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Raspberry Pi Based Reader for Visually Impaired

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Abstract: According to the World Health Organisation (WHO), 285 million people are estimated to be visually impaired worldwide among which 90% live in developing, countries and 45 million blind individuals worldwide. though there are many existing solutions to the problem of assisting an individual who is blind to read our solution bring out a smart and autonomous system that assists by reading out the page and provides a page-turning mechanism and interactive query session for them The system is developed in such a way that the user has to do is place a book in the system and the system does all the remaining tasks like reading out the text, turning the page after the text on the present page has been done reading. The system also helps the user understand the meaning of any word which he or she may not have understood completely with the help of a dictionary query feature where the user interrupts the system and asks the meaning of the world. The user can also pause or end the reading according to his or her wish. This is done by the press of the required buttons.

Keywords: Raspberry Pi, Dictionary Query, Buttons, Turning.

I. INTRODUCTION

In system - Raspberry Pi Based Reader for visually Impaired, we have represented the integration of a complete Text Read-out system with a page-turning mechanism and dictionary query features. The system consists of a webcam integrated with raspberry pi which accepts a page of a printed textbook, producing an image document. Once the image is pre-processed, the OCR (Optical Character Recognition) package installed in raspberry pi converts it into a digital text document. Finally, the text is read out by a text to speech conversion unit (TTS engine) installed in raspberry pi through the speaker or headphones. The system maintains overall synchrony with the page-turning mechanism and the dictionary features providing comfortable interactive sessions for the user. In the dictionary, we don't call the program unless the user wants it to [1]. The user can call the program with a press of a button and then the system interrupts whatever is being played and asks the user to say a word. After the user says the word, the speech is converted to text, and this text is sent over the web to find the meaning. this meaning is downloaded and is stored as a text document which is later converted to speech and read aloud to the user through a speaker.

II. BLOCK DIAGRAM

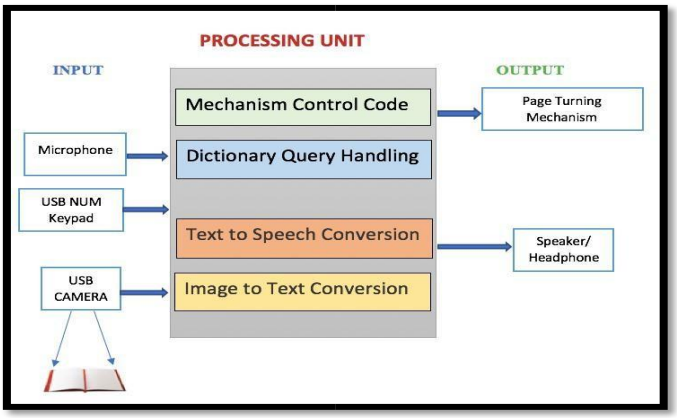

Fig 1. Block Diagram

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III. PROBLEM STATEMENT

To build an autonomous and interactive smart system that:

- Reads out the hardcopy of books pages aloud.
- Provides an interactive session of dictionary query.
- Provides an automated page-turning mechanism.

IV. OBJECTIVE

To create a system for a visually impaired person-

- Which reads the text in the given page loud to the user from the book placed in it.
- Which turns the page automatically after the current page has been done reading.
- Which can also be paused, resumed, and stop as per users' wishes.
- Which can give a meaning of any word to the user when asked using the dictionary query feature.

V. DESIGN REQUIREMENTS

Our design requires hardware and software resources which are discussed below:

A. Hardware: The hardware components used include:

- USB Camera - as an Input device for capturing the image from a book's page.
- Raspberry Pi 3/4 Model - is a processing unit.
- Speaker /Headphone -as output devices for listening to the speech output.
- Servo Motor - as the actuator for the roller wheel, lifter, and turner arms.
- Microphones - as input devices for dictionary query features.
- Push-button - as an interrupt button for BVI (blind and visually impaired) user interaction.
- Bench Support - rectangular plywood for hosting the mechanism, camera, and RPI.
- System all together tightly.
- Book is the main source in the system from which capturing the image and turning mechanism is been presented.
- Monitor – is used as a display device for verification of code or program or dictionary query feature.

VI. IMPLEMENTATION:

Initial Setup:

- Raspberry Pi is set up by powering it up using a USB adapter of 5V, 2A supply.
- The mechanism host bench for the book is set up with camera stands attached and focusing on the page so that the full content of the page is covered.
- USB camera is connected to one of the USB ports of the Raspberry pi model.
- USB soundcard is connected for microphone input.
- Speaker /Headphone is connected to Analog RCA (Composite Video, Audio) Cable for Raspberry Pi.
- All the 3 Servo Motors control wires are interfaced to Raspberry Pi. Rest is connected to 5V and GND supplies.[5]

A. PROCESSOR:

Raspberry Pi 3 or 4 Model is the third generation of Raspberry Pi. It is a powerful credit-card-sized single-board computer that can be used for many applications and projects. Fig. 2 shows the layout of RPi. It supersedes the original Raspberry pi Model B+ and RaspberryPi2 Model B. It brings you more powerful processing and 10xfaster computing than the first-generation Raspberry Pi. Additionally, it supports wireless LAN (Wi-Fi), Ethernet & Bluetooth connectivity making it the ideal solution for powerful connected designs.

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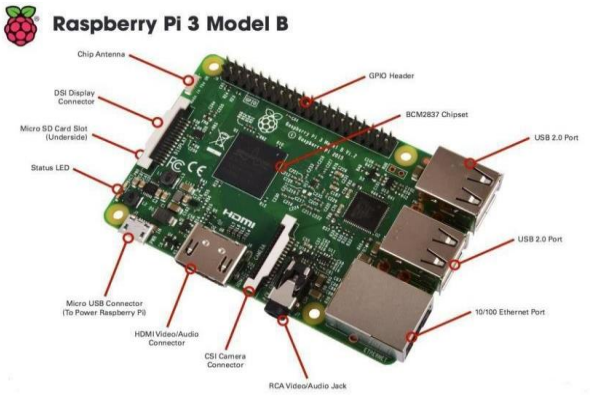

Fig 2. Raspberry board

B. Software:

The Raspberry pi is instructed through the Python 2.7 programming platform. The various modules installed on Python are:

- Google cloud vision AAPI or Python -Tesseract image to text conversion engine.
- Python VLC -sound player.
- Open CV library is used for image capture and pre-processing.

Raspberry Pi has:

- Python dictionary-for dictionary querying features
- Speech Recognition - for speech to text conversion.
- Low cost
- Consistent board format
- 10x faster processing

VII. FLOW OF PROCESS

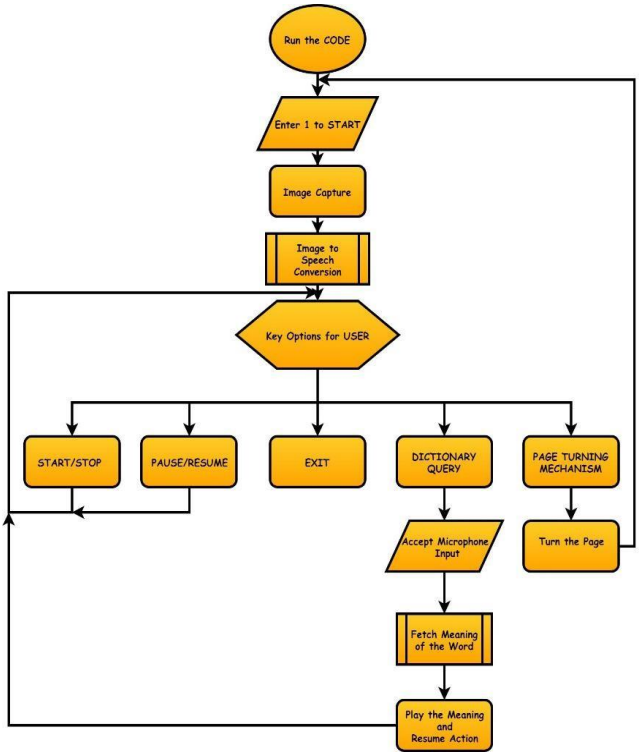

Fig 3. Flow Chart

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A. Image Processing:

Image processing is the method of applying some effects to the digital image like cropping, zooming, Gray scaling, thresholding, etc. To achieve some reformation in the image as per the requirements. image-processing done on a digital image stored on the computer is called digital image processing (DIP). In the design, we use DIP techniques to produce the captured image in suitable quality that tesseractOCR requires. So that, it can reproduce the good and accurate text. this method of processing the image before it is fed to image-to-text conversion by the OCR engine is called pre-processing.[2]

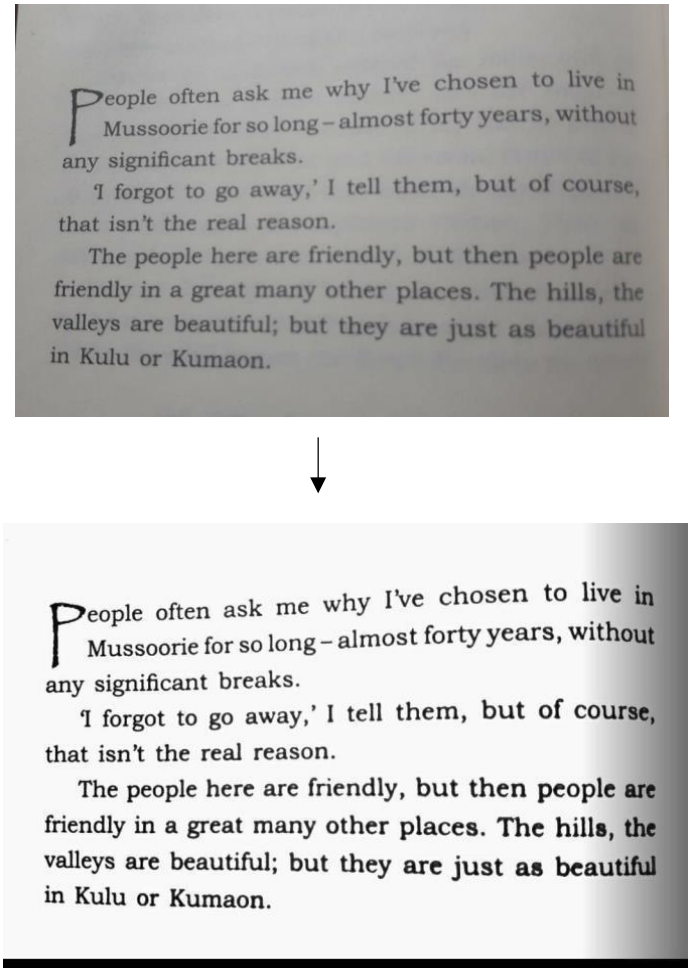

Fig 4. Image processing

B. Image to text conversion:

Once the image is taken from the camera it is not directly converted to speech and read aloud . once the image is taken, it is sent over to the google cloud platform and processed. This process is preposterous as the API uses machine learning to improve the accuracy under any circumstances, such as low light, when the camera shoots at uncanny angles, noise, etc. [7]

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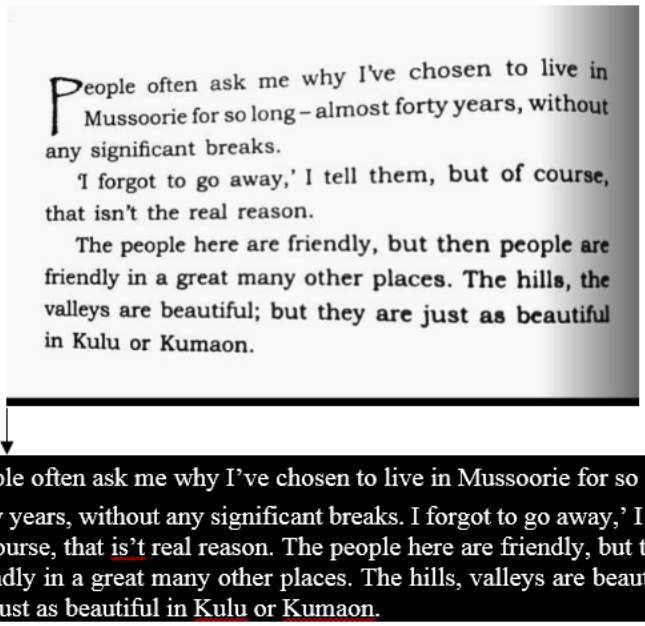
People often ask me why I've chosen to live in Mussoorie for so long – almost forty years, without any significant breaks.

'I forgot to go away,' I tell them, but of course, that isn't the real reason.

The people here are friendly, but then people are friendly in a great many other places. The hills, the valleys are beautiful; but they are just as beautiful in Kulu or Kumaon.

People often ask me why I've chosen to live in Mussoorie for so long-almost forty years, without any significant breaks. I forgot to go away,' I tell them, but of course, that is't real reason. The people here are friendly, but the people are friendly in a great many other places. The hills, valleys are beautiful; but they are just as beautiful in Kulu or Kumaon.

C. Text to speech conversion (tts):

The text is read out loud with the help of an API called google text to speech. This API takes any text from over 100 languages and sends it over to the server to decode it. This is done to reduce the computation on the raspberry pi CPU. here the API is open source, which gives the users the flexibility to change the voice speed, accent, and many other parameters according to his or her preferences.[3] Although, it is important to keep in mind that editing without the knowledge of the structure of the code and the use of each function could result in errors. Which could be minors or fatal to such an external where the API has to be removed and re-installed. Re-installation of the API is a tedious task. the user can also program the code to add any punctuation to obtain a more natural and periodic voice. if there is no punctuation the text will be read as one whole sentence instead of multiple sentences or paragraphs. The job, however, might be done. But it will not sound natural. The alternative for this is to use google cloud text to speech. This platform, like previously, uses machine learning and artificial intelligence algorithm which become better over time by simply using it more than often.[4]

VIII. DICTIONARY QUERY

The Dictionary query feature is used by the user at his or her discretion. As the name suggests this feature provides meaning for a word when the user seeks it. Even though this might seem as simple as asking modern virtual assistants - what is the meaning of a WORD, the process behind this could get quite complicated.

The user starts by pressing a dedicated button for the dictionary in the system. the system pause whatever process is going on and asks the user to say any word to which the user has not understood the meaning. the user is given a microphone in which he says the desired word. The Raspberry pi takes the input from the microphone in the form of a digital input as the microphone is connected to the microcontroller via a USB and not via an analog jack as the analog jack on the raspberry pi only provides the output and does not accept input of any sorts hence USB sounds card is used through which the microphone can send its input.

IX. PAGE-TURNING MECHANISM

This section mainly concentrates on the page-turning mechanism which is an electro-mechanical system that turns the page of the book when a user requests it. The page-turning mechanism is supreme to the education and empowerment of people with a disability by allowing them to independently perform this task using a suitable actuation device. It mainly consists of three parts:[6]

- Roller wheel
- Lifted Arm
- Turned Arm

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X. Mechanism Synchrony

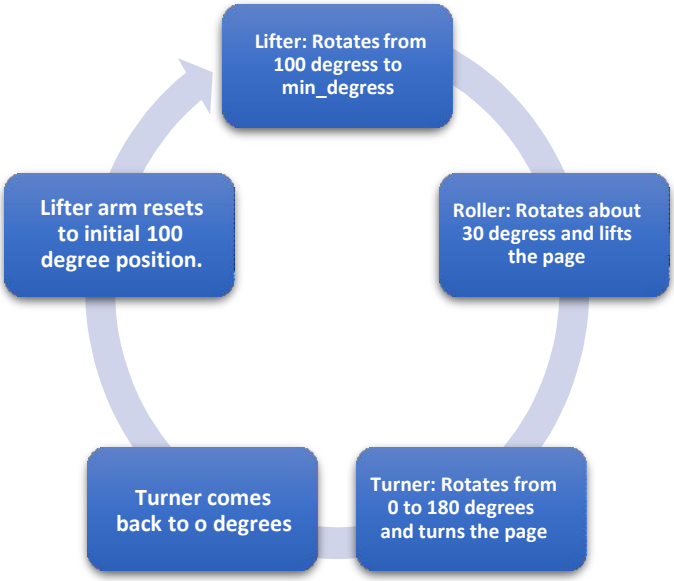

Fig 5. Mechanism synchrony

XI. CONCLUSION

In the proposed system - A smart Reader for BVI, we have successfully achieved the design and development of a working model which provides smart reading assistance for blind and visually impaired people. The system also provides an automatic page-turning mechanism and dictionary querying features, ultimately giving a feeling of comfort for the BVI. The system even finds small scale applications in school, libraries, etc the system is a budget product around Rs 5k once installed and configured can act as a perfect personal device for the user.

XII. ADVANCEMENTS

- The system can be extended to support languages other than English and to support different speech rates.
- The System can be made smarter in the sense whenever a user wants a particular page to be read, if the page is already existing then the system can skip the conversion of image to speech, rather should directly play the mp3 file.
- The system can provide the bookmark features if the user feels any sentence or paragraph important, he /she can save them and keep them for ease of access.
- If the user wants to navigate to the particular page number, the system should actuate a page-turning mechanism to go to the particular page.

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