be heard. The child must use both hands at the same time to receive music feedback. The design purpose of this block is to train muscles of both arms at the same time and stimulate cooperation of the two hands.

Velcro block: A music box is attached to this block by a screw, and several Velcro pads are attached with glue. Design purpose is to show the possibility

to expand this project by the user, demonstrating an example of how to mount some simple toys on to the blocks.

Total cost for the sound wall is approximately \$742.

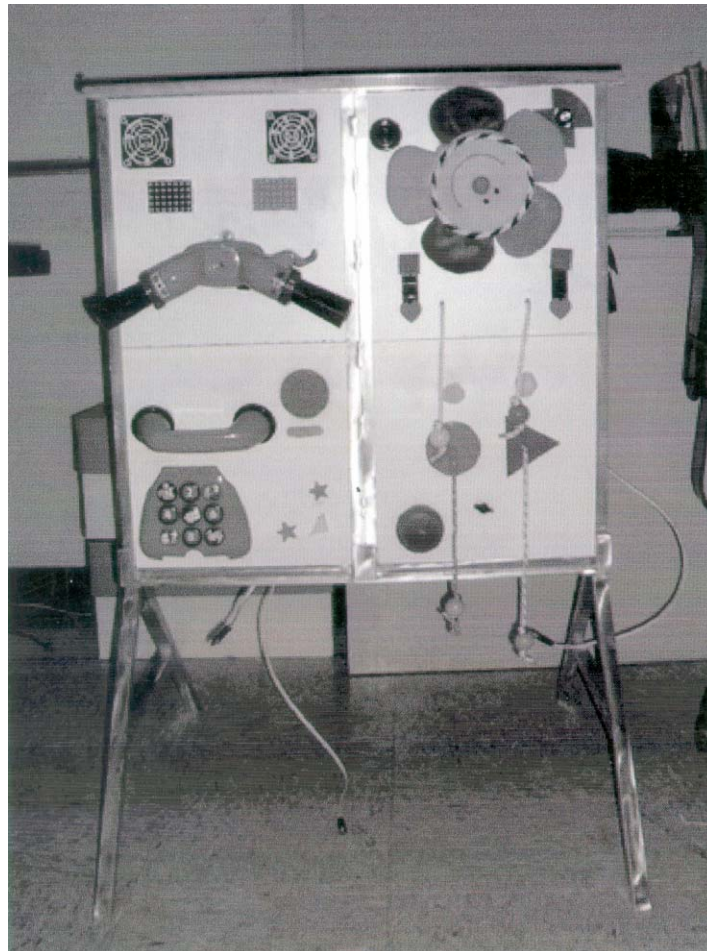


Figure 19.1. The Sound Wall.

TOY RETRIEVER FOR GRASPING OBJECTS FROM A WHEELCHAIR

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INTRODUCTION

The client is a two-year-old boy with a spinal cord injury at C-7, resulting in paralysis below the chest. He has normal cognition and uses a wheelchair for mobility, and his need is for a device that helps him fetch toys off the floor from his wheelchair. People currently use commercial grabbers and reaches to fetch a range of objects, but these devices require significant strength in the arm and grip that our client lacks. Also, they are awkward for fetching flat objects. Our goal was to build a lightweight retrieving device that attaches to a manual wheelchair, operates on batteries, and is easy to use. A device was built that consists of a scooper that is lifted and lowered by a telescoping pole, powered by a rechargeable battery. It requires a minimum amount of physical effort to use.

SUMMARY OF IMPACT

The device will benefit the client by enabling him independently to pick up objects from the floor. It will also relieve family members of time and stress from having to help him. Because of the simple design, our client can learn to use the Toy Retriever quickly by operation of two switches. The parents can detach the device efficiently, thus storing it easily when not in use.

TECHNICAL DESCRIPTION

The device consists of a scooper and blocker that are used to scoop the toy. When the user wants to pick up an object from the floor, he or she simply moves the wheelchair adjacent to the object, positioning the scooper just behind the toy as shown in Fig. 19.3. The "lower" button is then pressed, which lowers the scooper and blocker to the floor and the motor automatically shuts off. The user wheels the chair forward, which pushes the scooper under the toy. The blocker moves independently from the scooper. It sticks to the floor and helps prevent the toy from

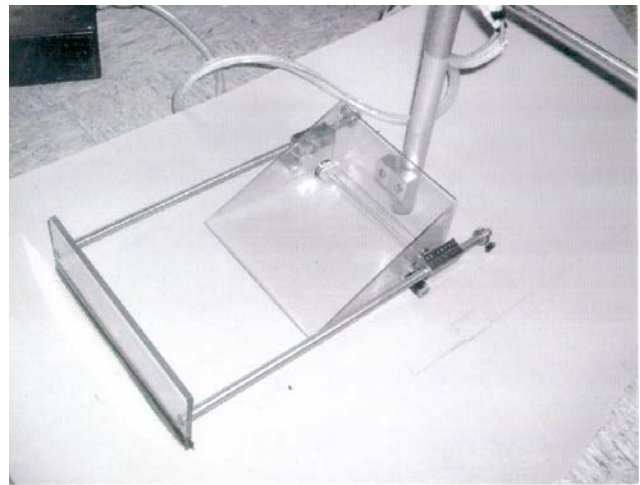


Figure 19.2. The Toy Retriever – Scooper and Blocker Design.

sliding away as the scooper slides underneath the toy. To retrieve the object, the user simply presses the "raise" button, bringing the scooper/blocker unit within hand's reach. The user may then take the object from the unit as desired. The device is easy to use and accomplishes the task of toy retrieval in a fast and efficient manner.

The device is designed keeping in mind the usual toys that the client would pick up. The material used for building the scooper and blocker is Lexan, which is strong and light. The scooper and blocker are connected with a sliding joint so that they can move independently. A rubber shelf liner covers the bottom of the blocker, so that it sticks to the floor when the client moves the wheelchair and scooper forward. The scooper and blocker unit is connected to a telescoping rod, which raises and lowers the unit. This is accomplished using a commercial power antenna and motor, purchased at an auto shop. The base of the antenna and motor is connected to one end of the telescoping rod. The tip

of the antenna is pushed through the hollow rod and connected to the other end. As the antenna extends and retracts, it causes the rod to extend and retract. The aluminum rod provides good rigidity compared to the relatively flimsy antenna.

When the user presses either the "lower" or "raise" switch, it triggers the circuit to turn on the motor in the appropriate direction. When the scooper and blocker are lowered to the floor or rise all the way up, the motor starts drawing a higher current. This triggers current limiters (re-settable fuses) in the circuit, which turn off the antenna motor. The battery and circuit are enclosed in a project box, completely isolated for safety. The box contains

ports for: 1) two switches, one for lowering the scooper/blocker unit, the other for raising it, 2) the battery recharging unit, 3) connections to the motor, and 4) a power switch. The primary source of power for the device is a rechargeable battery, which can be connected to a commercial charger through a port in the box. The battery has to recharge every few days. The antenna is connected to the wheelchair rod and the scooper and blocker unit in such a way that they can be easily attached and detached.

Total cost for the project is approximately \$439.

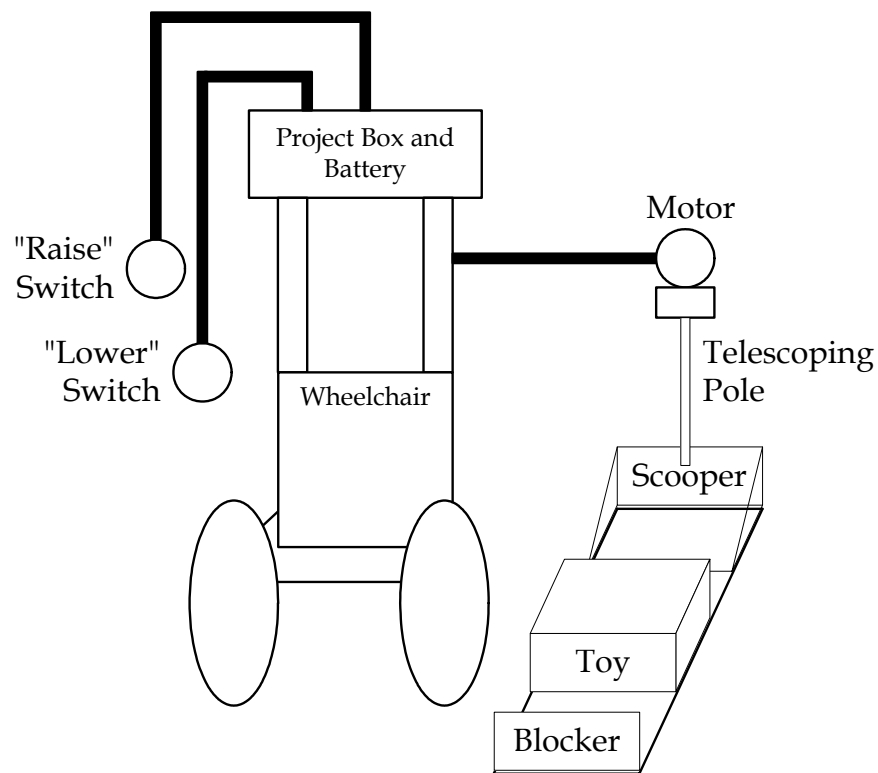


Figure 19.3. Block Diagram of the Toy Retriever. components.

PERSONAL ATTENDANT CALL

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INTRODUCTION

Amyotrophic Lateral Sclerosis (ALS) occurs due to degeneration of motor neurons in the brain and spinal cord. People affected by ALS or similar conditions have a constant need for communication with a personal attendant. This may be accomplished using a simple device like a doorbell buzzer. The patient presses a switch next to the bed and a buzzer (carried by the attendant) alerts the attendant. In current devices, the attendant is unable to differentiate between an emergency case and a non-emergency case when buzzed. This can add additional tension on the attendant and, as a consequence, could affect the quality of patient care. This newly developed device improves communication by allowing the patient to send one of three different messages to convey needs. Possible messages shown in Fig. 19.4 are "Help", "Water", and "Restroom". In addition, the device features the option to emit different tones for a specific message.

SUMMARY OF IMPACT

The patient is able to communicate efficiently specific messages to the attendant. The attendant, aware of the patient's exact needs, is able to work in a more calm and relaxed manner. Since the number of non-emergency instances is more than emergency instances, this device would significantly reduce the tension on the attendant. Both the transmitter and receiver unit are easy to operate, taking little time to learn. Messages on both units can easily be changed depending on patient needs.

TECHNICAL DESCRIPTION

The patient and the attendant each have their respective unit. On the patient unit, there are three different messages, which can be written on a piece of paper and inserted into the message text slot. The unit cycles through each message, indicating the current message by turning on LEDs (light emitting diodes) located underneath each one. When the patient has a need, he simply presses the hand



Figure 19.4. The Personal Attendant Call - Attendant and Patient Unit.

switch while the desired message is illuminated. For example, if the patient needs water, the button is pressed when the “water” indicator is on. A radio signal is then sent to the attendant unit. The attendant unit has the same set of messages as on the patient unit. These are also written on pieces of paper and inserted into message text slots over a bank of LEDs. When the unit receives a message, it illuminates the corresponding message to indicate what the patient needs. Also it alerts the attendant that a message has arrived through audible (a distinct tone and a recordable audio message), visual (the LED indicator), and physical stimuli (a pager motor vibrator).

Any standard commercial switch plugs into the 1/8 inch jack on the patient unit, and it can be changed to suit the patient’s abilities. The unit receives power from a commercial 9V transformer plugged into the wall. A Basic Stamp 2 (Parallax, Inc.) microprocessor is used to scan the input from the switch. Each message is coded with a numeric value. On selection of the message the numeric value is transmitted using a commercial 418 MHz RF (radio frequency) communication board (Parallax, Inc.). The default message on the unit is “Help” and it is always activated when the switch is pressed for an instant. Additionally, LEDs flash in sequence when no switch is detected on the unit. The programming for the microprocessor was done in the Basic Stamp PBasic language.

The attendant unit (powered by a rechargeable 9V battery) is light, durable and handheld. A Basic Stamp 2 microprocessor integrates the various

operations of the unit. The unit has a commercial 418 MHz RF receiver board (Parallax, Inc.). The current signal from the microprocessor is amplified with an NPN transistor 2N2222A and is used to power the pager motor. Similar circuits are used to power the LED banks and the audio circuit. The pager motor is attached to the underside of the unit and vibrates when turned on. Depending on the numeric code received, the appropriate display lights up. The display on this unit consists of three banks of LEDs arranged in parallel rows of three each. As in the patient unit, the messages are placed over the LEDs and are highlighted when the LEDs flash. The microprocessor also sends out a tone to the speaker, with its intensity controlled by a potentiometer. There is a specific tone for each message. Pressing the switch on top of the unit can reset the entire unit. Additionally a SPST switch provides an option to turn off the vibrate alert. The programming for the microprocessor was done in Basic Stamp PBasic as well.

Approximate cost for the entire device was \$325.

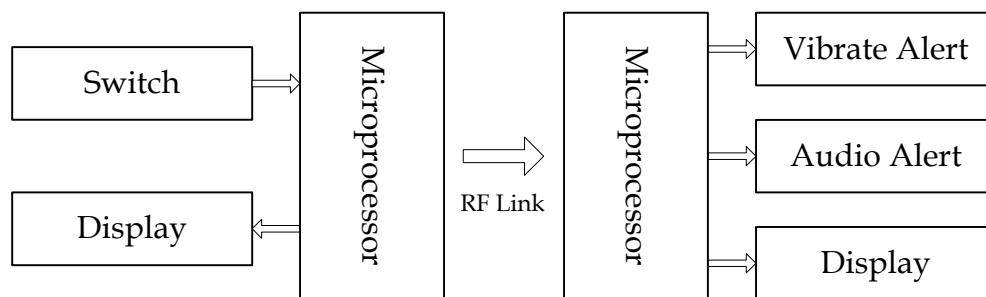


Figure 19.5. System Block Diagram: Transmitter (left) and Receiver (right).

