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Smart Braille Translator

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Abstract -**The Braille System is commonly used by people who are visually impaired for reading and writing. It uses raised dots arranged in a grid to represent characters. This project aims to create an Enhanced Braille System that can read text. The system scans an image from a camera and uses image processing techniques to convert the text into Braille code. The converted text is then sent to an Arduino UNO, which translates it into Braille code. The Braille display is created using solenoids that move the dots up and down, creating a tactile representation of the text. This project aims to provide an effective means of communication for visually impaired individuals.**

Keywords—**Text to Braille, Braille Display, Image processing.**

1. INTRODUCTION

The system used by the blind or visually impaired to read is called Braille. Braille was created by Louis Braille and is used throughout the blind community. The symbols that represent letters, numbers, and short phrases are formed inside Braille cells. Braille cells are made up of six raised dots in three parallel rows; each row has two dots. Each cell can be used to represent either a number, letter, punctuation, or abbreviation. The blind and visually impaired face a gruelling task when learning to read. The equipment available on the market is expensive and not easily accessible for all. Many of these devices are not user-friendly and may not be suitable for people of all age groups, particularly children.As society advances technologically, visually impaired individuals are often left behind as the majority of new developments and knowledge are designed for those with sight. The technology available to assist them is often either incompatible or too expensive for them to access. These individuals rely on Braille for reading and writing.

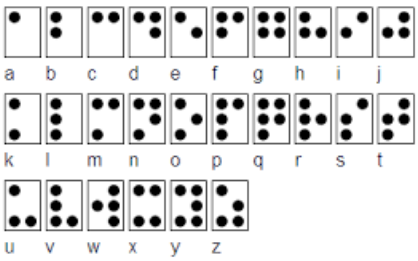

Fig.1 Braille Interpretation

Braille is a writing system created for individuals with visual impairments, where raised dots arranged in specific patterns represent characters that can be discerned by touching them with their fingertips.It was invented by Louis Braille [1]. Specialized schools for the blind are not accessible to the majority of visually impaired children in South Africa due to financial constraints [2]. Various approaches and technologies have been employed to teach Braille. In a study by Lopez and colleagues, they sought to determine the essential features required for a Braille teaching device based on inputs from end-users. They utilized a Kano model to present the device requirements, with the key requirements being availability, affordability, tactile learning, and support for multiple languages. Other features that contributed to customer satisfaction included ease of use, portability, durability, integration of descriptive speech, and more [3]. There has also been an emergence of Braille teaching apps and games that eliminate the need for trainers. These applications serve the purpose of teaching Braille and are not reliant on human trainers. An example of such an app or game is VBGhost [4].

Electronic braille blocks use tactile sensing and simultaneous listening to facilitate Braille learning, but their main drawback is the requirement of one block per character, making the device cumbersome and unwieldy. Past research has often neglected the varied levels of tactile perception among learners, with studies indicating that those born blind have superior tactile sensitivity compared to those who lost their vision later in life. Age and experience can also affect tactile sensitivity. The new learners,

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especially the children, need to be introduced to tactile sensing beforehand [5]. A single-character refreshable display would prove to be very useful to interpret the output precisely. As it would also achieve the standard size, the learners could use it for occasional short reading too; enabling them to practice. This way, the learner would not have to get accustomed to new systems/devices every time he/she decides to change to a new cell size. Various types of actuators are used to create tactile displays, and the selection of the actuator is based on several factors such as bandwidth, resolution, displacements, and force generated by the display. For Braille displays used in learning, a moderate bandwidth with a specific range of forces and displacements is typically required [6].

To effectively support learning, Braille displays typically need a moderate amount of bandwidth, and must be capable of producing a specific range of forces and displacements. Piezoelectric actuators, which are commonly used in Braille displays due to their fast response times, require a high voltage of 100-300V to operate and the resulting products can be quite expensive to produce [7]. The SMA-wire actuators generate a considerable amount of heat during their operation, which requires them to have a mechanism to dissipate heat. In addition, controlling these actuators can be challenging because of the hysteresis effect [8]. Adnan and colleagues' device employs energized solenoids to elevate the braille dots, but it fails to attain the standard braille cell size and dot height [9]. Jun Su Lee's proposal utilizes the hydraulic pressure generated by the volumetric expansion of molten paraffin wax. Nevertheless, the actuation time is a significant issue, as it takes approximately 50 seconds to complete. Therefore, these types of solutions are not yet suitable for developing a functional refreshable braille display [10].

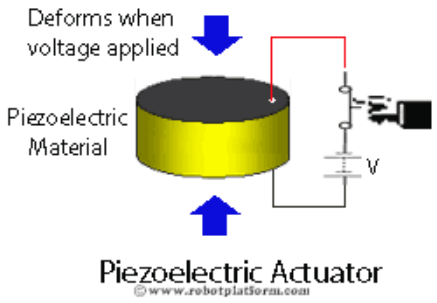

Fig.2 Previous Model

The purpose of this research is to address the issues mentioned earlier by creating a new and accessible refreshable braille display that is portable, cost-effective, and customizable in terms of braille cell sizes. The aim is to facilitate braille learning for visually impaired individuals without the need for additional trainers. The proposed solution includes an alert system, automated physical translation of English into braille, identification of objects and people through image processing, and notification through the braille translator. Additionally, the system can recognize words through images and communicate with a second person through a Bluetooth application at a short range. The goal is to make the braille learning process more intuitive and user-friendly than the current system.

2 .LITERATURE SURVEY

Shahruk Hossain and Abdullah Abyad Raied, in their paper titled “Text To Braille Scanner With Ultra Low-Cost Refreshable Braille Display”, proposed an open-source solution to the lack of access to Braille literature and educational material in many third-world countries. The proposed solution involves a low-cost, refreshable Braille display that utilizes a simple sliding mechanism to generate all Braille characters. Unlike conventional displays, this design consumes very little power and does not require individual slot excitation. Additionally, a mobile app that uses Google's OCR engine is presented as a text scanner that can convert English text from various fonts into Braille in real-time, without requiring an internet connection. This solution aims to make Braille technology more accessible and affordable for those who need it. Huang Jingyu, Dou Shilei, Xu Luning, and Han Li in their paper titled “Modeling Of Refreshing Rate And Its Parametric Analysis Of A Multi-Lines Braille Display Using Electrorheological Valves Matrix”, proposed Maintaining an appropriate refreshing rate of Braille dots is crucial for multi-line Braille displays that utilize electrorheological (ER) valves matrix, to cater to the reading needs of visually impaired individuals. A lower refreshing rate can discourage them from using the display, forcing them to rely on auditory learning. The ER valve’s flow rate, which acts as an actuator for each Braille dot, governs the refreshing rate. To understand the impact of critical ER valve parameters on the rate of flow, a mathematical model was created. The study found that the operational governed voltages of ER valves should exceed 1kV to achieve the desired refreshing rate for visually impaired people. Increasing the tolerance of channel parameters can reduce the minimum value of operationalgoverned voltages. These findings may be useful in the design of ER valves.

A M Muntasir Rahman and Shaker Mahmud Khandaker, in their paper titled “A Portable Braille Refreshable Display Using Micro Servos”, have proposed a refreshable braille display being a step towards smart braille devices. This paper proposes a single-cell refreshable braille display model that utilizes micro servos instead of solenoids or lead screw actuation to create various braille symbol patterns representing alphanumeric values or contracted words. While many existing refreshable braille displays perform well, this proposed model is distinguished by its portability, simplicity, and cost efficiency. A prototype of the model was built, and an experiment was conducted to demonstrate its efficiency, cost-effectiveness, and portability. The findings suggest that this particular model

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might be a more suitable option for creating refreshable Braille displays that are both affordable and easy to use.

In their scholarly article titled "A Dual-Purpose Refreshable Braille Display Based OnReal-Time Object Detection And Optical Character Recognition", K M Naimul Hassan and Subrata Kumar Biswas introduced an innovative braille system that offers two key functions to address the needs of individuals with visual impairments. This system is comprised of real-time object detection, which provides the user with information about their surroundings, and optical character recognition, which enables the user to read characters in both English and Bengali. The authors provide a detailed account of the methodology employed in this proposed system. The system leverages a pre-trained convolutional neural network (specifically, AlexNet) to perform object classification, while the OCR engine (Tesseract) in tandem with fundamental image processing is utilized for optical character recognition. Additionally, a refreshable braille display is designed to present braille characters to the user.

Sangeeta Kumari, AkshayAkole, and Pallavi Angnani, in their paper titled “Enhanced Braille Display”, have proposed an improved Braille system to assist the visually impaired in reading text and content. The system involves capturing an image with a camera and processing it using image processing techniques. This image is then converted into text using OCR technology. The recognized text is transferred to a raspberry pi, which identifies each character and converts it into Braille code and displays.

3. EXISTING SYSTEM

The existing system is a collection of different methods and ideas used to construct a stable and efficient braille translation system that physically emulates the language. Some of them do it in real time but all of them have a variety of drawbacks. Piezoelectric actuators are frequently utilized in Braille displays because they have a rapid response rate. However, in order to function, they need a substantial voltage of 100-300V, which can make the resulting products quite costly to manufacture. When SMA-wire actuators are in operation, they produce a significant amount of heat, which necessitates the inclusion of a heat dissipation mechanism. Furthermore, controlling these actuators can be difficult due to the hysteresis effect. Solenoids that are energized are unable to achieve the desired size and height of standard Braille cells. hydraulic pressure actuators take approximately 50 seconds to complete. Therefore, these types of solutions are not yet suitable for developing a functional refreshable braille display.

3.1. DISADVANTAGES

- Speeds of actuators is low.
- Energy losses are high which significantly affect the module.
- Not enough added features in the device, hence it lacks multidimensional properties.

4. PROPOSED SYSTEM

The system that is developed in this project is one that provides a suitable and very efficient solution for the troubles caused by the existing systems. The proposed system employs the usage of electromagnetic solenoid actuators to emulate the function of the braille translation. The system identifies objects that are essential to the user and people that are part of their daily life through image processing and intimates the user through the physical braille translator as well as gives an audio output. The module also processes images with printed text such as words and sentences, and translates it into braille. It alerts the user of sudden obstacles that may appear before them.

4.1 ADVANTAGES

- Quick and efficient translation.
- Very low loss in energy
- Assists the visually impaired to be independent by helping them identify their daily essentials.
- Alerts the person of any incoming obstacle before them.
- Affordable for people of all backgrounds.

4.2. BLOCK DIAGRAM

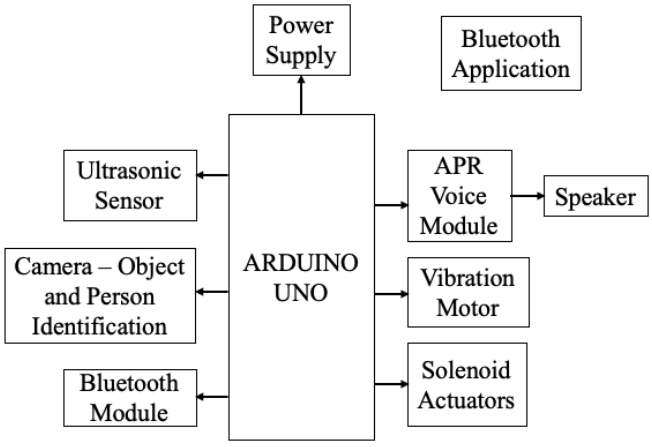

Fig.1 Block Diagram

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4.3 DESCRIPTION

4.3.1ARDUINO

UNO Opensource electronics platform Arduino is built on simple-to-use hardware and software. The Arduino Uno is a board with a microprocessor on it. It has a 16MHz crystal oscillator, 6 analog inputs, 14 digital input/output pins, a USB port, a power jack, an ICSP header, and a reset button.

The article is based on designs for microcontroller boards made with a variety of microcontrollers. For loading programs from personal computers, the board has serial communication interfaces, including on some models, USB.An integrated development environment (IDE) built on a programming language is presented in the Arduino paper.

Fig.2 Prototype of Arduino Uno

4.3.2APR VOICE MODULE

The APR9600 is an affordable and efficient sound recording and playback integrated circuit (IC) that uses a flash analog storage method. This means that recorded sounds are preserved even when the power source is disconnected from the device. The quality of the played-back sounds is excellent, with minimal background noise. With a recording duration of 60 seconds, the sampling rate is 4.2 kHz, resulting in a bandwidth range of 20 Hz to 2.1 kHz for recording and playback of sound. It has 8 record and playable slots that store audio data. Speakers can be connected to play audio data stored in them.

Fig.3 Prototype of GPS Module

4.3.3SPEAKER

An audio device used to play the recordings stored in the APR9600 voice module. The Quality of the audio output depends on the speaker itself.

Fig.4Speaker

4.3.4POWER SUPPLY

A power supply unit transforms mains AC electricity into low voltage, regulated DC power for a computer's internal components. Power supplies come in two varieties: switched mode and a linear mode. Transformers are used by linear power supplies to lower the voltage. When an electrical device needs power but lacks internal components to obtain the necessary voltage and power from the main power, an AC adapter is employed.

Fig.5 Power Board

4.3.5BLUETOOTH

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Bluetooth is a standard wireless technology used to transfer data between mobile and fixed devices over short distances using short-wavelength UHF radio waves within the 2.400 to 2.485 GHz range. Its primary use is for creating personal area networks (PANs). Initially, it was developed as a wireless replacement for RS-232 data cables.

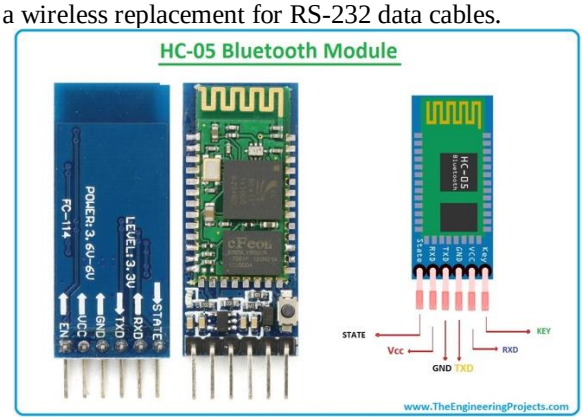

Fig.6HC-05 Bluetooth Module

4.3.6ULTRASONIC SENSOR

An ultrasonic sensor is a gadget that utilizes high-frequency sound waves to measure the distance between itself and an object. This is accomplished through the emission of ultrasonic pulses from a transducer, which subsequently bounce off the object and returns to the sensor as echoes. The unique patterns of these echoes can then be analyzed to determine the proximity of the object. The ultrasonic transducer is activated by a high-voltage electrical pulse, which causes it to vibrate at a specific range of frequencies, thereby generating a burst of sound waves. These sound waves are then reflected back to the sensor if any obstacle is in the path of the ultrasonic sensor, resulting in the generation of an electric pulse.

Fig.7 Ultrasonic Sensor

4.3.7VIBRATION MOTOR

A coin vibration motor is a device that is used to vibrate a larger device. It may be a phone, smart watch, fitness tracker and so on. Its size is typically around 5-6mm. When the Ultrasonic sensor detects any obstacle in front of it, the controller triggers the vibration module to vibrate.

Fig.8 Vibration Motor

4.3.8 CAMERA

A device that captures images and records live videos. It is used to collect pictorial data for image processing purposes. The Daily essential objects and family persons of the blind person are identified using a standard camera.

Fig.9 Camera

4.3.9 SOLENOID ACTUATORS

A solenoid is a device that transforms electrical energy into mechanical energy by using an electromagnet created by a wire coil. It uses the magnetic field generated by the electric current to produce linear motion. The solenoid actuator assembly includes a ferromagnetic plunger that slides within the coil. When power is applied, the plunger is drawn into the coil. A solenoid usually comprises of a coil of magnet wire that is wound multiple times and placed within a frame. The frame serves as a carrier of magnetic flux, which helps in increasing the effectiveness of the solenoid. The term solenoid may also refer to more advanced transducer devices that convert energy into linear motion beyond simple two-position actuators.


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Fig.10 Solenoid Actuator

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4.3.10 BLUETOOTH APPLICATION

A simple application is developed through the MIT App Inventor website. The app is interfaced via Bluetooth to the microcontroller. The application can send text input through a text where the user can type in. The app can also convert voiced input into text and send it. It is suitable for short-range wireless communication between the disabled and their next of kin within the same household.

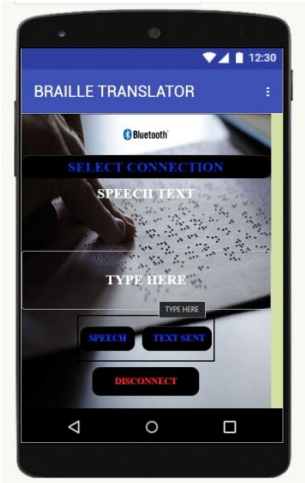

Fig.11 Bluetooth Application

4.3.11 OBJECT AND PERSON IDENTIFICATION USING PYTHON

The object and person identification process is done by Python programming using deep learning packages such as OpenCV. The Module is trained to identify the particular object and persons by using a collection of images. The visually impaired people typically live in a very closed world of their own because it's not easy for them to cope with normal people. A handful of objects are enough for them to get along with their day-to-dayneeds, and they only live with their next of kin. Identifying those essentials with ease will prove all the difference for them.

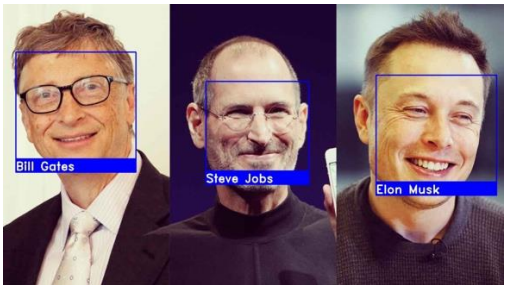

Fig.12 Person Recognition

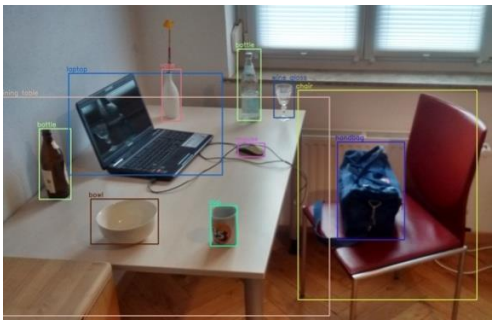

Fig.13 Object Identification

5. RESULTS AND CONCLUSION

5.1 RESULTS

The system that was developed in this project uses Python image processing to identify daily essential objects and the people who are part of the daily life of the visually impaired. The data obtained is then converted into an audio output and a physical braille display output on the constructed device. It notifies the user of intruders in front of them whom they may not recognize and alerts the user of any sudden oncoming obstacle.

Fig.14 Braille Display

5.2 CONCLUSION

The resultant product of the project has demonstrated its effectiveness without any significant limitations. It offers individuals with visual impairments a fresh avenue to engage and communicate with their environment, which could prove to be a substantial boost to their overall quality of life. Those who have been categorized as having different abilities are reliant on the goodwill of others, and it is our responsibility to extend a helping hand and provide all the support and assistance that we can. This project accomplishes precisely that, and it serves as a mere starting point for future innovations in this area.

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