Assistive Communication System for Deaf-blind People Using Multimodal Interfaces

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***Abstract*—Like anywhere else in the world, a wide range of the population in India needs assistive technology, including those with disabilities, those with long term medical conditions, the elderly, as well as anyone who experiences temporary or functional decline over the course of their lives. Combining vision and hearing loss, deaf-blindness restricts both visual and audio communication. The patient's capacity to communicate, learn, work and live independently are completely hampered by this condition. Currently, tactile sign language, tactile finger spelling, print on palm, tadoma are the available communication techniques for the deaf blind. The disadvantage of the current options is that a person must always accompany the patient to help. Here, we emphasize the tactile sensation of these people which can be used for their communication. The development of an intelligent communication tool for deaf blind person is the suggested solution. The advantage of the system is that normal individual will be able to communicate with deaf blind. The device transforms the audio from the normal people to text, which is then translated to Braille that the deaf blind can recognize. The Braille system is made up of Braille cells that operate under the principle of magnetism and electromagnetic induction. The proposed method also has the benefit of being portable, compact, and user friendly.**

***Index Terms*—Braille, Tadoma, Tactile, Electromagnetic induction**

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I. INTRODUCTION

Deafblindness is a unique and isolating sensory disability resulting from the combination of both hearing and vision loss or impairment. This has a significant effect on communication, socialisation, mobility and daily living. Dual sensory loss and dual sensory impairment are other terms that are used for deafblindness. Studies have reported from 0.2% to 2% of the population may be deafblind One study reported 36% of individuals over the age of 85 years are deafblind [1].There are mainly two types of deafblindness:congenital deafblindness and acquired deafblindness.Congenital deafblindness is a term used when people are born deafblind or when their combined hearing and vision impairment occurs before spoken, signed or other visual forms of language and communication have developed.People who are born with vision and hearing that deteriorates at a later stage in their life through accident, injury

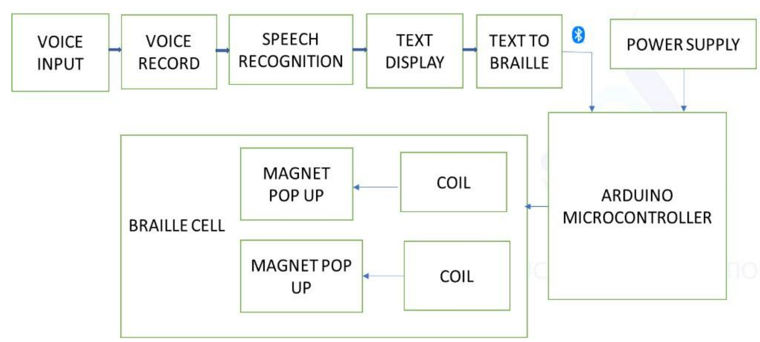

Fig. 1. Block diagram of the system

or disease termed as acquired deafblind.Deafblindness affects a person's ability to access information, to communicate and socialise. This can lead to feelings of isolation. Communication preferences for people who are deafblind may involve the use of a combination of methods. Print on palm, tactile signing, lip reading, Braille and use of other communication devices are some of the communication methods that may be used with people with deafblindness.

Many innovations are developed for the same objective.An electromagnetic based braille display that can represent two dimensional information using flip latch technology was proposed in [2].A novel concept on reading assistive technologies for the blind was introduced in [3]. The main parts of a braille translator and tactile terminal have been technically over viewed in the paper. The communication aid for deafblind is a device designed to help individuals who are both deaf and blind to communicate more easily.The Fig1 shows block diagram of the entire proposed solution. This device uses the principle of electromagnetism to convert voice from a person into braille, allowing the deafblind person to read what is being said to them in real-time. By converting spoken language into braille, this device enables deafblind individuals to participate in conversations, engage with others, and access information that might otherwise be inaccessible to them.

The device utilizes an Arduino microcontroller and Google Cloud Speech-to-Text API to convert speech into text, which is then translated into braille through an electromechanical actuation system. The communication aid for deafblind has the potentialto greatly improve the quality of life for individuals who are deafblind, enabling them to participate more fully in theircommunities and access information in real-time.

II. BRAILLE SYSTEM IMPLEMENTATION

A. Dimensions of Braille cell

Braille is a tactile writing system used by people who are blind or visually impaired. It consists of raised dots arranged in a specific pattern that can be felt with the fingertips. A braille cell is a unit of six dots, arranged in two columns of three dots each. Each dot in the cell can either be raised or not raised, creating 64 possible combinations, including the blank cell [4], [5].

The dimensions of a standard braille cell are approximately 2.5mm in height and 1.5mm in diameter. The dots themselves are roughly 0.5mm in height and 1mm in diameter, with a spacing of 2.5mm between dots in the same column and 6mm between dots in adjacent columns.

In this project, the dimensions of the braille cell are crucial to ensuring that the electromechanical actuation system accurately raises the correct dots to form the correct braille characters. The actuation system must be able to position the pins with high precision to ensure that the dots are properly raised and spaced according to the braille standard. Any errors in the positioning or spacing of the dots could result in unreadable or incorrect braille characters, making the device ineffective for communicating with the deafblind user.

B. Design of Braille cell

The activation of each cell depends on the alphabet. We considered the concept of electromagnetic when creating the braille cell. The braille cell was created in a way that the dot is activated by electromagnetic induction. In other words, the dot will rise when an electrical input is given, and it will fall when an input is not given. Electromagnetism aids in the popping up and down motion. [6], [7].The Fig2 shows the mechanism of the working of a Braille dot.

The solenoid that we bound in the body of the braille dot receives electrical input. The bodily component functions as a north and south poled electromagnet when an electrical input is applied. The bodily part’s one end transforms into the north pole and the other into the south pole. This electromagnet causes the magnet, which is positioned between the body part with the aid of a magnet holder, to respond. The magnet holder either attracts or repels to its respective poles depending on the electrical input. This attraction makes it possible for the dot to appear.

C. Driver circuit for Braille system

In this project, we use L293D motor driver module for the working of the braille cell. The motor driver acts as an interface between the arduino microcontroller and the braille

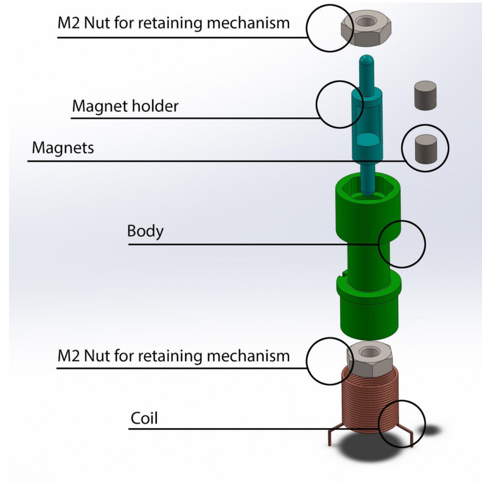

Fig. 2. Design of the Braille cell

cell. The input from the micro controller is received by the driver motor, and then according to the input, the motor driver will send the signal to the braille pin. Thus, with the help of motor driver, the pop-up and pop-down of the pin takes place smoothly. L293D is a dual H bridge motor driver IC which allows DC motor to drive on either direction.L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction.The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. One H-bridge is capable to drive a DC motor bidirectional. The H-bridge is an electronic circuit that looks like the letter H. An H-bridge is used to drive a load, such as a brushed DC motor, in both directions. And it controls the flow of current to a load.In this system, the H-bridge concept is used to control the up and down motion of the braille pin. In braille, the alphabet representation for each alphabets have significant variations. The pattern for each alphabet is different, and to change the pattern, or in this case, to control the up and down motion of each pin according to the requirement, L293D motor driver IC is used. With a single module we can connect two braille pins. Since a single braille cell requires six braille pins, 3 different L293D motor driver IC is used.

III. VOICE TO BRAILLE CONVERSION

The initial part of the system is the conversion of voice from a speaker into a text format in real time. This is one of the point that makes this project unique, because in the existing braille device, which is highly expensive, there is no real time conversion of voice of any format. Compared to its high price and inefficiency to convert voice to text at real time, the system proposed in this project is highly advanced and user-friendly. In this system, Google Cloud Speech-to-Text is used to convert voice to text. Google Cloud Speech-to-Text is a cloud-based service that uses advanced machine learning technologies to transcribe audio into text. When you send an audio file or a stream of audio data to Google Cloud Speech-to-Text API, it

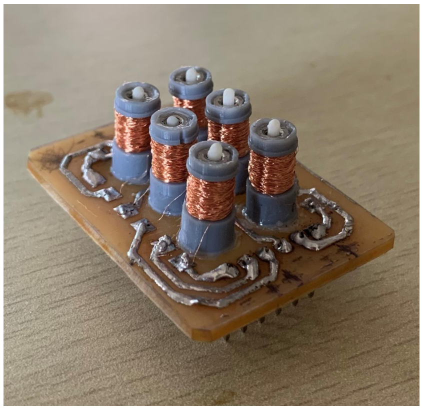

Fig. 3. Implemented Braille system

uses speech recognition algorithms to convert the audio into text.

The audio is processed in real-time, and the API returns a stream of text output, which includes a sequence of text strings representing the recognized speech. The output includes not only the text but also punctuation and capitalization.

The text output that is received here is displayed on the command window of the micro controller,which is required for producing braille output. To display the text in the command window of an Arduino, you can use a serial connection to communicate with the device or a WiFi module is used. You can send the text output from the Google Cloud Speech-to-Text API to the Arduino over the serial connection, and then display the text on the command window of the Arduino.

IV. RESULTS AND ANALYSIS

The outcome of this project is a communication aid for deafblind individuals that converts voice to braille in real-time using the principle of electromagnetism. The device has been successfully designed and developed, and tests have shown that it is able to accurately convert voice to braille. It has the potential to significantly improve the communication abilities of deafblind individuals, allowing them to have more independence and access to information. However, further testing and improvements may be needed to optimize the device's performance and ensure its reliability. Overall, this project demonstrates the potential for technology to improve the lives of people with disabilities.

The device developed in this project has several achievements:

- Real-time communication aid: The device enables real-time communication between deafblind individuals and others by converting voice to braille.
- Portable: The device is designed to be portable, allowing deafblind individuals to carry it with them wherever they go.
- Low-cost: The device is designed using low-cost materials and components,making it affordable for deafblind individuals who may have limited financial resources.
- High accuracy: The speech-to-text conversion algorithm used in the device is highly accurate, ensuring that the braille output is an accurate representation of the spoken words.
- User-friendly: The device is designed to be user-friendly, with a simple and intuitive interface that is easy to use even for those with limited technical knowledge.

Overall, the device has the potential to significantly improve the quality of life for deafblind individuals by providing them with a means of communication that is both affordable and accurate.

ACKNOWLEDGMENT

This was part of the final year project for the B.Tech Biomedical Engineering degree. We would like to thank the faculties of Biomedical Engineering Deapartment, Sahrdaya College of Engineering and Technology, for helping us to carry out the project.We would also like to thank Ms. Lavina Joesph, project guide for providing some useful guidelines for the project and Mr. Jibin Jose, the project coordinator for the valuable instructions and comments.

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