Design and Implementation of Assistive Aid for Blind and Visually Impaired Users Using Raspberry Pi 3 Arm11 (Bcm2837)

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Abstract: In this paper, we proposed an assistive aid for the visually impaired people. This will act as an identification and detection system which helps them to perform difficult tasks like reading, write and walk without help by means of sound commands. This paper carries a sequential operation of object and text recognition, currency denomination with fake note detection, obstacle detection and reading newspapers as well as books. Here the process is carried out in Raspberry pi ARM11 (BCM2837). In this processor, the text recognition and identification systems are integrated. The OCR (Optical Character Recognition) is used for converting the captured image into text and conveys to the blind people with the help of voice signals through Espeak engine. The currency notes with multiple denominations as well as fake note indication are detected using SURF algorithm. This integrated module helps the blind people to live their life independently without the help of others.

Keywords: ARM 11(BCM 2837), OCR(Optical Character Recognition), Espeak.

I. INTRODUCTION

According to the fact sheet of 2016, 39 million people are blind and 246 million have low vision. With 82% of the blind population being 50 Years old or above, there are many who have lived a majority of their lives with an inability to do tasks without the help of others. The method [1] approaches that the visually impaired people able to understand the words easily by Tesseract software. The vocally impaired people can communicate their message through text which can be read out by Espeak. The deaf people can hear others speech from text. The method [2] ensures the read printed text on handheld objects for assisting blind persons. Action –based method is used to detect the object interest is projected, While blind users simply shake the object for a couple of seconds. This method effectively distinguishes the object of interest from background or objects in the camera view. The OCR is used to perform word recognition on the localised text regions and transform into audio output for blind users**.** Text localisation and recognition [3] is done with the obtained ROI text. Using the [4] Optical Character Recognition (OCR) the printed text, document or scanned image is converted into computer recognition format.

The method [5] can efficiently detect the objects from query images by extracting frames one by one. Using SURF algorithm, the given query images at a run time generating the set of query features and it will find the best feature matching with other sets. A high recognition rate system [6] is detected using interest points from test and template images followed by SURF feature extraction. The average distance between the SURF descriptor for corresponding matched interest point is calculated to find the category of bank notes. LookTel was presented in [7] an extensive platform with mobile communication devices which returns real time banknote recognition results by a text to speech engine.Jauregi *et al*. proposed [8] a two-step algorithm based on region detection and feature extraction. This approach to improve the extracted features by reducing unnecessary keypoints, and increasing efficiency through accuracy and computational time. Signage and text detection [9] were designed to extract abstract symbol information directly from natural scene images. The MTS-enhanced method [10] can be integrated into existing personal mobile devices to take advantages of the rapidly developing internet, global positioning systems, and computing technologies to overcome several shortcomings of blind assistive devices. The contribution of this paper is threefold. An effort to minimise the dependence of the user on the people around him while carrying out chores on a daily basis. The concept of the wearable device, which supports the general human tendency of pointing at objects to interact with the environment. A prototype of a low- cost solution to the problems faced by the visually impaired while interacting with their environment.

II. PROPOSED SYSTEM

In this paper, we proposed to three major issues addressed by the prototype. First the inability to gauge the concept to identify objects present around the user. The object is identified using camera module. Second, the restrictions in identifying various currency notes while making payments and then fake currency also detected in this module. Third, the problem in avoiding obstacles present in path while walking indoors. We proposed a wearable device that can be worn by the users on his hand. To implement the proposed assistive aid system for visually impaired people the block diagram is shown below in figure

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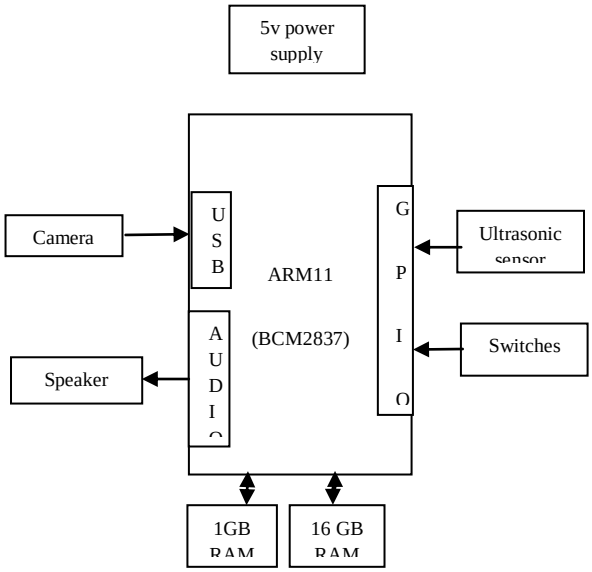

Figure 1: Block diagram of ARM 11(BCM2837)

REQUIREMENT SPECIFIATION

The requirements specification is a technical specification of requirements for the software products. It is the first step in the requirements analysis process which list the requirements of a particular software system including functional, performance and security requirements. The requirements also provide usage scenarios from a user, an operational and an administrative perspective. The purpose of software requirements specification is to provide a detailed overview of the software project, its parameters and goals. This describes the project target audience and its user interface, hardware and software requirements. It defines how the client, team and audience see the project and its functionality.

RASPBERRY PI

Raspberry pi figure 2 is a general -purpose computer, usually with a Linux operating system and ability to run multiple programs. Broad-com BCM2837 64Bit Quad Core Processor powered Single Board Computer running at 1.2GHZ. It consists of 1 GB RAM, 4 USB ports, 1 Ethernet port, 1full HDMI port and 40 GPIO pins. It consists of two interfaces: Camera interface (CSI), a Display interface (DSI). The major specification of Raspberry Pi3 is 802.11n Wireless LAN, Bluetooth 4.1.The ARM11 processor is interfaced to the camera and ultrasonic sensor.

Figure 2: Raspberry pi 3 ARM11 (BCM2837)

CAMERA

Camera figure 3 has a specification of USB 2.0 2M and a UXGA resolution (1600*1200). This USB Video Class (UVC) compliant camera module with video feature, designed for portable notebook PC image applications. It is made up of the following components, CMOS sensor, lens, holder, back end, PCB, image processing circuit and Connector, to come out a digital video device. It shall be a reliable device which is embedded in notebook PC to transfer video data through USB interface to notebook PC. The camera builds in AE, AWB and AGC for automatic image control supported by CMOS sensor. For image quality control, it also offers UVC standardized User Interface (UI) to let end user well tune image by property page.

Figure 3: USB Camera

The camera is interfaced with the processor for three purposes. First, detect the coloured object, and second, read the newspaper or books, while capturing the image and convert to the text file using OCR engine then spoke to that text file information using the speaker. Third, differentiate the various currency notes while making payments.

TEXT RECOGNITION MODULE

The Image has been acquired by capturing the photograph of a document or product or scanning the written text by the camera. The noise and the Gaussian effect in the scanned object are removed at the pre-processing stage by the min-max filter and Gaussian filter etc. The coloured image or the grey image is converted into a binary image by the method of the “Binarization”. The binary image is the combination of 0’s and 1’s.The positive values above the threshold level are taken as 1 and the background with negative values are taken as 0. On thresholding, the grey level image with pixel values ranging from 0 to 255 is converted into the binary image. Tesseract OCR (Optical Character Recognition) extracts text from the images.
The readable codes
are conveyed to the blind users as an audio output through Espeak engine. The process of text recognition is shown in figure 4

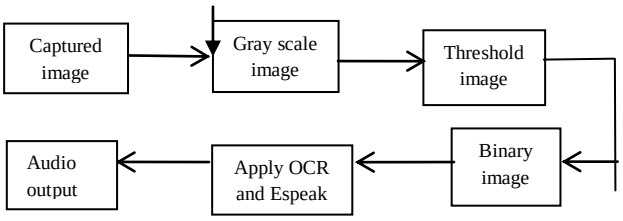

Figure 4: Text Extractor Block

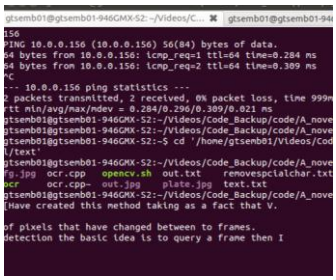

Figure 5: Software implementation of text recognition

OBSTACLE DETECTION MODULE

Ultrasonic sensor figure 6 is used for the obstacle detection and calculation of a distance between the obstacles for the visually impaired person. It will be interfaced to the Raspberry pi board. The Ultrasonic sensor consists of the transmitter, receiver and control circuit. It transmits the ultrasonic waves from its sensor head and again receives the ultrasonic waves reflected from an object.

Figure 6: Ultrasonic sensor

Whenever any obstacle comes in front of the ultrasonic sensor the sound waves will reflect back in the form of echo and generates an electric pulse. The sensor calculates the time taken between sending sound waves and receiving the echo. The echo patterns will be compared with patterns of sound waves to determine detected signal's condition. When the obstacle is detected, the user is indicated by voice command through speaker.

CURRENCY DETECTION WITH FAKE NOTE DETECTION

The Indian currency system has the multiple denominations of Rs.10, Rs.20, Rs.50, Rs.100, Rs.500, and Rs.2000. To detect the currency, SURF algorithm is used because it has robust algorithm such as contrast invariance, rotation invariance and scale invariance. The system based on the Raspberry pi communicates with the camera module catches frames which consist of a visible image of a currency note and process them. Given a test image, SURF first detects the interest points and generates corresponding descriptors. In the pre-processing stage, the different images with the different denomination of bank notes are taken.

Figure 7: Currency detection with fake note detection

The pre-computed SURF descriptors of template images in each category are then used to match with the extracted descriptors of the query image. Feature matching compares the test image and the template image to find the probability of highest match points for generating the result. Finally, by comparing all the features, the image is detected. If the features of the captured image are matched, then the Espeak engine conveys the denomination to the visually impaired user. Otherwise, it is a fake denomination.

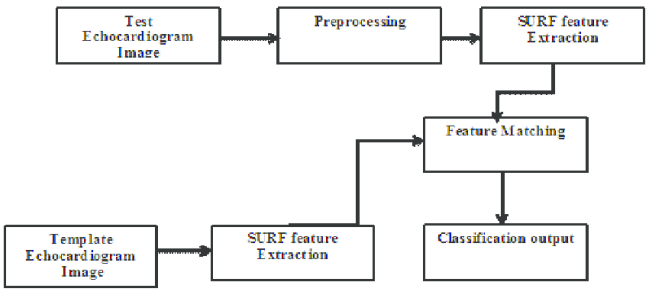

Figure 7(a): Bank note detection Rs.500

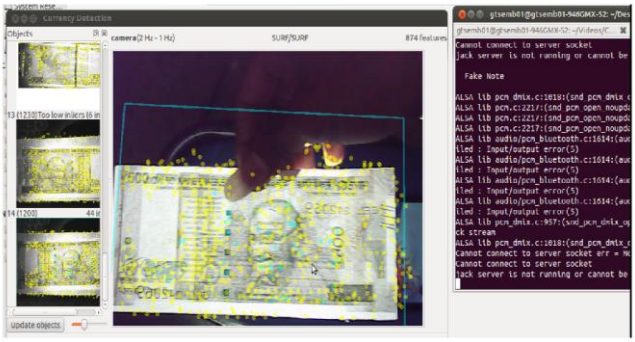

Figure 7(b): Fake note detection Rs.500s

PRODUCT-LABEL IDENTIFICATION MODULE

The product label identification system undergoes the following process. Capture the image, localise the text region, crop the text from the image and recognise the text code using OCR (optical character recognition). Text localisation and recognition are performed to acquire the text information. The system based on the raspberry pi interface with the camera module. For text scanning and recognition, the system integrates OCR. The image is captured using the camera module. An Object of interest detection and text localisation are the algorithm used for the processing. Image of an object is extracted using the object of interest detection algorithm. Text localisation is used to obtain the image region containing the text. Using the above algorithm text is recognised and is used to convert the image- based text into readable codes. The recognised text code is conveyed to the visually impaired users using the audio output.

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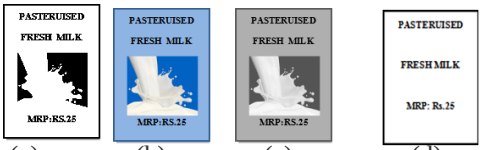

(a) (b) (c) (d)

Figure 8: An example of text localization and recognition from camera-captured images.
(a) camera-captured images;
(b) Localized text regions (marked in blue);
(c) Text regions cropped from image;
(d) Text codes recognized by OCR.

III.CONCLUSION

In this paper, we have designed a prototype assistive aid for blind and visually impaired users. Text recognition, currency recognition and fake note detection, product label identification and obstacle detection are employed in a single module. Our main motive is to facilitate the blind and visually impaired user. The added advantage of this paper is cheap, less weight and wearable device. With this device, the blind people can easily move from one place to another place confidently and independently without the guidance of other people.

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