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Voice to Braille, Braille to Voice using Raspberry Pi

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***Abstract*— An essential tool for those who are blind or visually impaired, the Braille system was developed in antiquity and allowed people to interact with the outside world and acquire knowledge. Learning to recognize the tiny tactile dots in Braille is a difficult task for students who are blind or visually challenged. There are several Braille devices available, but their high price makes them unaffordable, particularly in poor nations like India. An inexpensive, user-friendly learning tool with an emphasis on English language acquisition is being created to overcome these problems. Using an Arduino microcontroller, LCD, and solenoid actuators to progressively generate Braille characters and numbers, this creative project combines play and education to enable visually impaired people to succeed in literacy and communication.**

***Index Terms*— Braille Script, Raspberry Pi, FPGA, Mobile APK.**

I. INTRODUCTION

Information access is crucial in today's world, and everyone deserves it. This is especially true for the over 44 million people globally who are visually impaired. They, along with those with other communication challenges, face significant barriers. Thankfully, new technologies are emerging to bridge this gap and empower the visually impaired to better connect and access information.

This initiative tackles communication challenges, especially for the visually impaired. Braille is key. Illiteracy rates are high among this group because of limited accessible materials. Braille, a system of raised dots (see figures 1 & 2), allows the visually impaired to read and write. As a tactile language, Braille unlocks communication, education, and equal access to information.

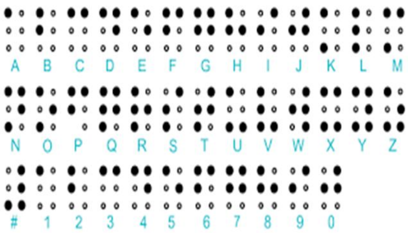

Fig.1 the braille system encompasses the alphabets of the english language.

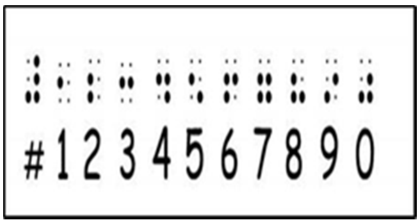

Fig.2 standard braille numbers of english language

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Braille, a tactile writing system, is specifically designed for individuals who are blind or visually impaired Braille, a raised-dot system invented by Louis Braille (Fig. 3) at 15, empowers blind and visually impaired individuals to read and communicate. Traditionally written on paper with a stylus or Braille writer, Braille is now produced quickly using electronic note-takers or computers with Braille printers. Braille's foundation lies in 'night writing,' but Braille's genius was in simplifying it. This tactile code remains an essential tool for literacy and communication.

II. LITERATURE REVIEW

Louis Braille, who lost his sight at 15, invented Braille, a tactile language for the blind. Raised dots represent letters and symbols on specially made Braille paper. Readers decipher sentences by feeling these bumps. Braille paper, first published in 1829, uses a system of six dots arranged in cells. These cells combine to create 64 possible characters, including letters and numbers. Interestingly, when adapting Braille to other languages (which lack the letter "W"), the symbol for "W" became "X," and so on.
Braille goes beyond language. In Canada, currency uses raised dots to indicate denominations. India offers Braille versions of parliamentary acts, and the UK mandates Braille on medicine packaging. Braille printers, essential for creating Braille documents, come in various types but are often expensive and noisy. Funding is a hurdle in India's development of these printers. Project DRISHTI offers a solution, leveraging existing computer facilities for visually impaired users. While innovators like B Dange and A Brahmani have developed Braille printers, their cost remains a barrier.
Braille's role in communication for the visually impaired is undeniable, making initiatives like Project DRISHTI essential. This project tackles Braille printing challenges by exploring dot matrix printers for their accuracy and standard sizing. Trials with Paul Blenkhorn paper have helped refine the method. Project DRISHTI goes beyond limitations: it converts Braille characters from a computer into printable Braille using a table-driven method, making it adaptable for various languages.

III. PROPOSED METHODOLOGY

Despite being vital members of society, blind people face significant barriers to information access. Limited access to computers, the internet, and quality software hinders their ability to learn, contribute to business, and participate in education. Closing this digital divide is crucial. This work explores a cost-effective solution: a Braille-to-text/speech converter using an FPGA Spartan 3 Kit. This system translates Braille input from a keypad into spoken English. VHDL code embedded in the FPGA decodes Braille characters. The resulting text is then converted to speech using an algorithm and displayed on an LCD screen. This innovative approach has the potential to empower visually impaired individuals, fostering better communication and inclusion across all aspects of life.

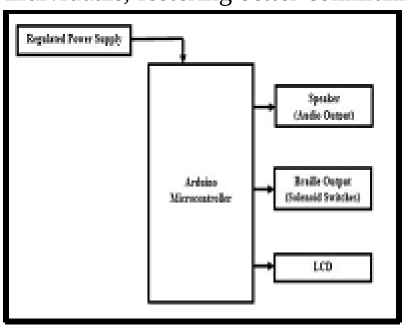

Fig.3 block diagram of the proposed concept

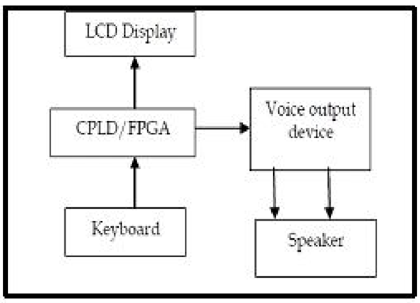

Fig.4 System Block Diagram

This project tackles communication challenges for the blind and deaf-blind with a wearable Braille keyboard. This innovative device translates Braille input into text and speech, promoting better understanding. The special keyboard integrates seamlessly with the system, built on the affordable and user-friendly Arduino platform. This ground breaking gadget empowers those with visual impairments to connect more effectively with their communities.
Braille, a raised-dot writing system, is crucial for blind and visually impaired individuals to access education and communicate. However, conventional Braille keyboards can be challenging. This project tackles these limitations, exploring ways to improve computing experiences for the visually impaired. It proposes a multimodal approach

using Braille input and spoken feedback (through speakers) to overcome the shortcomings of traditional keyboards. This project aims to enhance communication and computer interaction for the visually impaired by promoting greater accessibility and inclusion.

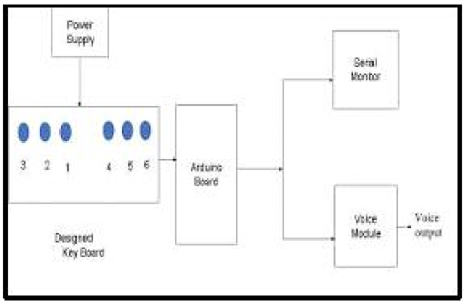

Fig.5 BLOCK DIAGRAM OF PROPOSED SYSTEM

IV. HARDWARE

The Raspberry Pi Pico is a cost-effective and versatile development platform designed around the RP2040 microcontroller, offering the following key features:

i) RP2040 microcontroller with 2MB Flash

The heart of the Pico is the RP2040 microcontroller, equipped with 2MB of Flash memory.

ii) Micro-USB B port

The Pico features a Micro-USB B port for both power and data, also serving the purpose of reprogramming the Flash.

iii) 40-pin DIP-style PCB

The Pico is designed with a 40-pin 21x51 'DIP' style PCB that includes 0.1" through-hole pins, facilitating easy integration into various projects. The PCB also has edge castellations for additional flexibility.

iv) 26 multi-function 3.3V GPIO

The Pico exposes 26 General Purpose I/O (GPIO) pins, supporting various functions. Among them, 23 are digital-only GPIO, while 3 are Analog-to-Digital Converter (ADC) capable.

v) Surface Mounting

The Pico can be surface-mounted as a module, providing adaptability for different applications.

vi) ARM Serial Wire Debug (SWD) port

It includes a 3-pin ARM Serial Wire Debug (SWD) port for debugging purposes.

vii) Flexible Power Supply Architecture

The Pico incorporates a simple yet highly flexible power supply architecture, allowing power from micro-USB, external supplies, or batteries.

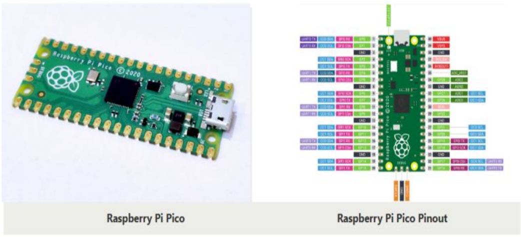

Fig.6 Raspberry Pi Pico

Considering its adaptability and ability to be configured as a Master or Slave, it may be used for a variety of wireless communication applications. With a data rate of 3Mbps, this Bluetooth module uses the Bluetooth V2.0+EDR (Enhanced Data Rate) standard to function. Using the CSR Blue core 04-External single-chip

Bluetooth system with CMOS technology and the Adaptive Frequency Hopping (AFH) function, it includes a full 2.4 GHz radio transceiver and baseband.

Fig.7 HC-05 Bluetooth Module

Key features of the HC-05 module

1) Bluetooth Version and Data Rate

The module operates on Bluetooth V2.0+EDR, supporting Enhanced Data Rate (3Mbps) for efficient data transmission.

2) Master/Slave Configuration

By nature, the HC-05 module is a MASTER/SLAVE module. AT COMMANDS can be used to customize the role (Master or Slave), with the default factory setting being SLAVE.

3) Adaptive Frequency Hopping (AFH) Feature

The module incorporates Adaptive Frequency Hopping, a feature that enhances the communication quality by adapting to the radio frequency environment.

4) Initiating and Accepting Connections

SLAVE modules are configured to accept connections but cannot initiate them. On the other hand, MASTER modules can initiate connections to other devices.

5) AT COMMAND Configuration

The configuration of the module, including its role as a Master or Slave, is done through AT COMMANDS, providing flexibility and ease of use.

6) Serial Port Replacement

The HC-05 module can be seamlessly used as a serial port replacement, facilitating connections between Microcontroller Units (MCU) and GPS, or between a PC and embedded projects. Overall, the HC-05 Bluetooth module is a reliable and convenient solution for wireless serial communication, offering flexibility in configuration, ease of integration into various projects, and adaptability to different communication scenarios. Its compatibility with the widely-used Bluetooth standard and the inclusion of features like Adaptive Frequency Hopping make it a versatile choice for wireless applications.

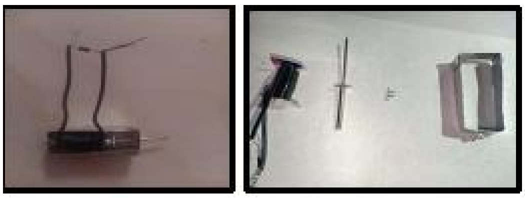

Fig.8 Pull-Push Solenoids

A 6-solenoid system refers to a configuration where six solenoids are utilized for specific applications. Solenoids are electromechanical devices converting electrical energy into linear motion by employing a magnetic field to move a plunger or armature within a coil of wire. Each solenoid in a 6-solenoid system can be independently controlled to perform various tasks or functions. For instance, in a 6-solenoid valve system, each solenoid manages the flow of a different fluid or gas. These systems are widely employed in industrial, automotive, and automation applications, such as hydraulic systems, pneumatic systems, and control systems. Solenoids are typically controlled using electrical signals, like voltage or current pulses, generated by microcontrollers, PLCs, or other control systems. They are known for their reliability, long service life, and cost-effectiveness, making them a popular choice for many applications. Solenoids come in various types, including linear, rotary, and latching solenoids, each with its own advantages and disadvantages. They can be easily installed into existing systems or machinery using screws or brackets and connected to the control system through wires or cables. Overall, a 6-solenoid system provides a versatile and reliable solution for various applications requiring precise control of fluid or gas flow.

Fig.9 16X2 LCD Display

A common display you'll see in many electronics is a 16x2 LCD. This compact liquid crystal display shows 16 characters on 2 rows, with each character formed by a grid of 5x8 dots. These displays are popular due to their small size, lightweight design, and ease of use with microcontrollers. Look for them in everyday devices like meters, thermometers, and digital clocks.

16x2 LCD screens are popular for a reason: they're small, low-power, and easy to use with microcontrollers. Built-in controllers like the HD44780 handle the grunt work (character display, cursor movement) freeing the microcontroller for other tasks. Connecting them to a microcontroller is straightforward - you'll typically use the GPIO pins and a simple protocol like 4-bit or 8-bit parallel interface to send data and commands. An extra perk? You can even create custom characters and store them in the display's memory, allowing you to add icons or logos for a more polished look.

V. Software

Building with Arduino boards? The Arduino IDE is your one-stop shop! This free, open-source software makes coding easier with features like auto-correction, code completion, and built-in libraries. Plus, a serial monitor helps you troubleshoot any hiccups. Don't know how to code? No problem! MIT App Inventor lets you design Android apps using a drag-and-drop interface with building blocks. It even connects to sensors and online services. Both Arduino IDE and MIT App Inventor are fantastic tools for beginners and educators alike to jumpstart their programming journey!

VI. Result

i. Voice to Braille Converter

With the help of mobile the application, send the voice message which will appear on the LCD screen. The message that is displayed on the LCD screen will be stored into the Arduino Mega 2560, and it is corresponding Braille output will be obtained on the Push-Pull Solenoid.

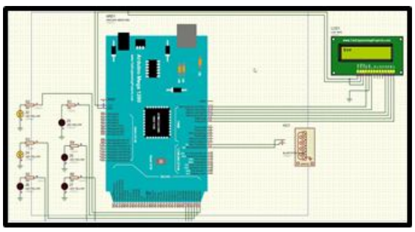

Fig. 10 Voice to Braille converter

ii. Braille to Voice Converter

With the help of the two 4x4 keypads, input will be given in the form of words or sentences for e.g the word is 'HELLO', by pressing the keypad key corresponding to 'H' which will have a bump having the code as the original Braille. This is how the entire word can be formed and with the help of the Enter button it will be displayed on the LCD screen.

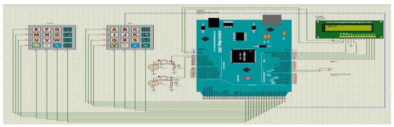

Fig. 11 Braille to voice converter

The word displayed on the LCD screen will also be stored into the mobile application and by pressing the 'Convert to Speech' button in the application it can be heard and seen.

VII. FUTRUE SCOPE

The project's complexity can be greatly reduced by using a PIC microprocessor and using company-manufactured solenoid coils, converting it into a handheld gadget. Solar cells are used to charge lithium-ion batteries, reducing battery consumption, and guaranteeing the PIC microcontroller has an uninterrupted power source. This not only increases the project's overall efficiency but also lowers its environmental impact. Furthermore, replacing handcrafted solenoid coils with professionally manufactured ones improves their efficiency, which can contribute to cost savings when purchased in bulk. Transitioning from a prototype to a large-scale implementation dramatically saves project costs, especially when purchasing components in bulk. This cost savings, together with greater productivity, make the project more economically feasible and scalable. Furthermore, large-scale deployment generates numerous job possibilities across various sectors, including solenoid manufacturing and software.

VIII. CONCLUSION

It is wonderful to learn that the voice to braille and braille to voice converters were implemented to successfully meet the difficulty. It is admirable that a bridge between the visually challenged and the wider public is being developed. A comprehensive and well-done solution is demonstrated by the successful output on the Solenoid Braille keypad and the mobile device, as well as by simulation in Proteus programmed using MIT App Inventor. The creation of a fully-fledged Mobile application adds a practical dimension to the project, and it's promising to know that the solution is ready for large-scale implementation. Such innovations, aiming to enhance accessibility and communication for the visually impaired, have the potential to significantly impact society positively.

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