Assistive Device for Blind, Deaf and Dumb

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***Abstract*—It is frequently necessary to employ specific technical solutions to address the difficulties experienced by people who have hearing, speech, or vision impairments. The goal of this project is to provide a single, easy-to-use, quick, precise, affordable, and efficient solution that helps people with disabilities regain their confidence and independence. We demonstrate an assistive gadget based on the Raspberry Pi that allows the blind, deaf, and mute to successfully see, hear, and communicate.**

With the aid of our technology, those who are unable to speak can communicate through sign language in front of a camera. Text is extracted from the captured image using Tesseract OCR (Optical Character Recognition), and voice synthesis is used to turn the text into audio. They are able to successfully express messages using this acoustic representation. Our method helps deaf people by converting spoken language into text messages through a special software. Speech input is gathered via a microphone, converted into text, and shown on the device's screen for simple viewing. For those who cannot see, these text messages can then be transmitted audibly through a speaker.

In addition, our system uses a camera to take pictures, which it then uses to translate the text into voice signals so that visually impaired people can hear the content provided as speech. This innovation improves accessibility for people with visual difficulties by integrating image-to-text and text-to-speech conversion processes.

Keywords— Raspberry-pi, Assistive device, OpenCV, LCD display, Speaker, Microphone

I. INTRODUCTION

Approximately 1.3 billion people struggle with different types of vision impairments; they include 188.5 million people who have minor vision problems, 217 million people who have moderate to severe visual challenges, and 36 million people who are completely blind. People 50 years of age and above tend to be the most afflicted population by vision impairment. It is acknowledged that the largest number of blind people reside in India. In addition, it is projected that 9.1 billion people struggle with speech and hearing impairments.

Given the speed at which technology is developing in this day and age, it is vital that society be inclusive. Ensuring fair access to the digital world for people with a range of skills and impairments is a fundamental aspect of this purpose. People with speech, hearing, or vision impairments are among those who face particular difficulties since they have to navigate a society that is primarily meant for people without disabilities.

In order to meet this need, the present research study introduces a novel and feature-rich assistive device that runs on the flexible Raspberry Pi platform. We argue that the traditional approach of treating the various difficulties brought about by these three impairments separately is intrinsically restrictive. Rather, we support an inclusive paradigm in which the diverse needs of people who are blind, deaf, or have speech impairments are met by a single, integrated system.

The redefining of accessibility's limits is central to our research. We support the universal idea that every person should have equal agency in accessing information, expressing their opinions, and actively engaging in society, irrespective of sensory or communicative impairments. With this goal in mind, we have painstakingly designed, developed, and assessed a complex assistive technology that not only meets the needs of people who are deaf, hard of hearing, or visually impaired, but also integrates their experiences into a cohesive and harmonious whole.

This study presents a thorough analysis of our innovative system, providing details on its technological elements, methodological underpinnings, and empirical results. Our integrated device offers a unified, cohesive solution to these interconnected challenges, from capturing and converting visual content into audible speech for individuals with visual impairments, to facilitating seamless communication for the deaf and enabling those with speech limitations to articulate their thoughts.

By utilising state-of-the-art technologies such as image recognition, speech synthesis, and text-to-speech conversion, which are all controlled by the Raspberry Pi platform, we hope to enable people who are struggling with disabilities to become more independent, have better communication skills, and engage with society.

Our research is more than just putting technology parts together; it is our steadfast dedication to equity, inclusivity, and the revolutionary power of innovation.

In the following sections of this manuscript, we conduct a thorough investigation of our assistive technology, examining its fundamental design tenets, complex functional elements, user encounters, and the significant potential for revolutionising the lives of its users.

In light of an inclusive and egalitarian future where all members of our global community, regardless of their skills or disabilities, can fully engage in the digital age, our research serves as a beacon of hope.

II. Literature Review

The Chucai Yi et al.-developed Optical Text Analysis Framework (2013) is a tool that helps people who are blind or visually impaired read text on handheld devices and product packaging that they come into contact with on a regular basis. This framework uses simple and easy-to-use tools to create custom imagery and includes a text-to-text support structure. The process entails the careful selection of the region of a dynamic item using a background subtraction technique that combines Gaussian elements. It performs accurate text detection and position tracking within a designated area of interest (ROI). Two new developments are presented: an object-centric image processing paradigm and a unique textual localization approach. Text characters that are contained inside the outlined textual zone are converted to binary and can be recognised using commercial optical character recognition software. The determined text is then distributed to those who suffer from visual impairments.

According to Shraddha R et al. (2015), the Bipartite Communication Paradigm for Aural Impaired Individuals is a crucial tool for improving interactive interaction between the speech-limited and hearing-impaired populations. The suggested approaches appropriately translate hand gestures into spoken words and vice versa by applying the advanced Hidden Markov Model (HMM). Sign language plays a vital function as a useful means of bridging communication between normal people and those with hearing impairments, thereby filling in the gap in spoken discourse. The technology skilfully performs the subtle translation of spoken language into vocalised articulation, thereby overcoming the time limits of the speech-impaired population and significantly enhancing communication effectiveness. This device skilfully converts audio signals into verbal outputs that are easily understood by the human hearing faculty. Therefore, those who are hard of hearing can utilise earthly signals in the form of hand sign language, which are then converted into spoken language. On the other hand, spoken words from a normative communicator are converted into written motions and manual sign language, which makes communication more fluid.

Modelling of communication between the hard of hearing and the general public is the foundation of the S.B. Shroke et al.-led project Assistive Linguistic Facilitators for the Deaf and Mute (2014). Through a glove-based communication system designed for the deaf and hard of hearing, the project's reach into the general public is increased. These gloves' internal architecture includes five accelerometers, touch-sensitive components, and bending sensors. Every distinct hand gesture sets off a corresponding resistance variation in the bending sensor, and the accelerometer records the hand's direction. The sensor enters the digital domain when its analogue output is converted to digital. This conversion takes place inside the confines of an ARM processor, which evaluates the input signal by comparing it to a cache of preset voltage thresholds stored in memory. This deliberate procedure then produces the necessary audio output, which is appropriately stored inside SPI memory under the guidance of a speaker. This novel approach provides a great deal of assistance to the deaf and hard of hearing by providing a means of contact with people who have normal hearing.

Pankaj Pathak's 2012 book Speech Recognition Technology: Applications & Future Prospects explores the field of voice or speech recognition technology. This revolutionary technology involves converting sound waves, spoken words, or spoken phrases uttered by any literate person into electrical impulses that are then transformed into patterns that are codified and given semantic meaning. The field of speech recognition technology has seen an unbridled and widespread invasion in various industries. Many business organisations have developed strong systems that result in the coordination of smooth voice communication that is directed in the right direction. In order for this technological paradigm to be successfully implemented, strict adherence to cross-compatible hardware and software matrices is required. This means that the central processing unit (CPU) must have concurrent processing capabilities in order to properly support voice input and data access functionalities.

Vasanti.G and Ramesh Babu's Visual Assistive Systems for Auditory Output of Text Labels (2014) relies on the reading of additional textual data generated by a camera-based device, providing the blind and visually impaired with a means of reading text labels and product packaging in their daily environment. Text capture is made possible by this system's camera interface, which is connected to a RaspberryPi. This enhanced functionality enables people who are visually impaired to easily access textual content.

Optical Character Recognition (OCR) software on the RaspberryPi is leveraged by the system to accelerate schema interpretation, modification, and subsequent segmentation. Textual data is then converted into digital format, which leads to its appropriate classification. After classification, the text is fed through a spatial speech converter (TTS engine) built within the Raspberry Pi, producing audio output before it is amplified.

III. Proposed System

You format and style the text of your paper using the template. Please respect the necessary text fonts, column widths, margins, and line spacing. You might observe oddities. For instance, this template's head margin is proportionately larger than usual. This measurement, along with others, is intentional; the standards anticipate your paper functioning as a component of the proceedings rather than as a stand-alone document. Kindly refrain from changing any of the existing titles. The described technique leverages aspect ratio to achieve real-time object detection. Our refined SSD method uses a vast amount of data, an easily trainable model, and faster GPUs to recognise and classify several elements in an image. The main features include object localization, object detection, loss function, truth box, feature map, and default boundary box. Our current project is to utilise the computing power of the Raspberry Pi 3 processor to create an effective text-to-speech conversion system. The first stage is using a camera to collect text within photos, which is then saved in a cloud-based database. Subsequently, text is extracted from photos using a synthesiser, and individual characters within the text are identified using a sophisticated Optical Character Recognition (OCR) technique. Finally, using the OpenCV library, the Raspberry Pi 3 assumes the task of turning this recognised text into audible voice. There are three basic tiers to this organisation:

Image to Voice (for the Visually Impaired): This component empowers individuals with visual impairments, facilitating their comprehension of textual content through the utilization of the Tesseract software.
Text to Voice (for the Speech-Impaired): Those with vocal impediments find a means of communication via text-based messages, which are then audibly articulated through the espeak tool.
Voice to Text (for the Deaf): Deaf individuals gain the capacity to perceive spoken words via text-based representations.

In summation, our system is engineered to cater to the diverse needs of individuals with distinct impairments. It augments accessibility through the seamless conversion of text into speech and vice versa, significantly enhancing their communicative capabilities.

IV. HARDWARE REQUIRED

A. RaspberryPi

The RaspberryPi is a credit card-sized computer that connects to a TV or computer display and may be used with a keyboard and mouse as input devices. It may be used for a number of tasks, including creating databases, playing live games, watching films in high definition, using it for military purposes, and monitoring systems. The Raspberry Pi 3B board, whose specs are as follows, is used to implement the paper.

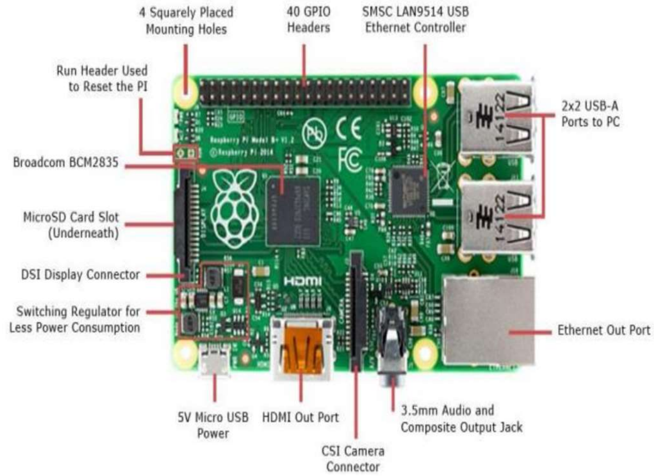

Figure 1.1

The Raspberry Pi Foundation, a UK charity, is the name of a line of single-board computers that it calls Raspberry Pi. Its mission is to provide access to computing education and promote computer literacy.

The Raspberry Pi is a very cheap computer that runs Linux, but it also provides a set of GPIO (general purpose input/output) pins, allowing you to control electronic components for physical computing and explore the Internet of Things (IoT).

1) ONE GB OF RAM (shared with GPU)
2) Composite video (PAL and NTSC) via a 3.5 mm connector and HDMI video outputs
3) A GPU with a Broadcom Video Core IV at 250MHz
4) Broadcom Soc BCM2836 (GDDR3, SDRAM, CPU, and GPU)
5) I/S input of audio
6) V power supply using GPIO or MicroUSB (General Purpose Input Output) header
7) MicroSD with 10/100Mbps Ethernet speed for storage
8) ARM Cortex A7 quad-core CPU, 900 MHz (ARMv7 instruction set)
10) Four USB outlets
11) 3.5 mm analogue audio output; HDMI and I.S. digital
12) A 15-pin MIPI video input connection for the camera interface (CSI)
13) 45g in weight (1.6 oz)
14) 17 HAT ID bus 5 and GPIO (General Purpose Input Output) peripherals with particular functionalities
fifteen) 85.60 x 56.5 mm
16) Power rating of 800 mA (4.0 W)

B. Supply

There have been rumours that wireless adapters require a lot of power, however the Raspberry Pi comes with an adapter that can be connected to the laptop and operates on a Samsung battery.

C. Logistic Camera

The Logitech camera is easy to use and requires no setup—

Figure 1.2

just plug it in. We can quickly make video calls on the majority of IMS and Logitech video in breathtaking resolution with a straightforward plug and play setup. The video recorded with this camera's VGA sensor seems natural. Its 5 Megapixel camera produces excellent images. Arrangement The built-in microphone with noise reduction is chosen by the camera. The resolution range of a XVGA video recording device is around 1024*768. This camera features 256 kbps internet for uploading, motion detection, and a universal clip. It comes with 200 MB of hard drive capacity and at least 512 MB of RAM. For simple utility, we can interface high-speed USB to other devices.

D. Ediax Wi-Fi

The little Edimax Wi-Fi USB wireless adapter has remarkable speed, range, and velocity. The tiny USB chains, in spite of their size, increased data rates to 150 Mbps when it came to the wireless device. Three times as fast. All we need to do is insert it into the USB port on our computer to start enjoying amazing high-speed wireless network access. It is possible to cut the power usage by 20–50%. In addition to giving you the greatest wireless technology available, the adapter protects the environment by consuming less energy and your wallet by monitoring your electricity costs.

Figure 1.3

The Debian squeeze package, which includes the image and a new driver module, was the software utilised. It may be found here. The file has a tar size and is intended to be unpacked twice. The software didn't require any more changes.

E. Screen display

The project comprises of a 5 inch resistive touch screen with an HDMI interface that was created especially for the Raspberry Pi and high hardware resolution. The control is resistant to touch. It connects directly and is compatible with every version of the Raspberry Pi that is currently in use. To save power consumption, it offers drivers and allows for the backlight to be set on or off. In accordance with the project specifications, a 5-inch display includes a keyboard built in so that people with voice impairments may input text on the screen.

Figure 1.4

Technical Specification

1) Drivers are available (compatible with Raspbian, Ubuntu, Kali, and Retropie)

2) No I/Os are needed while using the HDMI interface for display; nevertheless, the touch panel still requires I/Os.

Superior immersion gold surface plating

F. Microphone

The project makes use of the small, lightweight, high-quality USB microphone seen in Figure 8. The microphone is designed to block out unwanted background noise.

Figure 1.5

Due of its portability, compact size, and ease of use, it earns brownie points for the project. By adjusting the gain control or capture for more precision, it may be made more user- or background-friendly.

A microphone is a device that records sound waves on a recording media or through a loudspeaker by converting air vibrations into electrical impulses. Microphones allow for a wide variety of audio recording devices to be used for voice, music, sound, and recording of many forms of communication. Microphones can be installed in phones and headsets or they can be used independently.

Technical Specification:
1) 4.5V Working voltage
2) Weight 99.8 g
3) 2cm x 2cm x 0.5cm in size

G. Memory card

One kind of storage device that may be used to store images, movies, or other data files is a memory card. It gives data from the inserted device access to both volatile and non-volatile media. Another name for it is a flash memory. It is frequently found in gadgets such as MP3 players, gaming consoles, phones, computers, digital camcorders, and more.

MicroSD:

Also referred to as T-Flash or TransFlash, this kind of detachable flash memory card is used to store data. The first microSD card was created by SanDisk and became a standard on July 13, 2005.

Figure 1.6

It is frequently utilised with smartphones and other portable electronics that come in 128 MB to 4 GB capacities.

V. SOFTWARE REQUIREMENTS

A. Tesseract OCR

An optical character recognition (OCR) engine for several operating systems is called Python Tesseract. The method of electronically extracting text from photographs and reusing it for a number of purposes, such document editing and free text searches, is known as Tesseract OCR. Tesseract is the most well-known and high-quality optical character recognition engine available in open-source code. Artificial intelligence is used by OCR to recognise and search for text in photographs. Tesseract searches for patterns in words, phrases, letters, and pixels. It employs what is known as an adaptive recognition two-step technique. Character recognition takes place in one data step, and any letters that aren't covered by letters that fit the word or phrase context are filled in in the second stage.

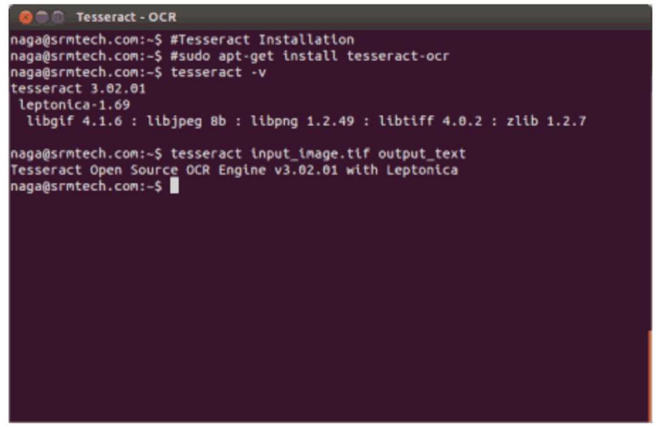

Figure 2.1

One technology that may change papers into updated data is optical character recognition (OCR). Tesseract works well with Windows, Mac OS, and Linux. Programmers can use an API to extract printed, written text from photos. Tesseract may access accessible third-party pages to use the GUI. The engine and language-specific training data are the two components that make up the Tesseract OCR installation procedure. Tesseract is available directly from several Linux distributors for Linux OS. Tesseract is utilised in our project to translate the text from the collected image into text format.

Features of Tesseract:
1) Analysis of page layout.
2) More languages are available for use.
3) Boost the accuracy of forecasts.

B. Espeak

It is a tiny, open-source voice synthesis programme for Windows and Linux that may be used to synthesise speech in English and other languages. It is employed to generate speech from text. It supports a large number of languages in tiny sizes. The eSpeak software is programmed using rule files that provide feedback. SSML is supported. It allows you to modify voice transitions. This text file gives you the ability to constantly alter the frequency in order to modify characteristics like pitch range, add effects like echo, whisper, and erratic speech, or alter sound quality. the speaker. Speaking at the default rate of 180 words per minute is too quick to understand. The text to speech signal conversion in our project is done using Espeak.

Many languages are supported by the eSpeak voice synthesiser; however, these are frequently preliminary versions that require further work to make them more accurate. For these and other new languages, assistance from native speakers is much appreciated. Some languages have superior text-to-speech synthesis than others when using eSpeak.

C. Opencv

One of the main components of real-time operation, which is crucial in today's systems, is OpenCV, a massive open-source library for computer vision, machine learning, and image processing.

It may be used to process photos and videos to recognise people, objects, and even handwriting belonging to a human.OpenCV (Open Source Computer Vision) is a collection of encoding methods primarily targeted toward factual-time computer vision. Itseez is now maintaining OpenCV, which was first shaped by Intel research and is now funded by Willow Garage. It is an open source collection of cross-platform resources that may be used for free. OpenCV mostly consists of modifications to the C++ interface with the goal of simplicity of use, more case-safe designs, and improved execution of already-existing ones. It serves a variety of functions, including motion comprehension, gesture recognition, and facial recognition.

D. WinSCP

Windows Secure Copy, or WinSCP, is a free and unblocked resource. SCP, WebDAV, FTP, and SFTP are all supported by Microsoft Windows.

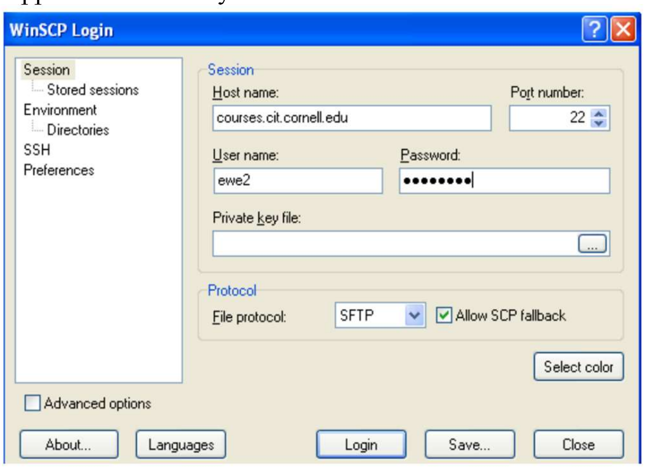

Figure 2.2

Its primary responsibility is to securely transfer files between local and remote computers.

In addition, it provides the essential file management and file harmonization features. It employs Secure Shell (SSH) and supports both SFTP and the SCP protocol for protected transfer. FTP and SFTP are two entirely separate protocols. It also provides the useful file management and file harmonization features. In addition to SFTP, it supports the SCP protocol and employs Secure Shell (SSH) for protected transmission. The protocols that SFTP and FTP use are entirely different. It is necessary for the server you are connected to offer SFTP to utilize it for secure connections. Both the streaming servers and the course web server support SFTP. Documentation may be sent over FTP and SFTP using the Windows program WinSCP.

The WinSCP main window shows the files and booklets on the distant SFTP site on the fitting point and the papers and folders as of from our PC on the left side of the main window. The characteristics of WinSCP are as follows: Discretionary saves session information.

VI. Design And Implementation

The Raspberry Pi is the main component of our system; it is the hub that links to all the essential peripherals, such as an SD card, LCD screen, Pi camera, and speaker. The Python programming language has been used to carefully build the source code that supports this system. To enable smooth communication, the Raspberry Pi and my PC are linked to the same wireless network.

Our system's main goal is to identify sign language and offer simultaneous text and audio translations. The general setup and functions of the gadget are described below:

A. Device Configuration:

The LCD screen, speaker, SD card, and camera are all connected to the Raspberry Pi, which acts as the device's support system. Most notably, the camera captures sign language that individuals with speech impairments use. The output helps those who are blind or visually challenged by playing audio signals through the speaker. Concurrently, the message is graphically shown on the LCD module to accommodate those who are hard of hearing. This complex system is intended to fully address the requirements of those who are visually and/or audibly challenged.

Text to Voice:

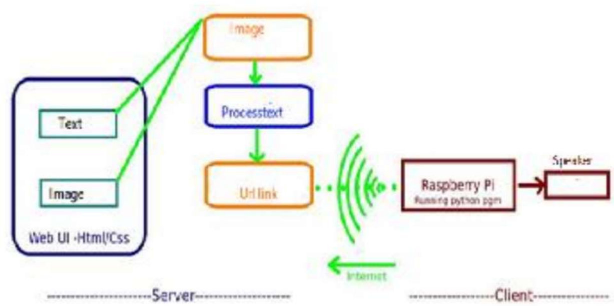

Figure 3.1

This feature is designed for those with speech impairments. It works by translating text into vocal signals that are then played over a speaker, enabling people to communicate their ideas. Text may be entered into the Raspberry Pi via a keyboard interface, and it will automatically translate to speech.

Image to Voice:

With the help of this function, those who are visually impaired may now access information included in photos. Users may come across items or writing within photographs, especially those who are visually impaired. We have included a Logitech camera for picture taking to make this easier. To create binary pictures, the collected images are processed using Optical Character Recognition (OCR) methods, such as adaptive thresholding. After being converted into character outlines, these binary representations are then synthesized into speech. When these synthetic words are combined, they create a cohesive sentence that Espeak then audibly conveys.

Voice to Text:

This feature is intended for those with hearing impairments who have trouble understanding spoken language. An assistive technology that can translate spoken words into text has been created for deaf people. The online application is utilized to expedite this procedure.

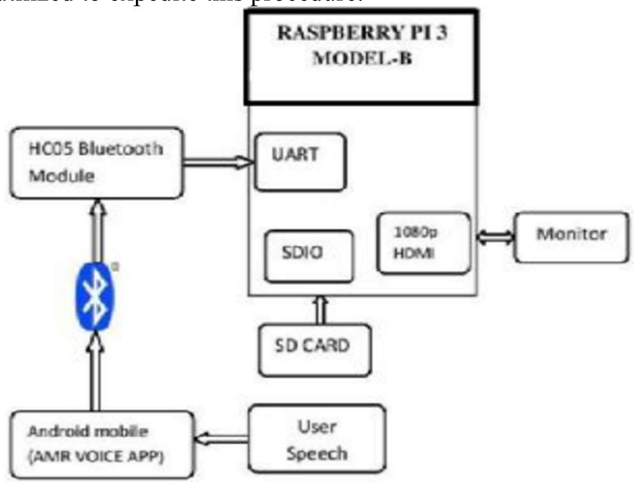

Figure 3.2

Blind Module:

1. To turn on the module, move the three-way slider to "blind mode."
2. Written papers or books can be photographed using the camera that is attached to the Raspberry Pi.

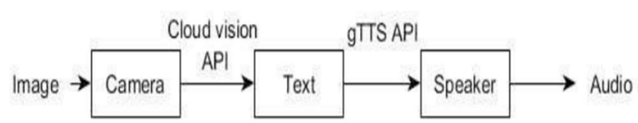

Figure 3.3

3. After taking pictures, they are stored in JPEG format and text is extracted using the Google Cloud Vision API.
4. The gTTS API is then used to turn the extracted text into voice, resulting in an audio file.
5. The Raspberry Pi is linked to a high-quality speaker that plays the audio output, making it possible for those with visual impairments to interpret printed materials or books through audio.

Dumb Module:

This module gives people with voice impairments more autonomy by allowing them to vocalize words by typing on a screen.

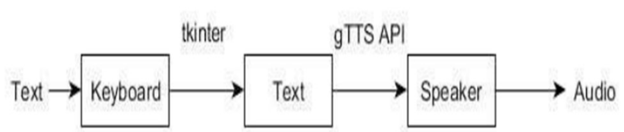

Figure 3.4

1. The three-way slider is adjusted appropriately to activate the dumb module.
2. The HDMI screen attached to the Raspberry Pi shows a personalized on-screen keyboard.
3. Users with speech impairments can utilize this on-screen keyboard to enter their messages.
4. Using the gTTS API, typed text is transformed to audio format, creating an audio file containing the supplied text.
5. The audio file is played on a top-notch speaker that is linked to the Raspberry Pi, amplifying the messages that people with speech impairments are trying to express.
6. Users can conveniently switch between modes as needed.

Deaf Module:

This module converts spoken words into text so that those with hearing impairments can virtually hear the words.

1. Select "deaf mode" with the three-way slider.
2. Using a USB microphone attached to the Raspberry Pi, audio or spoken words addressed to the user are captured and stored as an mp3 file.

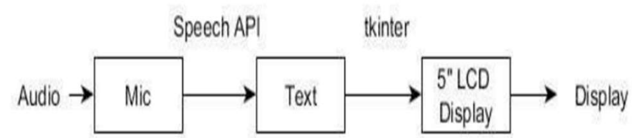

Figure 3.5

3. The Google Speech API is then used to process the audio file and turn spoken audio into text.
4. Using the help of a pop-up window made with Python tkinter, the transformed text is shown prominently on a 5-inch HDMI LCD screen. This makes it possible for users—deaf people in particular—to comprehend spoken words swiftly and effectively.
5. The gadget may be readily customized to meet the demands of the user by adjusting the slider to move between modes.

To sum up, our gadget provides a complete and inclusive solution that meets the special requirements of those who are speech-impaired, blind, and deaf. These people are empowered to communicate and obtain knowledge in an inclusive and effective manner by its well-organized modules and modalities.

VII. Result And Discussion

When the linked Raspberry Pi module with Bluetooth, LCD display, and speaker is turned on, users may choose which picture and text-to-voice conversions to make using the buttons. The text that is selected on the mobile device will both speak out loud from the speaker and show on the LCD display when the user touches that specific image or text. The user must first establish a Bluetooth connection in the AMR voice app before speaking into the app to enter text. The text is then translated to text and delivered over Bluetooth to the Raspberrypi module, where it is subsequently shown on an LCD screen. The individual can operate the equipment with ease, and we can see how the connection is set up for the job. The primary goal of this study is to facilitate communication for the deaf, dumb, and blind so that they may interact with regular people and with one other with ease. Hopefully, the findings were obtained in the anticipated manner.

VIII. Conclusion And Future Work

With the help of this suggested effort, we have created a prototype model that uses a single, small gadget to assist those who are hearing, speaking, and vision challenged. This system's primary goal is to help these individuals feel more comfortable managing their websites on their own and enabling contact both with other users and with regular people. This system's primary benefit is its small weight and lightweight design, which make it portable. You may use a basic coding language to continue this project and make it less complicated with additional sophisticated gadgets. Due to little technologies that can benefit individuals worldwide, these electronics can lessen issues.

```
sen = input("Enter your value: ")
```

```
Enter your value: hello sir how can i help you
```

```
print(sen)
SpeakText(sen)
```

```
hello sir how can i help you
```

Figure 4.1 (for the DUMB person)

```
deaf()
```

```
Listening...........
Recognizing...........

'hello sir can i get a coffee for you'
```

Figure 4.2 (for the DEAF person)

In this way we had created an interface for blind, deaf, and dumb persons.

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