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TACTILE SYSTEM FOR VISUALLY IMPAIRED PEOPLE USING EMBEDDED TECHNOLOGY

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Abstract-People who are visually handicapped or blind rely on others to get from one place to another. In metropolitan settings, various systems are utilized to tell blind people of the direction of their travel. The majority of navigation systems dedicated to guiding the blind are voice-based. However, due to the tremendous noise produced by heavy traffic in urban locations, voice information is unreliable. It drastically reduces perception of commands generated by the blind person's ear buds. This study describes the invention of a vibrotactile approach for guiding a visually impaired person in metropolitan environments. It is a straightforward and successful strategy. It is made up of soft wovibrators that are placed on the left and right arms of their shoulders and produce vibrations by hapticperception, which is specifically produced by regulated hardware and software. Even in heavy traffic, the blind person can quickly identify the safe path on a walk using touch sensing. This tactile technology largely overcomes the shortcomings of the voice-based approach.

Keywords: Tactile, Vibrotactile Vibrator, Vibroactuator, Visually Impaired People

1. INTRODUCTION

Embedded systems are everywhere. It is characterized as a computational device with a single purpose. It is made up of both hardware and software. The hardware components are managed by software. There are many equipment such as VCD players, DVD players, printers, fax machines, mobile phones, and so on. Each of these appliances will include a CPU and unique hardware to fulfill the application's specific requirements, as well as embedded software that is performed by the processor to meet those requirements. The embedded software is sometimes known as "firmware." Here, we are utilizing the embedded technology in the tactile system, which is utilized to guide the blind on the direction of a stroll. The technology is intended to provide navigation for huge, complicated venues such as conference halls, theatres, and other relevant settings. Furthermore, the instrument is designed to be as inexpensive and simple as possible. This solution requires only a USB stick and an Android or iOS handset that can connect through Bluetooth [1]. Guidance using rotational and directional vibration patterns, wearable Cognitive Aid System for Blind People, wearable obstacle detection system based on neuro fuzzy, ARGUS autonomous navigation system, Goren-Goz, a white stick named NaviBaston, and Sesli-Adimlar are just a few of the visually impaired applications described in the literature [2,3]. A portable mid-range localization system with infrared LEDs provides a versatile indoor/outdoor pedestrian guide system for the sight impaired.

A fixed active beacon and a receiver using an ultrasound time-of-flight method, as well as a differential infrared intensity method that can give a uniform signal field of more than 30m, are also shown. [4]. For visually impaired people, detecting objects and obstacles encountered during route following is critical, but so is tracking the person's location and following his or her trajectory, because the person's location must be correlated with the stored environment in the navigation environment's interface [5,6]. Ultrasonic distance measurement devices, optical systems (stereo vision systems [9, 10]), infrared sensors, and other technologies [7, 8] can identify obstacles.

2. RESEARCH AND MECHANISMS FUNCTION OF TACTILE SYSTEM USING EMBEDDED TECHNOLOGY

- The tactile system employs a tactile device, which is a mechanical equipment that uses touch to assist those with disabilities such as deaf-blindness in determining the direction of a walk.
- • The first is an information provider–it is the system responsible for the recognition of spatial localization and geographical positioning. Systems with an electronic compass are widely utilised.
- • A second part makes judgments, which is usually a computer and specifically built software. It determines the projected travel direction using information from the first block and the built-in knowledge base. It could include maps and possible safe trajectories.

  • A third block is in charge of providing information on suggested movement directions to the blind person. Wear is looking into the prospect of using haptic perception to offer relevant information. Tactual perception in which both the coetaneous and kinesthetic senses provide crucial information about distant objects and events is referred to as haptic perception.

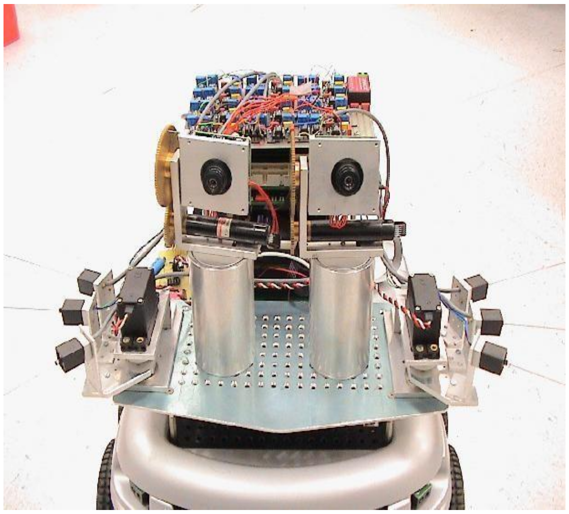

Fig.1 Tactile device

The coetaneous sense is produced by a tactile device and refers to the perception of stimuli on the skin's outer surface. It is caused by stimulation receptors in the skin and the nerve system that controls them. A mechanical stimulus delivered to the skin is processed both temporally and spatially. As a result, transmitting information through skin sensation necessitates conveying compressed information through either a hearing in tact intermediary or a speech-to-tactile transduction device. This study describes an experimental system for transmitting walking direction information via vibrotactile stimulation. Nowadays, haptic gadgets are frequently employed. The majority of them are buried in practically every GSM phone, allowing you to answer the call without startling others.

3. USE OF VIBRO ACTUATOR IN TACTILE DEVICE

The vibrotactile actuators should be small in size, low in power, and produce discernible vibrations. These massive actuators with amplitude adjustment and a wide frequency range of vibrations were outfitted with a big and powerful permanent magnet.

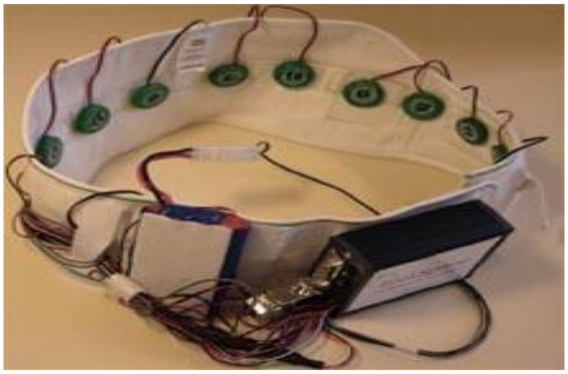

Fig.2 Vibrotactile Vibrators

They are built around small DC motors with an imbalanced load attached to the shaft of the rotor. The frequency and amplitude of vibrations, however, cannot be controlled. These vibrators, on the other hand, have a minimal power consumption, which allows for the creation of a battery-powered gadget. A vibroactuator is made out of a tiny DC motor enclosed in a plastic housing. The case has an adhesive plane on one side. It enables the vibrator to be connected to the belt. Hepatic and vibrotactile devices are extremely important for the blind. They are used even for graphical information representation. Vibrotactile devices can also be used to draw the attention of waterways in traffic. The primary goal is to create a means for conveying information to the blind utilizing vibrotactile technology.

4. COMPONENTS

HARDWARE

The controlling unit is developed around the ATMega48 microcontroller (Atmel).

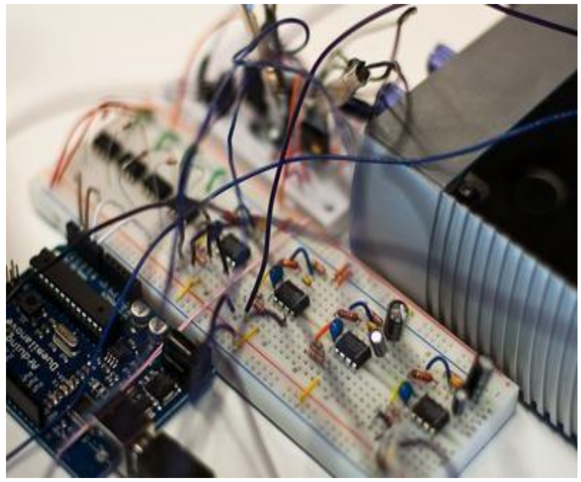

Fig.3 Actuator Circuit Design

The microcontroller has the ability to control up to four vibroactuators (in the presented study only two of them were used). The Darlington pair of NPN transistors is used to construct the drivers. The microcontroller memory contains the vibrator control algorithm. Because the amplitude and frequency of vibrations are defined by the manufacturer, another vibration control approach was devised.

- There are two possible states for the vibroactuator:
- **ON**
- **OFF**

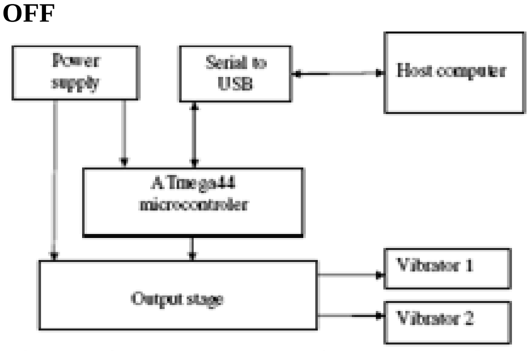

Fig.4 Block diagram of the system for controlling of the vibroactuator

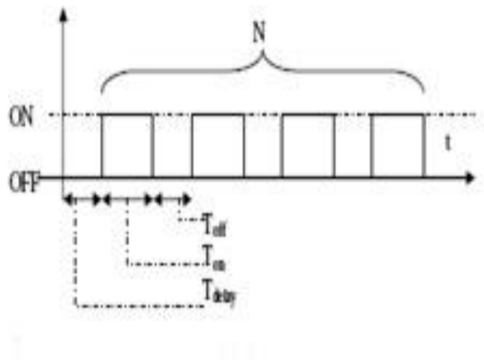

Fig.5 Possible sequence scheme
of activating the vibrator

Each vibrator could be activated for the period TON and then deactivated for the period TOFF, and this could be done N times. T delay is the time elapsed between vibrators. Time has a resolution of 10ms and is a 16-bit variable, whereas Ni is an 8-bit value. T delay, T on, T off, and N could be separately configured for each vibrator through serial interface. Each vibrator receives a separate command for delivering sequence parameters. The parameters are saved in the microcontroller's memory, and the same sequence can be utilized multiple times. The conventional EEG system was used to conduct an objective assessment of touch sensibility. The EEG device used may conduct an evoked potential investigation with a stroboscope lamp.

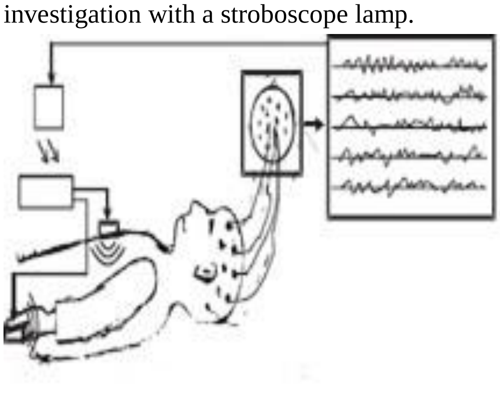

Fig.6 Setup for the objective study

Because the EEG system was constantly utilised in clinical practise, it was important to build an optically triggered vibrator driver. Every stroboscope flash activates the vibrator for an indeterminate period of time. A 500ms period was employed.

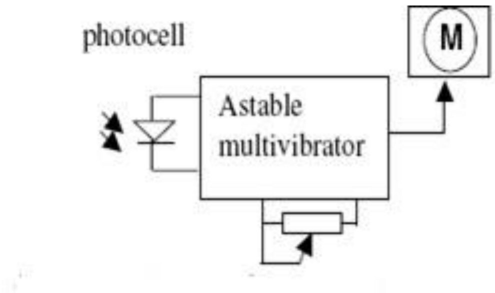

Fig.7 Block diagram of the optically triggered vibrator

SOFTWARE

A specific game has been designed to test the recognition of commands sent via vibrators. Only three states have been chosen to decrease the quantity of information to remember:

- GOSTRAIGHT
- TURNLEFT
- TURNRIGHT

The initial settings of the vibrators can be loaded into the microcontroller's memory via a PC software. The computer selects one of the states at random, sends it to the microcontroller, and initiates a single vibration scheme. Two vibrators are affixed to the examined person's left arm above the elbow. The examined person resolves the command in response to a vibration pattern. All data, including the response, has been saved in the form of a list, which may be saved as a daftest file. Any additional software can be used to analyse the answer in connection to the command. It is necessary to consider the use of two vibrators to reduce power consumption.

The experimentalist was made up of a laptop and a custom-built electrical circuit that controlled the vibrators. The humorous belt was fastened to the vibrators.

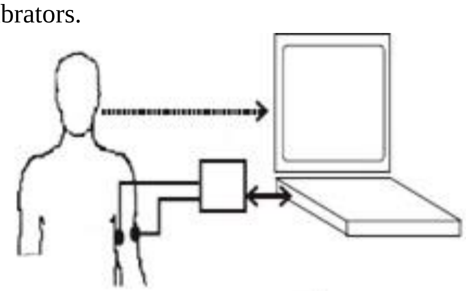

Fig.8 The setup for testing of understanding the communicates sent via vibrators

5. MODES OF VIBRATOR ACTIVATION

Vibrators can be actuated in a variety of ways. Information can be sent using one to four vibrators that can work simultaneously, providing a wide range of options. The power demands of the two forms of vibrator excitation, among others, were used in the study in mobile devices. The time delay between vibrators V1 and V2 was chosen for command coding. Two vibrators were describing the "advance" command at the same time. The vibrator V1 was activated before the vibrator V2 in the left direction. The opposite pattern was employed for the right direction. Tables 1 and 2 include the parameters for two randomly chosen systems. The gathered parameters differ in terms of pulse delay time and number of pulses per communicate (Table: 1).

TABLE 1: PARAMETERS OF STIMULUS NO 1

		T_{delay} [ms]	T_{on} [ms]	T_{off} [ms]	N
FWD	V_1	100	100	100	1
	V_2	100	100	100	1
LEFT	V_1	100	100	100	1
	V_2	200	100	100	1
RIGHT	V_1	200	100	100	1
	V_2	100	100	100	1

TABLE 2: PARAMETERS OF STIMULUS NO 2

		T_{delay} [ms]	T_{on} [ms]	T_{off} [ms]	N
FWD	V_1	100	100	100	3
	V_2	100	100	100	3
LEFT	V_1	100	100	100	3
	V_2	150	100	100	3
RIGHT	V_1	150	100	100	3
	V_2	100	100	100	3

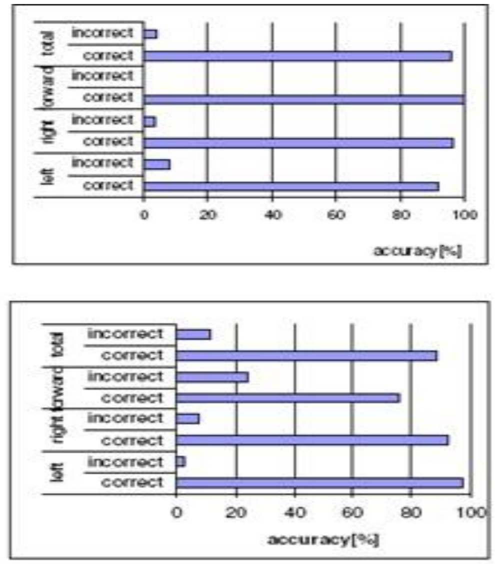

Fig.9 Result of recognizing vibration patterns by blind person (first patter and second pattern)

Averaging 80 electroencephalographic waves demonstrates that stimulations have an effect on recorded EEGs. Furthermore, it is visible in the predicted brain locations (somatosensoric ones). The subjective examination results are shown in Figs. 9 and 10, respectively. Figures show the results of three separate instructions recognised using two different stimulus coding procedures. Data for blind and normal subjects were compared. Without input from the system, each examination required at least 100 questions. The results presented show that the first pattern (Table1) was more effective, with many fewer errors recorded.

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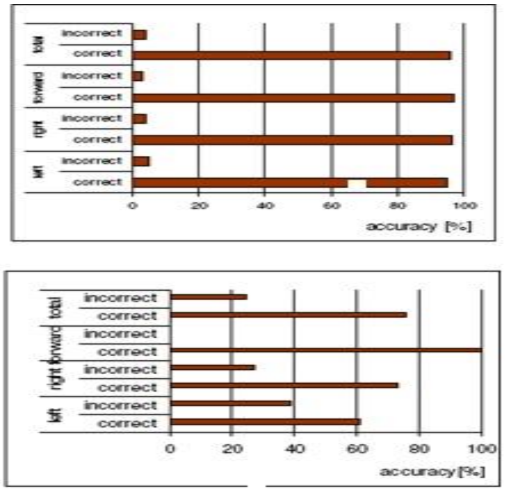

Fig.10. Result of normal patient examination
a) first pattern, and b) second pattern

6. CONCLUSION

A simple and dependable tactile system comprised of two vibrators placed on the left and right arm of the shoulder and producing vibrations via haptic perception has been designed. It allows the user to choose the best vibration parameters for signaling movement direction. This article demonstrated that the blind person was more sensitive and accurate in distinguishing vibration patterns. In order to ensure the best command discrimination, the appropriate citation pattern and quantity of vibroactuators must be used.

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