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A Braille Language Based SMS System for Blind-Deaf People

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***Abstract* - Braille is a tactile writing system used by a blind and the visually impaired. It is a traditionally written with embossed paper. They can write Braille with the original slate and stylus or type it on a Braille writer. In this project we are developing a new methodology using a Braille system in order to read a message for a blind-deaf people. Here we are using a GSM modem to receive a message the contents/letters of the message can be read by blind people easily just by feeling the vibration of the vibrator motor and the same contents/letters will be displayed on the LCD so that even deaf people can easily read it. Buzzer is working as a message alerter. This system introduces a new communication channel for the deaf blind and visually impaired people which consist of dissimilar subsystem providing services to improve the communication skillfulness of the visually impaired people. The proposed system is to help the blind and deaf person to use these applications through tactile communication. This project describes a bidirectional and bilingual translation system to facilitate communication.**

***Index Terms* – Arduino UNO, Vibrator motor, LCD, Buzzer, GSM, Keypad.**

INTRODUCTION

Braille is the main system of conveying information by tactile sensation, and it was designed for visually impaired people. There are more than 200 million visually impaired people in the world, and this number is on the rise [1]. Braille is easily accessible in everyday life, but mainly provides information for guidance in public facilities and cannot provide personalized information for individuals. Meanwhile, as technology advances rapidly, it has become possible to access desired information anytime and anywhere through portable personal devices such as smartphones, but it mainly provides information through a visual display. Therefore, the development of the braille device is essential to reduce the gap of information acquisition between visually impaired people and non-disabled people. A refreshable braille display solves the intrinsic problems of braille that it cannot reproduce different information and is bulky. Various principles have been applied to the refreshing mechanism [2], [3], [4], [5], [6] but the most universal principle is piezo-actuator based braille display module [7], [8]. These actuators automatically raise and lower braille pins but are limited to displaying braille information. A braille cell is composed of 6 to 8 pins and represents a single character, and the pin-to-pin and cell-to-cell spacing are different, which means that there is a limit to expression of information other than text information. In this regard, research on tactile display have been conducted to provide two-dimensional (2D) information through an even pin-to-pin spacing of array type display [9], [10]. If 2D information is provided, not only text, but also graphical information such as pictures, maps, and plots can be expressed [11], [12], and more interactive expression can be represented [13]. This will help visually impaired people in education, mobility, and life convenience, and non-disabled people will also be able to use it in environments with limited vision. In order to satisfy the small pin-to-pin spacing for all pins, the actuator must be much smaller, and at the same time, they must be able to produce a protruding force that can be felt through our fingers.

Tactile displays are also being researched based on various operating principles, and we propose an actuator based on an electromagnetic (EM) principle. An EM actuator is composed of the voice coil and permanent magnet and utilizes their attractive/repulsive force. It is mainly applied to the vibration motor of portable devices due to its low operating voltage and ease of miniaturization [14]. Since refreshing braille has a relatively simple mechanism, requiring only linear motion (up and down), applying EM actuators to braille display seems appropriate. However, application to a tactile display requires several challenges. First of all, an EM actuator moves the magnet through the magnetic force, which means that the magnetic interference with the surroundings must be considered. In order for the finger to detect the curvature while moving on the display, the braille pin must maintain a certain amount of protruding force, especially if intended to remain as a fixed statement for some duration. On the other hand, the generated magnetic field must be weak so as not to affect the surrounding pins during driving. This will have a trade-off relationship and must be resolved through the design of its magnetic structure [15], [16]. Second, the issue of heat generation should be considered. The tactile display consumes energy not only when driving the pins, but also when maintaining the positions of pins. Since the continuous flow of current on the solenoid generates heat, heat dissipation was an essential condition for the design of the EM actuator [5]. Finally, the energy consumption should be considered. Since the tactile display is composed of a large array of pins, the energy consumption per each pin must be low. In particular, to be applied to portable devices, the energy consumption rate needs to meet the power and capacity limits of its battery.

In order to meet the considerations, various design concepts of structurally locking the braille pins have been applied to the EM actuator [11], [17], [18], [19]. However, as mechanical complexity increases, longer coils are needed to overcome friction problems. As with piezo actuators, the array of thick actuators in a display is difficult to implement a portable device in terms of volume and weight [10]. In this research, we focus on the tactile display for portable devices and use the following research questions: How can one generate large protrusion force with an EM actuator in a small volume? How can one achieve low energy consumption with a braille display which is composed of a large array of EM actuators? We describe our solution to the preceding questions in the following sections.

LITERATURE SURVEY

Louis Braille is considered the teacher of blind people. He was born in France in 1809 and became completely blind at the age of five because of eye injury. He is the inventor of Braille alphabet writing/ reading system which allows blind people to easily communicate. UNESCO has universalized Braille alphabet in 1950 [3], and in 2005 has considered the Braille alphabet system as a "vital language of communication, as legitimate as all other languages in the world."

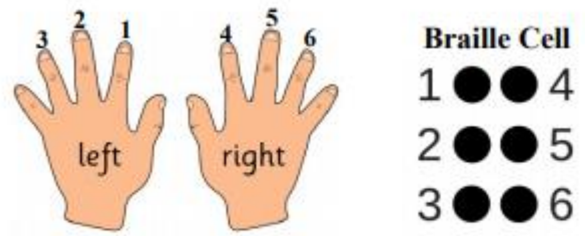

Fig. 1. Matching of vibro-tactile braille display vibrators and braille cell

The blind people have two options to access electronic contents: tactile displays and text-to-audio conversions which are not preferable in some cases [4]. Tactile displays use pins that move up and down to generate braille characters and mathematical notations. Braille is a prominent language for blind people. Braille alphabet letters, punctuation, numbers, and mathematical symbols are represented in patterns of six embossed raised dots which is called a Braille cell as shown in Fig. 2. Braille system consists of 63 symbols represented by six dot's combination (3x2), where each set of dots forms a character [5]. A conventional Braille keyboard involves six main keys which each key is paired with one of the six dots of the braille cell and one more key for the space function. The blind user needs to simultaneously press the intended set of keys in order to input a braille alphabet character. In the past few years, as technology has evolved, researchers and scientists have developed new technologies to help the visually impaired people to engage in society by facilitating their literacy process and promoting cultural and scientific exchange opportunities, some of the previous studies in this field are reviewed below.

A Braille-based writing system compatible with mobile phone touchscreen devices was proposed in [6, 7, 8]. The proposed system allows visually impaired people to input text on the mobile touchscreen devices with auditory channel feedback. Entry a Braille text on Smartphone as in [9], where matrix cell of 3 x 2 size is displayed on screen of Smartphone. The system gets an input when the matrix cell is touched in a certain pattern, and then examines it and translates it to the matching English character. In literature, many works used the vibro-tactile feedback to enhance users' performance with touchscreen devices as in [10, 11]. as in [12], different vibration patterns was used to convey progress information, such as users' scrolling rate and position on the screen, while in [13] it was possible to send semantic information with using only one actuator through different vibration features such as frequency, rhythm, and strength. In [14, 15], multiple actuators were used in order to produce different patterns of vibration and may flow in one direction to simplify the interaction with mobile devices for blind people. Body-Braille system was presented in [16]. It is a system designed to assist deaf-blind people to communicate by attaching six vibration motors on the users' whole body. In [17], an innovated low-cost Braille hand glove was proposed. The developed Braille hand glove contains six vibration motors which are positioned on the five fingers and on the palm. For reading a character from the computer, then the vibrators motors will be actuated corresponding to the Braille code that represents the Braille character cell. Moreover, the user input text characters to the computer through hand gestures of all the Braille codes by implementing slot sensors on each finger of the glove and one on the wrist. These Braille codes are generated based on the hand gestures and then wirelessly sent to the computer that process and convert them and display the corresponding alphabets.

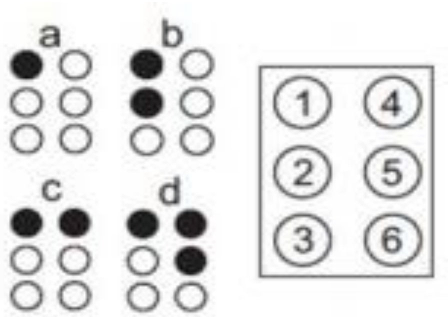

Fig. 2. Braille alphabet letters a, b, c and d

In [18], UbiBraille system was proposed which is a vibrotactile reading device that allows the blind people to read textual information. The UbiBraille system consists of six rings augmented with vibrotactile capabilities and they are worn on the index, middle, and ring fingers of both hands. The device communicates the letter by simultaneously actuating vibrators on the fingers based on the Braille code cell. Generally, previous works have revealed that vibrotactile signals could be used for communication and conveying the semantic information and especially when no auditory or visual feedback is available. Furthermore, controlling the features of vibration such as frequency, rhythm, and intensity, allows generating of informatics feedback. In this paper, a new Braille-based vibro-tactile reading and writing system is presented as described in the following section III. The proposed system provides an alternative reading\writing method that does not rely on attachments of any sensors or actuators to the body of blind users. Therefore, the users do not need to wear any gloves or rings.

DESIGN AND IMPLEMENTATION

This section describes the design and implementation of a Vibro-Tactile Braille (VTB) reading and writing system. As shown in Fig. 3, the proposed system consists of an Arduino MEGA Microcontroller, VTB display which consists of six vibration motors connected to the microcontroller as outputs, and the Braille keyboard which consists of nine buttons connected to the microcontroller as inputs, and finally a GUI run on a computer for configuring the Braille display and keyboard system.

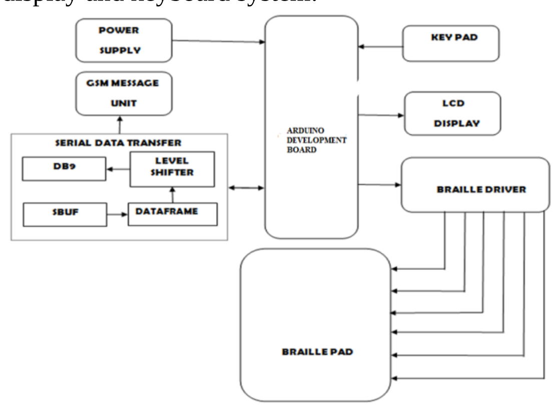

Fig 3: Block Diagram

Hardware Requirements

- Arduino UNO R3
- Gsm Modem
- Keypad
- Lcd Display
- Vibration Motor
- Motor Driver
- Power Supply

Software Requirement

- ARDUINO IDE
- Embedded C

HARDWARE IMPLEMENTATION

Arduino UNO

The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by arduino. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under Common Creative Attribution Share-Alike 2.5 license and is available on the arduino website. Layout and production files for some versions of the hardware are also available. "UNO" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The UNO board and version 1.0 of arduino Software (IDE) were the reference versions of arduino, now evolved to newer releases. The UNO board is the first in a series of USB arduino boards, and the reference model for the arduino platform. The ATmega328P on the arduino UNO comes preprogrammed with a boot loader that allows uploading new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol. The UNO also differs from all preceding boards in that it does not use the FTDI USB-to serial driver chip. Instead, it uses the Atmega16U(Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Fig -2: Arduino Board

LCD

Liquid Crystal Display (LCD) is used to display the output to the user in the form of GUI (Graphic User Interface) and a mono chromatic display. LCD used in this project is JHD162A series. There are 16 pins in all. They are numbered from left to right 1 to 16 (if you are reading from the backside). Generating custom charcters on LCD is not very hard. It requires the knowledge about custom generated random access memory (CG-RAM) of LCD and the LCD chip controller. Most LCDs contain Hitachi HD4478 controller. CG-RAM is the main component in making custom characters. It stores the custom characters once declared in the code. CG-RAM size is 64 byte providing the option of creating eight characters at a time. Each character is eight byte in size.

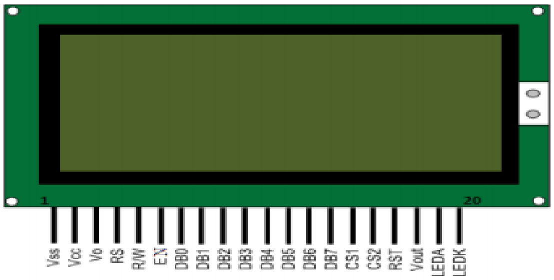

Fig 3: LCD

GSM Module

An energy meter is a device that measures the amount of electrical energy supplied to or produced by a home or building. The most commonly used energy meter is kilowatt hour meter. Instantaneous power is calculated by taking the product of the instantaneous current and voltage. This instantaneous power is then integrated against time to give energy used by the consumers. The meters are classified into two basic categories, electromechanical and electronic. The energy consumption is calculated by using the output pulses of energy meter. The load is said to consume 1 unit of electricity when the internal counter of microcontroller counts upto 3200 pulsesGSM engine works on frequencies 850MHz, 900MHz, 1800MHz and 1900MHz.It is very compact in size and easy to use. It is designed with RS232 level converter circuitry, which allows you to directly interface PC serial port. The baud rate can be configurable from 9600-115200 through AT command. Using this modem, you will be able to send and receive SMS and also connect to internet via GPRS through simple AT commands.

Fig-4: GSM

VIBRATOR MOTORS

An Eccentric rotating mass vibration motor (ERM) uses a small, unbalanced mass on a dc motor, when it rotates it creates a force that translates to vibration. A miniature DC vibration motors have the benefit of being easy to implement and are low cost. A small vibartion motor can be integrated into a design so that equipment operators and users can rely on the sense of touch, no longer requiring line of sight or high volumes. This is one of the obvious benefits with mobile phones, you can receive notification when a device is in your pocket without disputing those around you. Now there are a wide range of application that use this tiny vibration motors to offer vibration alert notification and haptic feedback.

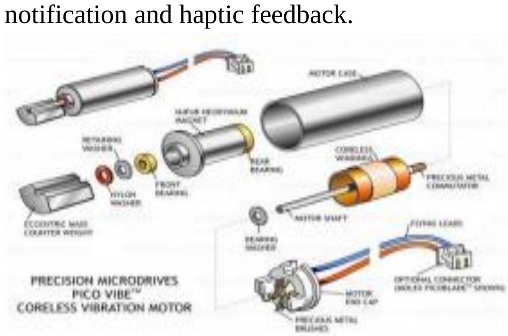

Fig-5: Vibrator Motor

Keypad

An alphanumeric keypad is a keyboard that contains both numbers and letters on the same keys. Typically, they are found on telephones and cellular phones. They also can appear on laptops, ATMs or any device where both numbers and letters are equally necessary. There is half a second delay in characters of a same button. For example button 1 is printing 1a,b,c. Now if we want to print b, press button 1 first time then within half a second press it second time, then in half a second press it third time and b will be displayed on the 20x4 LCD. If you do not press the button in half second you will stuck to the last printed character and will be unable to go next character.

Fig 6: Keypad

RESULTS AND DISCUSSION

The hardware implementation is shown in figure 7, it has two sections. The first section transmitter consists of Braille keypad interfaced with microcontroller. The purpose of microcontroller is to converts the Braille key signal into equivalent English code by using the lookup table. The lookup table is nothing but equivalent hexadecimal code of Braille alphabet or words; they are stored inside the microcontroller. The 8K Bytes of In-System Programmable (ISP). Flash Memory is used to store the lookup table. As any person hits the Braille key the microcontroller receives the key code and matches with internal key code stored in lookup table. From figure 2 the OK button is used to enter the first character and allow concatenation of second character into one string. The SPACE button is necessary to enter a space in two strings. The internal registers of the microcontroller hold the message. The SEND button is used for passing the message hold by the register to the GSM modem. But the application software in the microcontroller first encloses the message into AT commands as listed in table 1. The AT commands initialize the GSM modem and activates the message services. Once these services are activated on GSM modem, the message is transmitted to the recipient mobile.

The second section is receiver, it is essential to receive a message. When a sender sends the message to the blind person then his mobile is interfaced with the microcontroller. The microcontroller receives the message through the AT commands and converts the letters of the message into the equivalent electrical signals of Braille language by using the lookup table which are stored in the internal memory of microcontroller. These electrical signals are fed to activate the 6-relay stack with solenoid valve interfaced with microcontroller. To understand the received message the blind person has to place his hand over the stack of solenoid valve, the valves are arranged in such a way that the person can understand looks like Braille letters. An electrical signal energizes the relay, and the respective solenoid valve does vibration and these vibrations are sensed by the blind person.

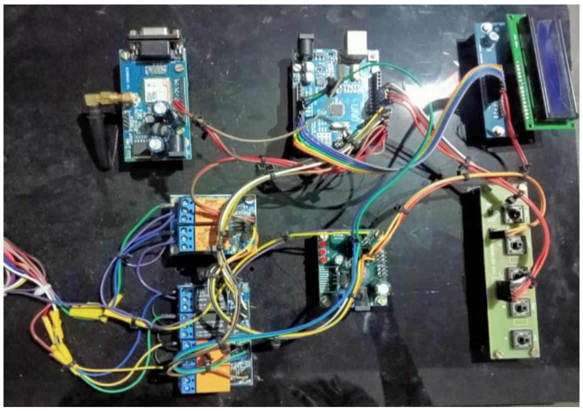

Fig 7: Experimental Setup

CONCLUSION

The advanced messaging system for blind people is based on the conversion of Braille key to text and Text to Braille key with the use of two microcontrollers. The system performance and various parameters are tested for proposed systems. The algorithm designed for conversion time, data transfer and receive rate execute in 0.1 microsecond. For multiple messages the blind person has a provision to change the operating speed of the microcontroller. By varying speed the blind person can read the letters of the message simultaneously. As far as the cost point of view the most expensive component of the system is the solenoid Braille cell to read the message. In future vibrating touch screen devices may replace these expensive components In future the system has scope to read and access emails, newspaper etc. With some modification we can also help these peoples to access home appliances. And this system truly becomes more efficient, smaller in size and cost minimum system.

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