INDIAN CURRENCY RECOGNITION AND SPEECH SYNTHESIS FOR THE VISUALLY IMPAIRED PERSONS

Venkata Sai Teja. D \(^1\), *A Krishnamoorthy\(^2\), P Boominathan\(^3\)

\(^1\) UG Student, \(^2\) Assistant Professor(Senior), \(^3\)Associate Professor

1,2,3 School of Computer Science and Engineering (SCOPE), Vellore Institute of Technology, Vellore, India

Corresponding Author *krishnamoorthy.arasu@vit.ac.in

Abstract—The assistive technology is one of the most basic and important system that helps a person with a disability to work around his challenges. This paper presents progressive efforts for developing an assistive technology for visually impaired. The system is divided into two parts, first part is the selection part which will either select color or currency according to the users wish and the second part is navigation part. The selection module will help them in color identification of various object around the user and currency denomination recognition for making payment and finally aural output being produced in the form of natural language by using the best featured RPI camera to capture the currency, these processing being done in MATLAB. The navigation part is used for obstacle detection, to help them for free navigation by providing the aural instruction using text to speech converter module. The note denomination can be easily identified by the visually impaired persons using the braille script that has been imposed into the new currency Indian notes. So, we consider this manual verification as the first validation and the second validation will be tested based on the HSV values of the security thread.

Keywords-Assistive technology, segmentation, features extraction, template matching, text to speech, edge detection, visually impair.

I. INTRODUCTION

The technological development and researches have been improving in our daily life, the human computer interaction has been becoming the must source in our everyday life. These technologies will help the visually impaired to take part in some of their social activities. So, in order to mix with the surroundings and society also to be independent in doing their daily routine activities, this project has been initiated as a good start for the blind people. Therefore, there should be an assistive device for the visually impaired which would allow the blind people to easily navigate or make use of the functionalities of the device to mingle with other people in the society. Now a days, we are aware that most of the people who are visually impaired are dependent on other persons and cannot stay independent. At present, in order to provide an independent life to the blind people many researches have been came into existence. One among them is the currency note recognition device. Secure walk without any hesitate and without help from the human within the urban environment is completely a troublesome to undertake for the blind and visually impaired individual. The main fundamental goal is to give support with an ease or help them financially which will permit them to explore themselves independently or freely into the environment. This project is mainly concentrated on the area of “Image Processing” using MATLAB and Raspberry Pi. This project is mostly a hardware based project that uses the MATLAB software.

I used a simple algorithm in this project which works in a suitable way as it is implemented for. The first step will be the capturing of currency note with the help of an RPI-Camera or webcam that is linked to the raspberry pi. The watermark present in the note will be highlighted if we use ultraviolet LED’s. Next step is the pre-processing of the image taken through the RPI-camera and performing of the basic concepts of image processing such as segmenting, edge detection and the feature extraction [1].

We know that, MATLAB works as the perfect tool for digitalized analyzing using image processing. The next challenging task in image processing is the feature extraction. This leads to the extraction of invisible as well as visible features from the Indian currency. This is the type of approach which consists of different techniques included such as acquisition, edge detection, image segmentation, feature extraction and feature matching [2].

There are more than 320 million visually challenged people worldwide. Everything that surround us are in the form of statements, receipts, reports etc., which Contain printed text on it. Even though screen readers as well as optical aids help the blind users, there exists few devices which can render better access to common hand-held objects such as the product packages and objects printed with text. There are already some portable systems in use that cannot handle product enabling, for example, barcode readers that helps to identify various products in the extensive product database to enable blind users to access information about products through Braille and speech. But there was difficulty in finding him possession of the barcode so pen scanners might be employed in the cases. Everything has got an alternative to help the blind, except in the cases of currency. So, in order to overcome such situation, I decided to implement an algorithm in MATLAB and connect it to a Raspberry Pi to make it helpful for the visually impaired persons in currency detection and speech synthesis.

The aim of this project is to find the comparative results over the same input data and find the efficient machine learning algorithm to classify with more accuracy with the efficient use of hardware resources. These machine algorithms are also preferred for Web scraping ie content extraction and whose applications and components are mainly used for Web indexing, Web mining, and data mining. The scope of finding the best algorithm is to classify the google earth satellite images taken from satellite by using the hardware resources efficiently and with the maximum accuracy.

In this project, we gathered all the aspects of the Image Processing terminologies and made a simplified recognition of the currency value technique, which would be worked as an initial standard for future scope in Identification of the bank notes. This project not only follows the methodology of the software oriented MATLAB, but also uses the techniques of...
hardware oriented Raspberry Pi-Simulink. A clear variation and combine usage of Raspberry Pi and MATLAB will be understood by this paper.

In Section I, we discussed about the Image Processing techniques. Literature Review for the related works is done in the Section II. The methodologies used in this paper are listed in the Section III. The Implementation part of the project listed in the paper has been concentrated and is illustrated clearly in the Section IV whereas in Section 4.1, we discussed about the architecture diagram of the project along with Functioning sequence diagram in Section 4.2. The Section V explains about the Results obtained in the project and concentrates on the discussions about results whereas the Section VI concentrates mostly on the analysis and on overall conceptual conclusion along with the references in Section VII.

II. LITERATURE SURVEY

In the literature survey, a few implementations and published works are found in the improvement of the currency recognition along with the benefits, risks, security as well as protection techniques were explained. An approach to the Portable camera based assistive text and product label reading from hand-held objects for blind persons is performed in [1]. Another approach to the efficient banknote recognition based on selection of discriminative regions with one-dimensional visible-light line sensor is mentioned in [2]. In another approach [3,4], Currency recognition using a smartphone and Comparison between color-SIFT and gray scale SIFT algorithms. The Indian currency identification using image processing has been explained clearly in [5].

In another approach, the implementation of Automatic recognition and counterfeit detection were defined briefly in [6]. Analysis and recognition of currency notes and the processing of images as well as feature matching has been clearly explained in [7]. The Mobile based application for fake currency detection and recognition is well defined in [8] and to the continuation for it, the forensics has been clearly stated in approach [9]. The review of various image processing techniques for currency note authentication is explained in [10].

The speech assistance technique using OCR for visually impaired has been clearly stated in [11], whereas Digital image processing techniques have been mentioned in [12]. In another approach, the fraud detection terminologies in [13] along with the features of original notes in [14] as well as fake notes in [15] and their recognition has been clearly explained in [16]. The feature extraction techniques as well as Security thread comparisons are stated in [17,18] whereas, the working of ATM’s and fake note detection case study has been explained in [19,20].

III. METHODOLOGY

The main methodologies that acts as a basement and also which has the capability of most of the consideration values were defined and explained as follows viz.,

Image Acquisition: The process of retrieving an image from an external source such as hardware based for processing is termed to be known as ‘Image Acquisition’.

Binarization of an Image: The conversion of an image from gray scale to binary by means of thresholding function is known as ‘Binarization of an image’. The binary document type image will require very less space to get stored.

Segmentation: The process of partitioning an image or text into parts [7] in order to make them use for the image processing functionalities such as feature extraction, recognition, etc., is termed to be known as ‘Segmentation’.

Feature Extraction: The process of extraction of the features that act as essential as well as required characteristics such as symbols, text, etc., is termed to be known as ‘Feature Extraction’.

Recognition: The process of identifying the features after extraction is termed to be known as ‘Recognition’.

The Block Diagram that defines the order of the performance of the above mentioned methodologies in this project has been illustrated as follows in Fig a viz.,

IV. IMPLEMENTATION

The main process that starts the project is the connectivity of Raspberry Pi with MATLAB. Raspberry Pi connectivity with the MATLAB software can be done using an existing interface present
in MATLAB called ‘Simulink’. Simulink is a hardware connectivity tool used in MATLAB. We used Simulink to connect Pi with MATLAB. The project at the start is maintained in such a way that the currency note will be exposed to the UV LED in order make the water mark of Gandhi Visible along with the Security thread line. We then use the Raspberry Pi take the snapshot of the Currency using RPI-Camera module.

In order to have the clear impact on the currency recognition, the setup has to be well designed and maintained to detect correctly. After the capture of the image, the image is sent to the pre-processing stage. After performing of all the image processing terminologies such as image acquisition, image binarization, edge detection, image segmentation, feature extraction and feature matching, the identified currency value is converted to text format and later the text is converted to speech and is speech synthesised in order to help the blind recognise the value correctly.

4.1 Architecture Diagram:

The Architecture diagram that defines the project has been illustrated clearly as follows in Fig b viz.,

![Architecture Diagram](image)

The connectivity between the hardware and software can have either wired or wireless whichever is meant to be flexible to use with. This Project highlights the fact that each research used their own kind of setup and the setups were reasonably good in their niche of work. But, all these setups had one common thing they used android based currency recognition to help the user know the value of the currency and though some of them promised real-time information it didn’t prove to be that much efficient. Even though there exists many more ways of implementing this process, since being the image processing features an operational project, nothing can overcome MATLAB. Even Python becomes into the second category for this project. That much importance has been given to MATLAB for this project implementation.

4.2 Functioning Sequence:

The sequence of these Image processing terminologies and the state of order has been explained clearly in the below activity sequence diagram as shown in Fig c which will further lead to the identification of the currency note value and speech synthesis of the value that has been recognized.

In order to perform the recognition process, we have to implement and need to follow the following setup viz.,

1. Capture the Currency with the Raspberry Pi Cam using UV-LED’s or visual light
2. Apply Image Operations in MATLAB to the captured currency image.
3. Convert the RGB image to Gray-scale image.
4. Covert Gray-scale image to Binary image and do image segmentation.
5. Now extract the features and characteristics and verify them with the help of algorithm proposed.
6. Speech out the currency value using the speaker (This happens only when image was clear). This pattern can further be acted as a future work for this project.
7. Whether the captured note is original or fake will be resulted in this project

![Functioning Sequence](image)

V. RESULTS AND DISCUSSION

With the help of features extracted and characteristics matching which has been obtained from the image processing operations, the proposed MATLAB model that has been built in this project will recognize the currency value and return the value in the form of speech.

Sample Test Cases

The below table viz., Tab.1 explains clearly about the few possible test cases by considering the input patterns based on manual testing as well as the digital validation techniques using HSV. Based on these considerations, the sample test cases have been mentioned below for three types of new Indian notes as reference such as 2000rs, 500rs and 200rs. These scenarios along with their output that will be generated has been clearly stated in the table Tab1

There are many methods for identifying a fake note, each have its own significance. One should be cautious while detecting a fake note. Our paper mainly deals with the development of a device that is portable and effective in nature in terms of intelligent systems for the banknote validation for the visually impaired persons. Thus, due to the maximal requirements number for the development, the blind people finds difficult in using the device. Therefore, for an effective performance and usage of the proposed device we used some of the cheap and effective electronics; i.e., RPI-Camera for communication, UV LED’s or visual light and MATLAB.
software along with Simulink and synthetic speech (if possible). So, we can use either the UV or Visual Light as a constraint to perform the project. Feature recognition as shown in Fig d will be obtained along with the text extraction and speech if possible as shown in Fig e.

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Manual Testing</th>
<th>Digital Validation based on HSV</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Braille Script 7 lines-success</td>
<td>No. of black lines = 0 or 1</td>
<td>Fake 2000rs Note</td>
</tr>
<tr>
<td>2.</td>
<td>Braille Script 7 lines-success</td>
<td>No. of black lines ≠ 0 or 1</td>
<td>Original 2000rs Note</td>
</tr>
<tr>
<td>3.</td>
<td>Braille Script 7 lines-fail</td>
<td>No. of black lines = 0 or 1</td>
<td>Fake Note</td>
</tr>
<tr>
<td>4.</td>
<td>Braille Script 7 lines-fail</td>
<td>No. of black lines ≠ 0 or 1</td>
<td>Fake Note</td>
</tr>
<tr>
<td>5.</td>
<td>Braille Script 5 lines-Success</td>
<td>No. of black lines = 0 or 1</td>
<td>Fake 500rs Note</td>
</tr>
<tr>
<td>6.</td>
<td>Braille Script 5 lines-Success</td>
<td>No. of black lines ≠ 0 or 1</td>
<td>Original 500rs Note</td>
</tr>
<tr>
<td>7.</td>
<td>Braille Script 5 lines-fail</td>
<td>No. of black lines = 0 or 1</td>
<td>Fake Note</td>
</tr>
<tr>
<td>8.</td>
<td>Braille Script 5 lines-fail</td>
<td>No. of black lines ≠ 0 or 1</td>
<td>Fake Note</td>
</tr>
<tr>
<td>9.</td>
<td>Braille Script 4 lines &amp; 2 Dots-Success</td>
<td>No. of black lines = 0 or 1</td>
<td>Fake 200rs Note</td>
</tr>
<tr>
<td>10.</td>
<td>Braille Script 4 lines &amp; 2 Dots-Success</td>
<td>No. of black lines ≠ 0 or 1</td>
<td>Original 200rs Note</td>
</tr>
<tr>
<td>11.</td>
<td>Braille Script 4 lines &amp; 2 Dots-fail</td>
<td>No. of black lines = 0 or 1</td>
<td>Fake Note</td>
</tr>
<tr>
<td>12.</td>
<td>Braille Script 4 lines &amp; 2 Dots-fail</td>
<td>No. of black lines ≠ 0 or 1</td>
<td>Fake Note</td>
</tr>
</tbody>
</table>

Tab.1 Sample Test Cases

VI. CONCLUSION

This project enables a visually impaired person to be aware in validating the currency note to detect whether the currency is original or fake. My MATLAB technique when deployed in Raspberry Pi with a scanner or a camera so that it will capture the currency note and perform the image processing techniques imposed in the project by differentiating whether the currency is original or fake based on the parameters of HSV values of the currency note which in front gives the power to an impaired person in detecting it.

This project can further be extended to form a naïve device using Raspberry Pi and Simulink by creating a model and injecting it into the raspberry pi. The extended version can also include completeness of the speech synthesis capability from the naïve raspberry pi device that can be acted as a portable device carried out by the visually impaired persons with utmost flexible manner.

VII. REFERENCES


