AUTOMATIC READER FOR THE VISUALLY IMPAIRED PEOPLE

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ABSTRACT -There are roughly 285 million blind and visually impaired people in the world. Visually impaired people are individuals who have partial or total loss of vision. Reading is one of the biggest challenges for visually impaired people. In this project Automatic Reader for the Visually Impaired People is designed which converts text to audio signal. Here the input document is captured by a webcam. Finally it is converted into a digital format using Optical Character Recognition (OCR). Then the digital text is converted into an audio signal by the open-source E-speak module Text-To-Speech (TTS) engine. This can be hearable by the visually impaired people. To automatically detect the text areas from the entity, a text location and Tesseract algorithm is accomplished by learning gradient properties of stroke direction and distribution of edge pixels in an Ada boost model. This project converts text to audio signal in English language only. This can be extended to other Indian regional languages in future. The proposed method achives 77.2 % conversion of text to audio signal for the benefit of visually impaired people. This can be improved further by using a higher end camera at the input.

Keywords-component: Optical character recognition(OCR), Raspberry Pi, eSpeak TTS.

1 INTRODUCTION

There are roughly 285 million blind and visually impaired people in the world. Visually impaired people are individuals who have partial or total loss of vision. This can range from mild impairment where they can see some shapes and colors, to complete blindness where they cannot see anything at all. Visual impairment can be caused by various factors such as genetics, diseases, injuries, or aging.Visually impaired individuals face various challenges in their daily lives, including difficulties with mobility, communication, and accessing information. They often rely on specialized tools and technologies, such as white canes, guide dogs, screen readers, and braille devices to help them navigate the world.

Despite these challenges, visually impaired people can lead fulfilling lives and engage in various activities, including education, employment, and social activities. Many organizations and resources exist to support visually impaired individuals, such as advocacy groups, training programs, and assistive technology.It's essential to be respectful and understanding of visually impaired individuals and to be willing to accommodate their needs. This includes providing appropriate accommodations in public spaces and workplaces, such as braille signage, audio descriptions, and accessible technology.Visually impaired people often face significant challenges when it comes to reading. Reading is an essential skill that enables individuals to access information, communicate effectively, and participate fully in society. However, for visually impaired individuals, reading can be a difficult and frustrating process.One of the biggest challenges that visually impaired people face when it comes to reading is accessing printed materials. Most printed materials, such as books, newspapers, and magazines, are not accessible to individuals with visual impairments. This is because the text is often too small, and the contrast between the text and the background is not sufficient for visually impaired individuals to read comfortably.

To overcome this challenge, visually impaired individuals often use assistive technologies such as screen readers, which convert text into audio, or braille devices, which convert text into braille. However, not all printed materials are available in accessible formats, making it challenging for visually impaired individuals to access information.Another challenge that visually impaired individuals face when it comes to reading is learning to read. Children with visual impairments often face difficulties in learning to read, as they may not have the same access to visual cues as their sighted peers. This can impact their literacy skills, which can affect their education and employment opportunities in the long run.To address these challenges, various initiatives and organizations exist to promote literacy among visually impaired individuals. These initiatives include the development of accessible reading materials, the provision of assistive technologies, and specialized training programs to teach visually impaired individuals how to read and write in braille.

An Automatic Reader for the Visually Impaired Person is a device that has been designed to help individuals who are visually impaired read printed text. This device works by capturing images of the text and converting them into an audio output that the user can listen to. The process involves using a camera to take a picture of the text, which is then processed by optical character recognition (OCR) software to convert it into a digital format. The digital text is then read aloud by a text-to-speech (TTS) engine, allowing the user to listen to the text. Automatic readers for the visually impaired are also portable and lightweight, making them easy to carry around. They can be used at home, in the office, or even while traveling. Additionally, some models are designed to be user-friendly, with intuitive interfaces and voice-guided menus. This makes them accessible to people with varying levels of technological expertise. In conclusion, automatic readers for the visually impaired are an innovative and useful device that can help improve the lives of individuals with visual impairments. They allow for greater independence and freedom, enabling people to read printed material without assistance from another person. This, in turn, improves their access to education and employment opportunities, as well as their ability to participate in everyday activities. With the advances in technology, automatic readers for the visually impaired are becoming more affordable and widely available, making them an accessible solution for people with visual impairments.

2 RELATED WORKS

Rawaa Farhan et.al.,[1] (2022) have proposed designing and implementing a clever solution for assisting individuals with visual impairments involves utilizing a Raspberry Pi connected to a camera interface that captures an image of text. Through the implementation of OCR technology, the image is converted into text by optically recognizing characters and extracting the relevant textual data before being transformed into audio. The audio output is then transmitted through speakers and an amplifier. The Raspberry Pi is equipped with both OCR and a text-to-speech conversion unit, with the former responsible for optical character recognition and the extraction of text from images, and the latter for converting the extracted text into speech and delivering it via headphones or speakers. [2] Nabendu Bhui et.al., (2019) presented a paper on the development of an automated reader for the visually impaired using Raspberry Pi has demonstrated significant progress compared to prior similar efforts. The system comprises various elements, such as capturing images using a Raspberry Pi camera, recognizing text through the Tesseract OCR framework, and converting text into speech using eSpeak TTS. The effectiveness of the model largely relies on the optimization and processing of these components to produce satisfactory output. However, issues with inaccurate text output from OCR due to processing problems necessitate the inclusion of preprocessing as a critical aspect of the entire system. The model's performance is affected by factors such as small or unclear characters, light issues, or the presence of graphics within the text. Our proposed solution overcomes these challenges through binarization, producing superior results in English, Bengali, and Hindi languages without internet dependency.

Mohammed Ali Mohammed et.al.,[3] (2020) presented an Audio Reading System that employs a camera as an input device and a speaker as an output device to assist blind persons in reading text. The Audible Reading System consists of three primary steps: input, processing, and output. The first step is to use a camera to take an image of the text that you wish to read, and then send it through the processing stage. Second, image processing will be utilized to filter and extract the text using the Optical Character Recognition (OCR) technique, and finally, the Text-to-Speech algorithm will be used to pronounce the text using a speaker device. The main features of our system are as follows: it simulates the system's real-time, uses cloud computing to avoid client hardware limitations and collect data (data centralization), page localization to assist the blind person in capturing the complete view of the text, and modifies the Efficient and Accurate Scene Text (EAST) algorithm for identifying text sequentially. In addition, there is a text correction process and index table technology.

Norharyati binti Harum et.al.,.[4] (2020) have publishedthis project that makes use of IoT technology, including an IoT device, IoT infrastructure, and a service. The Raspberry Pi IoT device is utilized, which is incredibly energy efficient since it merely requires 5V of power to function. It is also a very portable gadget that is only the size of a credit card and can be taken anywhere. The book reader will photograph the book pages using a camera and then process the photos with Optical Character Recognition software. When a book reader recognizes a picture, he or she will read it aloud. As a result, folks who are blind or have impaired eyesight will be able to hear it without having to touch it with their fingertips. The user may experience both soft copies and hardcopy books by employing an online text-to-audio converter and IoT networking protocols such as Wi-fi connectivity and 4G services. A camera is inserted in hardcopy books to photograph the page. The inspiration for creating this product was to inspire all blind individuals to read regular books. This will allow them to get specific information from reading without having to learn Braille. Ying Li, Junxin Cheng et.al.,[5] (2019) have describedThe optophone is a device designed to help people with visual impairments to read written materials just like those without such impairments. The system is composed of a Raspberry Pi, a camera, and an Android app. The camera is connected to the Raspberry Pi interface to capture images of reading materials. The audio output device is also connected to the Raspberry Pi audio interface to provide audio playback for the users. The Android app is used to control the operations of the Raspberry Pi, including identifying images to convert to text, selecting reading materials, and controlling playback. Compared to previous versions of similar devices, this optophone is much more user-friendly since it can be controlled directly from the user's phone. This article provides a technical overview of each subsystem of the optophone and explains how they work together to provide an improved reading experience for people with visual impairments.

3. PROPOSED METHOD

A proposed OCR system utilizes a grid infrastructure for character recognition across multiple languages, given prior input. The grid infrastructure streamlines recognition of diverse characters and supports a range of document functionalities, including editing capabilities like the current system. However, the new system expands upon this by enabling document search capabilities not currently available.

3.1 ARCHITECTURE OF THE PROPOSED SYSTEM

The three main components of the system architecture in a grid infrastructure are explained in detail.

The basic block diagram for the same is shown in figure 3.1.

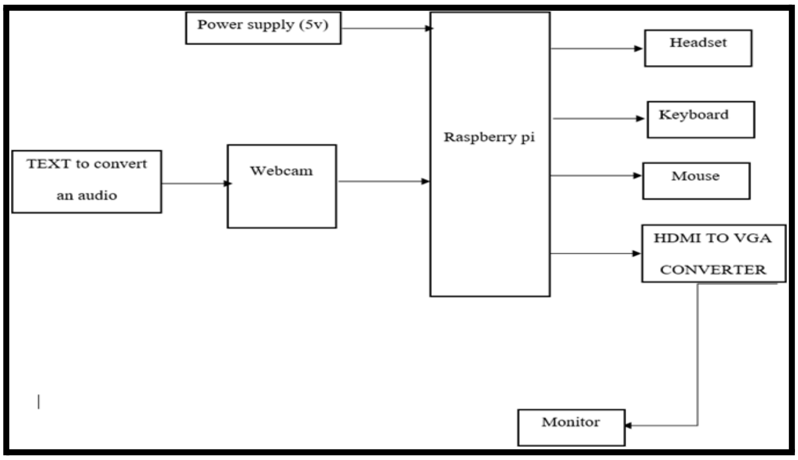


Figure 3.1 Block diagram of the proposed system

3.2 SCANNER

The main role of the scanner is to scan the document thoroughly and convert the paper document into the scanned document. The illuminator which is attached with the scanner provides better lighting for better performance and increased efficiency. Thus the scanned document is kept under the detector for detection of the characters in the document.

3.3 OCR hardware and software

The image of the scanned document then goes through a number of processes. Document analysis is one of the processes where the whole document is analysed line by line or every word by word. Once the document is analysed then OCR starts its process by detecting each word through a process called character recognition where each word is recognised letter by letter. Contextual processing is a method which is used to develop new word meanings as they are found in the context of a story.

3.4 Output Interface

It is the interface between the user and the software that being processed. The output of the OCR after going through the different phases of detection is finally processed as each word is recognized and understood by it. Thus, the final output of the scanned document is converted into text format and is presented to the user with the help of some interface through which the user can make use of this new technology The three main components of the OCR system architecture in a grid infrastructure are illustrated in figure 3.2

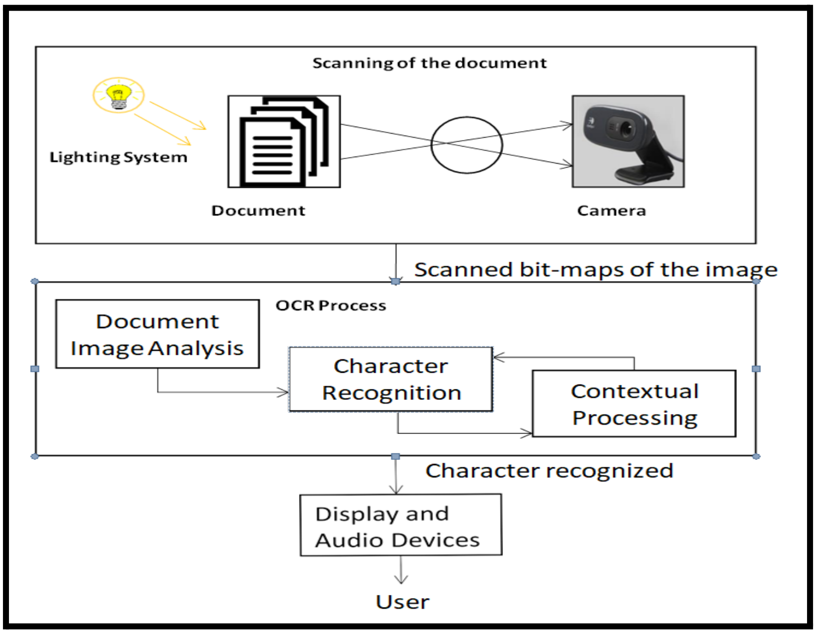


Figure 3.2 OCR architecture

Intended audience and reading suggestions

To implement the OCR system effectively, it is crucial to identify the target audience who have a direct or indirect interest in the product. Based on the analysis, it can be inferred that the primary beneficiaries of this technology are visually impaired individuals, as well as research and development teams in government institutes, and corporations.

Therefore, the following groups can be considered as potential stakeholders for the implementation of the OCR system:

- At order to process the word document that contains the base paper for their analysis, researchers at telecom institutions such as scientists, research scholars, and fellows are
- interested in adopting OCR systems. The visually impaired persons who are fond of reading and for those who want to read and understand documents and articles around them.
- An OCR system must be used by a professional to manage the information contained in older books while creating a virtual digital library.

- This OCR technology is highly sought after by numerous websites that sell electronic books in order to scan all the books in order to make money.The reading suggestion for the people who are interested in the OCR system can make use of the following instructions: -
- In order to read the document of the reader's wish. The document should be kept under the camera range at a proper distance so that the camera captures the maximum portion of the document.
- Once the document is placed properly the user has to press the capture key which captures the image of the document and analyses the complete document. Then each word is recognised letter by letter by the OCR through character recognition and contextual processing.
- The final output of the OCR after analysing and recognising the complete document is given through an interface through which the user can interact i.e as text on the display screen or as an audio output through an audio output device, depending on the application of the user.

3.5 Optical Character Recognition (OCR)

Optical Character Recognition (OCR) is a technology used for recognizing text from printed or written documents, which can then be converted into editable digital files. By optically scanning the text and converting it into a bitmap, the OCR machine is able to transform the text into a format that can be edited and manipulated digitally, using ASCII or Unicode character representation.

Often, we desire the ability to modify the contents of a hard copy text such as a book or magazine. To achieve this, a digital camera or scanner is utilized to capture the images, which are then processed by a recognition system resulting in the creation of an MS Word document.

Scanning a sheet of paper generates a digital version of a physical document, but the resulting image file does not allow for easy manipulation of the text contained within. However, Optical Character Recognition (OCR) technology can recognize the characters in the image and convert them into editable and searchable text, similar to a Word document. This enables the efficient storage and sharing of large amounts of information in a compact digital format. As OCR technology continues to advance, it is revolutionizing the way we store and share information in the modern era.

A block diagram in Figure 3.3 provides a visual representation of the framework working principle

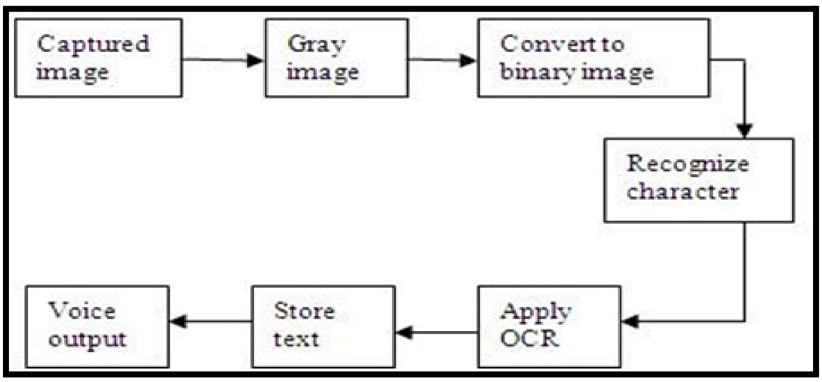


Figure 3.3 Working principle block diagram

3.6 IMAGE CAPTURING AND PREPROCESSING

Using a webcam, the video is captured and the video frames are then segregated and pre-processing is performed on them. First, the objects are captured from the camera in a continuous manner and are adapted for further processing. After removing the object of interest from the image of the camera is done, a gray image is obtained. To recognize the character from the object, the 'haar' cascade classifier is used. There are two major stages in the working of a cascade classifier: training and detection

3.7 AUTOMATIC TEXT EXTRACTION

In order to handle complex backgrounds, two new feature maps are used to extract text characteristics based on, respectively, edge distributions and stroke orientations. Here, “Stroke” is characterised as a uniform area of constrained width and significant extent. These feature maps are merged to produce a text classifier based on the Adaboost model.

3.8 TEXT REGION LOCALIZATION

On the camera-based image itself, text localization is performed. The existence of text information in an image patch is confirmed by the Cascade ‘Adaboost’ classifier, but in the entire image it cannot do so, so henceforth to extract image patches prepared for text classification from candidates, heuristic layout analysis is performed. Usually, text information appears like horizontal text strings in the image containing only three-character members.

3.9 TEXT RECOGNITION AND AUDIO OUTPUT

Before releasing educational words from the localised text regions, off-the-shelf OCR first performs text recognition. The text region identifies the smallest rectangular space that can hold characters. As a result, the content region borders touch the edge boundary of the text character. However, this experiment has shown that the background text character segments are assigned binaries before proper margin areas are assigned to better-performing text regions generated by the OCR.

The recognized text codes are saved in script files. The Microsoft Speech Software Development Kit is used to load these files, display the audio output of the resulting text information, and play it back. Users who are blind can change their speaking tone, volume, and rate to suit their preferences. Basically, these are made and can be found in most computers using the same USB technology in order to interface with the dedicated computer systems easily. Static random-access memory (SRAM) is a kind of semiconductor memory that uses bi-stable latching circuitry to store each bit individually.The suggested system makes it possible to read printed text on portable objects to aid the blind. The common targeting issue for blind users is anticipated to be resolved by a motion-based method, which only requires the blind user to shake the object for a brief period of time. This technique is useful for clearly separating the subject of interest from any surrounding objects or background in the camera view. An Adaboost learning model is used to find text in images taken with a camera. Off-the-shelf OCR is used in the localised text regions for blind users to perform word recognition; the results are then converted into audio output.

4 SYSTEM MODELING

4.1 RASPBERRY PI

The Raspberry Pi is a processor that connects to a computer or a television. It is the size of a credit card. When it connects to the computer, it can be connected to a standard USB keyboard and mouse for input. It is a highly efficient system that is designed in such a way that makes it easier for users to grasp the knowledge on how to make the best use of it. It also allows users to learn and explore the computer language Python.

4.2 DETAILS OF THE RASPBERRY PI BOARD

In the market, two models of Raspberry Pi processors exist- Model A and B. Model B is similar to Model A, only being more technically advanced than the latter. Model B has 512MB Random Access Memory (RAM) and 2 USB ports. On the other hand, when compared to Model B, Model A has only 256MB of RAM, 256MB less than that in Model B—also, it only has1 a USB port. Moreover, Model B contains an onboard Ethernet port, whereas Model A has no such provision.

4.3 Power supply

The Raspberry Pi system requires a 5V power supply to function. In case the supply exceeds the 5V limit, then its proper functioning cannot be guaranteed. The supply should also carry at least 500mA, preferably 1A. If the supply is less than 500mA, it may malfunction. Therefore, it is not recommended to power the system with a laptop's USB port, since it might not supply enough current. Hence, the Raspberry Pi requires a Micro-USB connection from a PC. It should be able to provide a current that is at least 700 mA (or 0.7 A) at 5V

4.4 Storage

For Raspberry Pi to store all of its information, including ROM and RAM, an additional storage card is required. For this purpose, an SD card could be used. An SD card may have 4, 8, 16GB, or larger in size. This card stores the operating system, codes, and calculation results.

4.5 Input

Externally, a computer keyboard and/or a mouse can be connected to the Raspberry Pi system via a USB port. Additionally, no other software is required to operate them.

4.6 WEBCAM

Using either a USB connection, Ethernet or a Wi-Fi, a Webcam, or in other words, a video camera, continuously feeds live images to a computer system. By making use of this system, computers can be linked to each other for video calling purposes, like conference calls. Since conference calls are done over the web, this video capturing system got its name- Web- Cam. The figure 4.1 represents the web camera.

Figure 4.1 WEBCAM

4.7 HEADPHONE

They consist of two ear cups that cover the ears and are connected by a headband that rests on top of the head. Headphones can be connected to a variety of audio sources, including raspberry pi to hear the output audio signal. The figure 4,2 illustrates the headphone.

Figure 4.2 Headphone

5 SOFTWARE DESCRIPTION

5.1 PYTHON

The project has been built by usage of Python programming language. It's a very simple, powerful artificial language. It gives an efficient, straightforward approach to object- oriented programming and consists of a very economic high-level information structure. With new functions and information varieties enforced in C or C++ (or different languages owed from C), the Python interpreter is obviously extended. It is also suitable for customizable applications as an extension language. Hence for all major platforms in the supply or binary type, the Python interpreter and hence the customary library area unit is freely accessible.

5.2 OCR

The conversion of typed, handwritten or printed text into digitally editable data files is known as Optical character recognition. Many OCRs are in productive use and have been developed for quite a lot of languages around the world.

5.3 OCR PROCESSES

Firstly, scanning and then digital reproduction of the text in the given image this is how the OCR process begins. As shown in figure 5.1, the following discrete sub-processes occur in the OCR process.

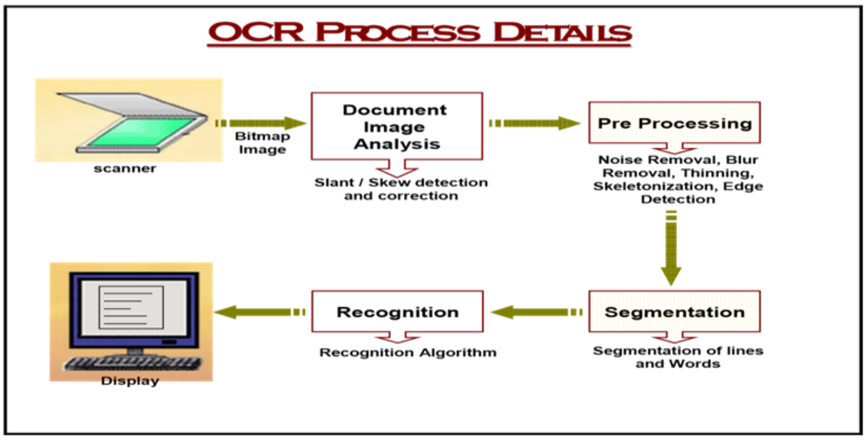


Figure 5.1 OCR processes

5.3.1 SCANNING

Through the use of a flat-bed scanner that operates at 300DPI, the printed material on the page is transformed into a bitmap image.

5.3.2 Document image analysis

The bitmap picture of the text is therefore examined, and any skew or slant that may be present is then eliminated. The printed material contains a substantial amount of text in addition to tables, graphs, and other visuals. Therefore, it is necessary to perform localization and extraction as well as discrete text area identification from the other images that are there.

5.3.3 Preprocessing

Many morphological procedures, such as edge identification, thinning, banalization, and noise and blur reduction, take place in the text picture in order to provide an OCR-ready image of the text region that is free of noise and blur.

5.3.4 Segmentation

If the entire image is made up entirely of text, the image is first divided into separate lines of text. These lines finally split into words and then letters to give us individual letters. After all the letters have been identified, localization has been carried out, and segmentation has been completed, the recognition algorithm can decide whether it wants to put the text in the image into a text processor.

5.3.5 Recognition

The most crucial stage is applying the recognition algorithm to the images available in the text image, where segmentation has already been applied at the character level. Due to the recognition character code being given by the system that matches to the image, it is sent to a word processor where it can be edited, modified, and stored in a new file format. The word processor then displays it on the screen.

6 RESULTS AND DISCUSSIONS

The various components employed in the OCR project are shown in detail in the figure 6.1. The OCR's brain is a Raspberry Pi 3B. Images are taken using a Logitech webcam. The output device for OCR is a Headphone/Speaker that is connected to the Raspberry Pi through a 3.5mm connector. Additionally attached are a keyboard and mouse, and the processor is powered by the CPU. A USB port is used to connect the webcam. A stand is used to support the webcam to read the book that help to keep it stable, the clear image is taken by webcam.So that the image to text conversion by tesseract is done faster and it keeps helping the espeek module to convert the text to speech and the accuracy is more when the clear image is captured. The stand helps to take a clear picture.

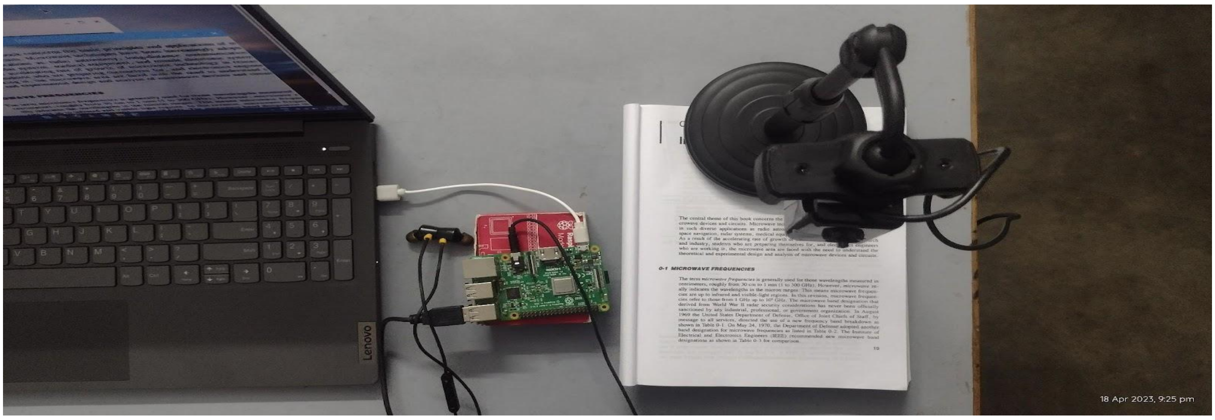


Figure 6.1 Hardware components

The figure 6.2 shows the webcam on the stand to capture the image clear without shake during the capturing quality image is taken by webcam and give it to the tesseract module and convert the image to text accurately by python program which search in the library and gives the correct output audio by espeek module.

Figure 6.2 Webcam in the stand

In the figure 6.3 the input window is ready to take the command to start the webcam by writing the program in the input window. The program line is sudio python3 code.py to start the program. This is the first step in the process of giving the starting command in the VNC viewer to start the program.

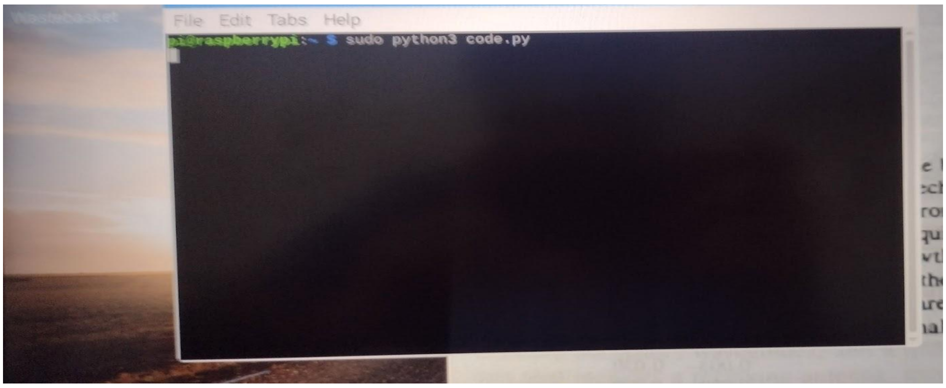


Figure 6.3 VNC viewer

The figure 6.4 displaying the live feed from the webcam capturing the image to convert it into audio. After the command code is given in the window the raspberry pi gives the signal to capture the image by turning on the webcam by pressing the space bar in the keyboard. The image is captured and sent to the tesseract module by open cv method.

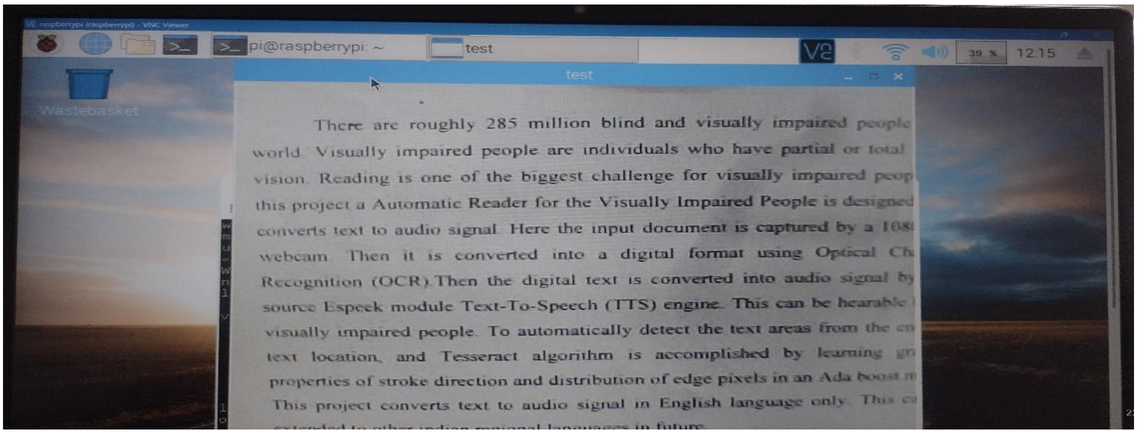
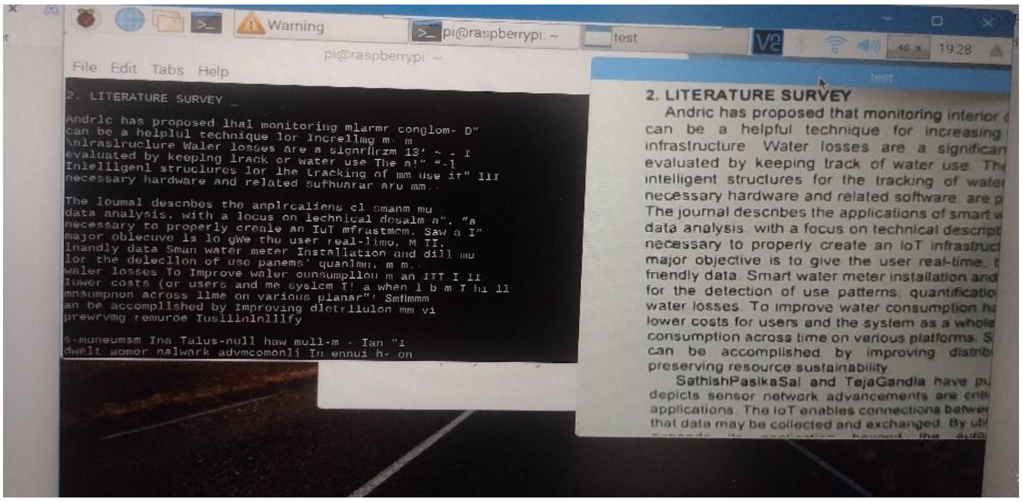


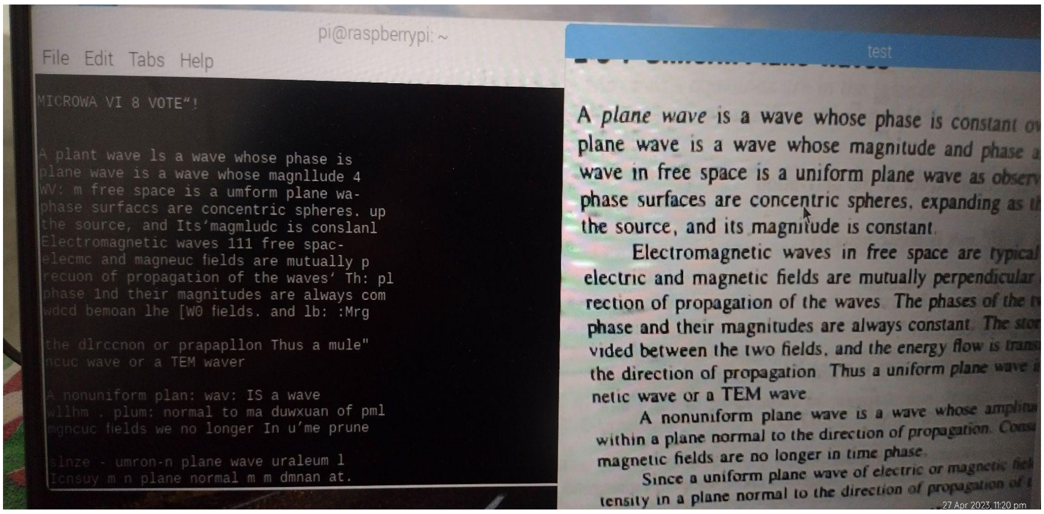
Figure 6.4 Webcam captured image

6.1 RESULTS:



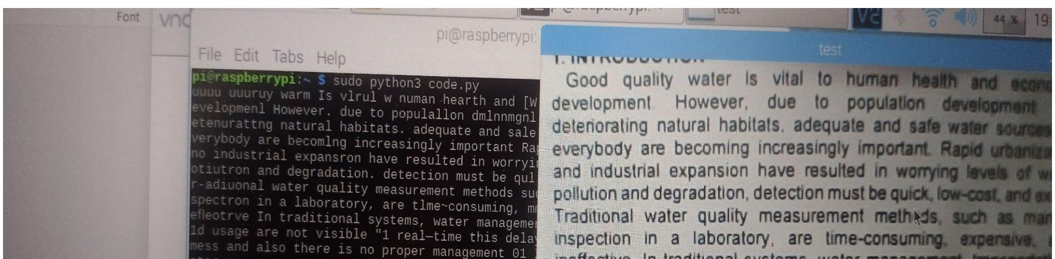
a

Total number of input words given in the image is 86,then the number of misspelled words is 19 ,finally the number of currectly pronounced words is 67 with the accuracy of 77.9%



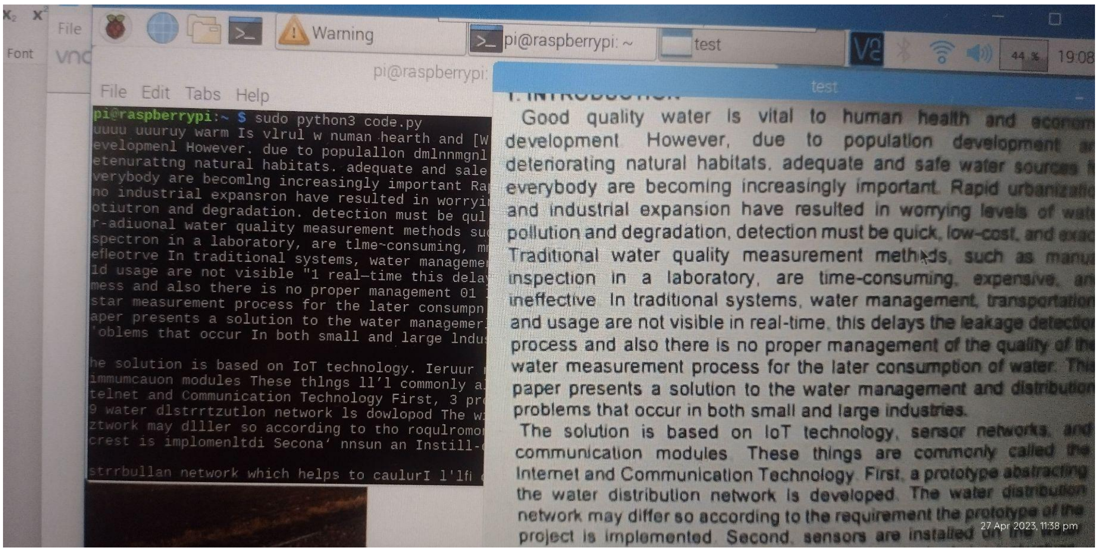
b

Total number of input words given in the image is 129,then the number of misspelled words is 28 ,finally the number of currectly pronounced words is 101 with the accuracy of 78.2%



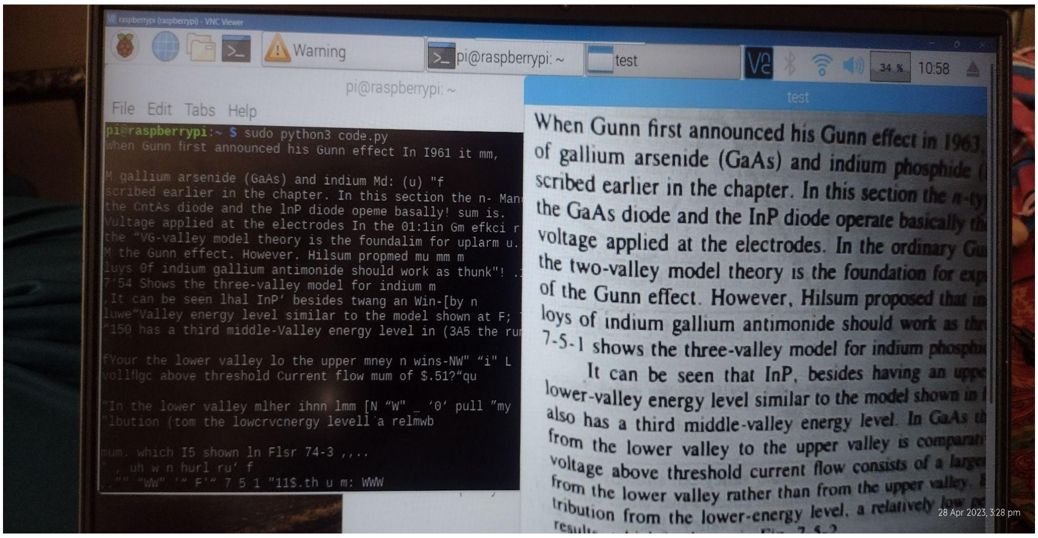
c

Total number of input words given in the image is 179,then the number of misspelled words is 44 ,finally the number of currectly pronounced words is 135 with the accuracy of 75.4%



d

Total number of input words given in the image is 106,then the number of misspelled words is 23 ,finally the number of currectly pronounced words is 83 with the accuracy of 78.3%



e

Figure 6.5 (a-e)

Total number of input words given in the image is 136,then the number of misspelled words is 42 ,finally the number of currectly pronounced words is 94 with the accuracy of 69.11%

Table 1 Result of the testing image

Sl.No	Figure 6.5 (a-e)	Total number of Input Words given in image	Number of misspelled words	Number of correctly pronounced output words in audio
1	a	86	19	67
2	b	129	28	101
3	c	179	44	135
4	d	106	23	83
5	e	136	42	94

A Raspberry Pi with 1 GB of RAM was used for the project, along with a 5 pbk camera that was installed. This project's overall accuracy value is 77.2%. Using a high-end camera and a Raspberry Pi with a large amount of RAM will increase the accuracy of the audio output.

7 CONCLUSION

The use of Raspberry Pi, OCR (Optical Character Recognition), and Espeak to develop an automatic reader for visually impaired individuals has immense potential to enhance their reading experience. The device can effectively scan and read printed materials aloud, making it an invaluable tool for individuals with visual impairments to access information independently and efficiently. The combination of Raspberry Pi, OCR, and Espeak provides a low-cost and user-friendly solution for visually impaired individuals to read books. It can recognize various languages and fonts, and its customization options make it an ideal choice for people with different needs. Moreover, the use of this technology for reading books can improve the educational and leisure opportunities for visually impaired individuals. It provides an effective way for them to access a vast range of printed materials, including textbooks, novels, magazines, and newspapers. This, in turn, can promote their overall literacy and learning, leading to better communication and integration into society. Although there are still challenges to overcome, such as improving the accuracy of OCR and Espeak technology and ensuring the device is user-friendly, the automatic reader for visually impaired individuals using Raspberry Pi, OCR, and Espeak has tremendous potential to improve their quality of life. In summary, the development of an automatic reader using Raspberry Pi, OCR, and Espeak is a significant advancement in assistive technology for visually impaired individuals, providing them with greater access to information and educational resources. This device has immense potential to promote social inclusion, enhance literacy, and empower individuals with visual impairments to live more independent lives. This can be extended to other Indian regional languages in future. The proposed method achives 77.2 % conversion of text to audio signal for the benefit of visually impaired people. This can be improved by using a higher end camera as the input.

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