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Book Reader for Blind

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Abstract: *Human communication today is mainly via speech and text. To access information in a text, a person needs to have vision. However those who are deprived of vision can gather information using their hearing capability. Book reader is a camera based assistive text reading to help blind person in reading the text present on the text labels, printed notes and products .It involves Text Extraction from image and converting the text to speech converter, a process which makes blind persons to read the text. This is the first step in developing a prototype for blind people for recognizing the products in real world, where the text on product is extracted and converted into speech. This is carried out by using Raspberry pi, where portability is the main aim which is achieved by providing a battery backup and can be implemented as a future technology. The portability allows the user to carry the device anywhere and can use any time.*

Keywords: *Raspberry PI, Open CV, Optical character recognition Tesseract, Text-to-Speech*

I. Introduction

Human communication today is mainly via speech and text. To access information in a text, a person needs to have vision. Visually impaired people report numerous difficulties with accessing printed text using existing technology, including problems with alignment, focus, accuracy, mobility and efficiency. Machine replication of human functions like reading is an ancient dream. However, over the last five decades, machine reading has grown from a dream to reality. Today, there are already a few systems that have some promise for portable use, like portable bar code readers designed to help blind people identify different products in an extensive product database can enable users who are blind to access information about these products through speech and Braille.

Braille is a method of reading and feeling text through touch, rather than sight. It is mainly used by those with impaired vision; however, sighted people can read Braille as well. There are many reasons for this, especially for those with a blind or visually impaired person in their household. There are many types of Braille, including musical, mathematical, and multiple types of literary Braille. Reading speed is significantly slower than for print reading or recorded materials. Daily and current brailed information is not readily available. Braille materials are expensive to produce. But a big limitation is that it is very hard for blind users to find the position of the bar code and to correctly point the bar code reader at the bar code. It takes up considerable space and presents portability and storage problems. Spelling skills require special attention because of the constructions. Specific elements of Braille present serious problems to a number of multiple handicapped individuals.

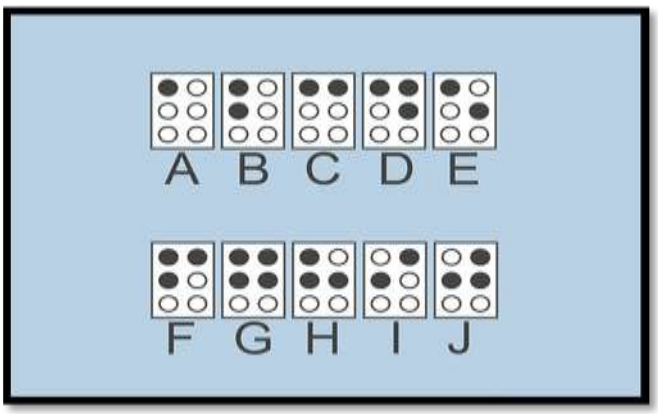


FIG 1.1 Braille System

This is a smart device that assists the visually impaired which effectively and efficiently reads paper-printed text. It uses the methodology of a camera based assistive device that can be used by people to read Text document.

This method consist of a text read out system for the visually challenged. It's a fully integrated system has a camera as an input device to feed the printed text document for digitization and the scanned document is processed by a software module the OCR (optical character recognition engine). A methodology is implemented to recognition sequence of characters and the line of reading. As part of the software development the Open CV (Open source Computer Vision) libraries is utilized to do image capture of text, to do the character recognition. Most of the access technology tools built for people with blindness and limited vision are built on the two basic building blocks of OCR software and Text-to-Speech (TTS) engines. Optical character recognition (OCR) is the translation of captured images of printed text into machine encoded text.

OCR is a process which associates a symbolic meaning with objects (letters, symbols, number) with the image of a character. It is defined as the process of converting scanned images of machine printed into a computer process format. Optical Character recognition is also useful for visually impaired people who cannot read Text document, but need to access the content of the Text documents. Optical Character recognition is used to digitize and reproduce texts that have been produced with non- computerized system. Digitizing texts also helps reduce storage space. Editing and Reprinting of Text document that were printed on paper are time consuming and labour intensive. It is widely used to convert books and documents into electronic files for use in storage and document analysis.

OCR makes it possible to apply techniques such as machine translation, text-to-speech and text mining to the capture / scanned page. The final recognized text document is fed to the output devices depending on the choice of the user. The output device can be a headset connected to the raspberry pi board or a speaker which can spell out the text document aloud. The system consists of a webcam interfaced with raspberry pi which accepts a page of printed text.

Controller coding for the Raspberry pi is done through PYTHON language. The audio output is obtained after the captured image is converted to text. The image captured by the camera is converted to text and displayed in the form window and then the text is obtained as audio output. Raspberry pi has the audio port where the output can be heard through the headphone or the speaker. Once the image is converted to text raspberry pi takes few milli seconds to convert it as a voice output.

II. Methodology

1.1 Raspberry Pi

Raspberry pi is a SoC (System on Chip), that integrates several functional components into a single chip or chipset. The SoC used in Raspberry Pi 2 is the Broadcom BCM2836 SoC Multimedia processor. The CPU of the Raspberry Pi contains an ARM Cortex-A7 900MHz processor which makes use of the RISC Architecture and low power draw. It is not compatible with traditional PC software. Therefore it has to be connected to a monitor separately and thus it is called as a mini computer.

Raspberry pi has an on-chip DSP processor which is used to perform the floating point operations. The raspberry pi uses AMBA (Advanced Microcontroller Bus Architecture) which is an on-chip interconnect specification for the connection and management of functional blocks in system-on-chip (SoC) designs. It facilitates development of multi-processor designs with large numbers of controllers and peripherals. The GPIO pins of the Pi differ by the model. There are 40 pins, out of which there are 4 power pins and 8 ground pins. Rest of the pins is used as GPIO's. The networking capabilities of the Pi can be used as a wired Ethernet (IEEE 802.3) or the wireless IEEE 802.11 Wi-Fi.

Raspberry pi has an internal memory of 1GB RAM and external memory is extendable up to 64GB. HD webcam or raspberry pi camera which has a 5MP HD camera with a resolution of 1920x1200 can be used to capture the images. The speech output is given through the earphones connected to the raspberry pi's 3.5mm audio port.

Raspberry PI parts	Specifications
Chip	Broadcom BCM2837 SoC
CPU	ARM11
Memory	1.2 GHZ Low Power ARM1176JZFS Applications Processor - Provides Open GL ES 2.0, hardware-accelerated OpenVG, and 1080p30 H.264 high-profile decode - Capable of 1Gpixel/s, 1.5Gtexel/s or 24GFLOPs with texture filtering and DMA infrastructure
Operating System	Boots from Micro SD card, running a version of the Linux operating system
Ethernet	10/100 BaseT Ethernet socket
Video Output	HDMI (rev 1.3 & 1.4) - Composite RCA (PAL and NTSC)

Audio Output	3.5mm jack, HDMI
USB	4 x USB 2.0 Connector
GPIO Connector	40-pin 2.54 mm (100 mil) expansion header: 2x20 strip - Providing 27 GPIO pins as well as +3.3 V, +5 V and GND supply line

Table no: 1.1 Raspberry PI & its Classifications

2.2 Blocks of Raspberry Pi

1. Broadcom GPIO (BCM 2837)
2. LAN 9514
3. Voltage regulator
4. Display unit
5. Camera module
6. Wi-Fi

FIG 2.1 Raspberry Board

2.2.1 LAN

It is device to control the entire USB hub and Ethernet hub

USB Hub

The integrated USB hub is fully compliant with the USB 2.0 Specification and will attach to a USB host as a Full-Speed Hub or as a Full High-Speed Hub.

Ethernet Controller

The Ethernet controller implements four USB endpoints: Control, Interrupt, Bulk-in, and Bulkout.

FIG 2.2 GPIO Classification

2.2.2 Voltage Regulator

• This series of fixed-voltage integrated-circuit voltage regulators is designed for a wide range of applications.
• These applications include on-card regulation for elimination of noise and distribution problems associated with single-point regulation

2.2.3 Features of Logitech Webcam

• Plug-and-play setup (UVC)
• Video capture: Up to 640 x 480 pixels
• Photos: Up to 1.3 megapixels (software enhanced)
• Frame rate: Up to 30 frames per second (with recommended system
• Hi-Speed USB 2.0 certified
• Fixed focus
• Universal clip fits notebooks, LCD or CRT monitor

2.3 Proposed Scheme

The proposed project involves Text Extraction from image and converting the Text to Speech converter, a process which makes blind persons to read the text. This is the first step in developing a prototype for blind people for recognizing the products in real world, where the text on product is extracted and converted into speech. This is carried out by using Raspberry pi, where portability is the main aim which is achieved by providing a battery backup and can be implemented as a future technology. The portability allows the user to carry the device anywhere and can use any time.

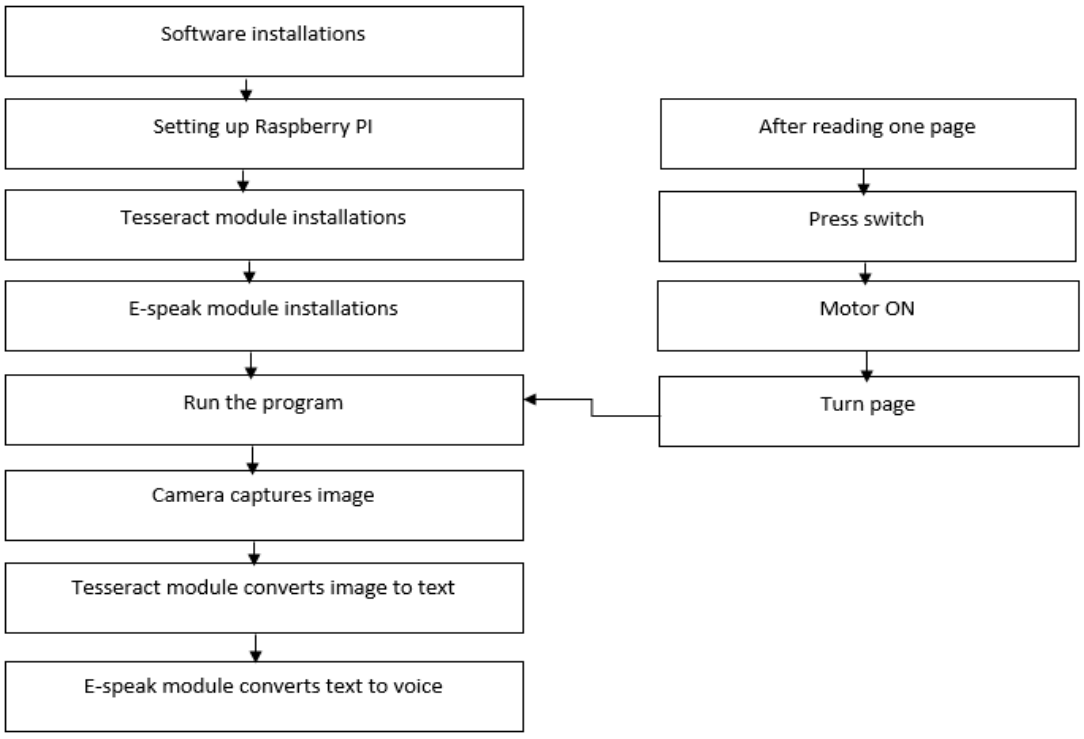
III. Experimental Setup

3.1 Components Used

Main components used include:

- Raspberry Pi 2
- HD Web Camera
- Key board
- Mouse
- Monitor
- Speaker

3.2 Flow Chart of Book Reader



3.2.1 Image Acquisition

In this step the image of the text is captured using raspberry pi camera or an HD webcam with high resolution. The acquired image is then applied to the image pre-processing step for reduction of unwanted noise.

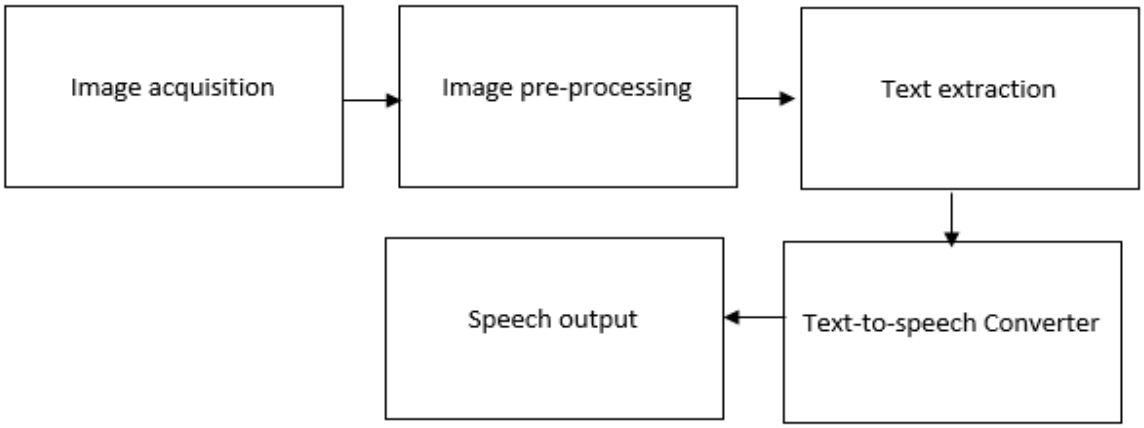


FIG 3.2 Schematic Flow Chart

3.2.1.1 Image Pre-processing

In image pre-processing the unwanted noise in the image is removed by applying appropriate threshold (OTSU), morphological transformations like dilation and black hat transformation, discrete cosine transformations, generating the required contours and drawing the bounding boxes around the required text content in the image. Initially the captured image is rescaled to appropriate size and converted into gray scale image such that it will be more useful for further processing. Then the discrete cosine transformation is applied to the gray image to compress the image which helps to improve processing rate. Then by setting the vertical and horizontal ratio unwanted high frequency components present in the image are eliminated.

Then the inverse discrete cosine transform is applied for decompression. Then image undergoes morphological operations like black top-hat transformation and dilations. The black top-hat transformation is applied to the image by generating appropriate structuring elements and extracts the objects or elements which are smaller than the defined structuring elements and darker than their surroundings. Then dilation operation is performed, which adds the pixels to the boundaries of the objects present in the image. The number of pixels added to the objects depends on the size and shape of the structuring element defined to process the image. After the morphological operations, thresholding is applied to the morphologically transformed image.

Here the OTSU's thresholding algorithm is applied to the image, which is an adaptive thresholding algorithm. After thresholding, the contours for the image are generated using special functions in Open CV. These contours are used to draw the bounding boxes for the objects or elements present in the image. Using these drawn bounding boxes each and every character present in the image is extracted which is then applied to the OCR engine to recognize the entire text present in the image.

3.2.2 Text Extraction

In this step the recognized text present in the image are extracted using OCR engines. In this project we use tesseract OCR engine which helps to extract the recognized text.

3.2.2.1 Tessaract

Tesseract was probably the first OCR engine able to handle white-on-black text so trivially. At this stage, outlines are gathered together, purely by nesting, into Blobs.

Blobs are organized into text lines, and the lines and regions are analyzed for fixed pitch or proportional text. Text lines are broken into words differently according to the kind of character spacing. Fixed pitch text is chopped immediately by character cells. Proportional text is broken into words using definite spaces and fuzzy spaces.

Recognition then proceeds as a two-pass process. In the first pass, an attempt is made to recognize each word in turn. Each word that is satisfactory is passed to an adaptive classifier as training data. The adaptive classifier then gets a chance to more accurately recognize text lower down the page.

3.2.3 Text to Speech (TTS) System

In this step the extracted text is first converted into speech using the speech synthesizer called TTS engine which is capable of converting text to speech using predefined libraries. In this project the festival TTS engine is used for conversion of Text to speech.

3.3 Software Specifications

Operating system : Raspbian (Debian)
Language : Python2.7
Platform : OpenCV (Linux-library)
Library : OCR engine, TTS engine

IV. Conclusion

The book reader for blind helps the visually challenged to be independent. Without the assistance of a third person a visually blind person can overcome the challenge of reading a book. Even though many systems are present as bar code reading, Braille system, Book reader can be very useful in any manner to read a book and make it audible to a blind person without his effort.

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