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Image Processing Techniques for Extraction of Serial Numbers on Currency Notes While Depositing in Cash Deposit Machine Using Python and Raspberry Pi

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Abstract:

Nowadays, serial numbers of currency notes are collected and entered in a register manually. If any robbery occurs in banks, ATM's or CDMA's, the notes are tracked by using the serial numbers that are entered manually. The aim of this project is to extract the serial numbers, which are unique to a note, and storing them in a database automatically. We can retrieve the information about transactions with the notes in ATM's or Banks. The serial numbers are extracted using Python and Raspberry Pi. Now the values that are extracted are stored in a file in the text format by linking the serial number to the corresponding value.

Keywords: *Currency notes, serial numbers, OCR, Image Processing, Python and Raspberry Pi*

I. INTRODUCTION

In digital image processing extraction of features from an image is a challenging task. The feature extraction is used in extraction of serial numbers of a various currency notes. Here the extraction can be done from the original data base which can be used in the identification purpose, but during process, the dimensions of the image or data can be reduced. Due to the technical limit in the memory and the computational time, these techniques can always a need/necessary. A best feature extraction method/technique must maintain and enhance those features of the input image data which make different pattern classes separate one from each other. In the ongoing years, alongside the accelerative advancements of the world financial matters consolidation course, the beginning of euro region, and the expansion of Asia financial aspects, wilderness exchange and individual intercourse of different nations are much of the time expanding. The people travelling from country to another can take paper currency always. Probabilities that the paper monetary forms of different nations are appropriately interleaved together in this manner rises progressively. It is a test for regular paper money framework. In any case, the focal point of the greater part of the regular cash acknowledgment framework and machines perceives fake money. It isn't sufficient for commonsense organizations. The explanation is that in many banks, particularly the global banks, there are enormous amounts of money having a place with a wide range of nations should have been handled and it is conceivable that every one of them are genuine money.

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Optical character recognition (OCR) is used to convert the printed document or any scanned page into the ASCII characters, which a computer system can recognizes. PC frameworks furnished with such an OCR framework improve the speed of information activity, decline some conceivable human blunders and empower minimal capacity, quick recovery and other document controls. The scope of utilizations incorporates postal code acknowledgment, programmed information section into enormous regulatory frameworks, banking, programmed cartography and perusing gadgets for daze. Precision, adaptability and speed are the principle includes that portray a decent OCR framework. A few calculations for character acknowledgment have been created dependent on highlight determination. Some of them have been found financially practical and have gone into creation like Omni Page, Word check, Type Reader and so on. The exhibitions of the frameworks have been compelled by the reliance on textual style, size and direction. The acknowledgment rate in these calculations relies upon the selection of highlights. A large portion of the current calculations include broad preparing on the picture before the highlights are separated that outcomes in expanded computational time.In this project, we built a currency note serial number extracting system based on optical character recognition (OCR) using the Raspberry Pi 4 and python. Where the serial numbers on the currency notes can be can be extracted easily during the process of counting the notes. The main processing system of this system is Raspberry Pi 4 which controls motors, camera modules and other sensors in the system, and processes the images of the notes captured by the camera module using the Tesseract OCR algorithms for faster extraction of the serial number from the currency note. These results are converted into the excel sheet and stored in the memory from where it can be send to the bank servers and E-mail for tracking the currency.

II. Review of Literature

Bo-YuanFeng,Xu-YaoZhang, Ching Y.Suen [2013]proposed an binarizationmethod which is based on edge detection. This method uses a system which extracts the RMB characters directly from scanned RMB images. First, 2 different techniquesnamely skew correction and orientation identification which are used to detect the region which contains the serial number of the RMB image. The detected text region is binarized by a combined thresholding technique.

J Bhaskara Rao, A SivaKumar[2018]proposed a Heuristicanalysis of characters is set for the purpose of getting accurate features of characters before feature extraction in currency. To recognize any type of character from the given currency note image, here the feature descriptors of such image are need to be extracted. As the extraction method used here is considerably affects the quality of the whole OCR process, this is very important to extract features, which are invariant towards the variety of light conditions, used as the font type and the deformations of such characters caused by the skew of the input image.

Lokendra Singh Banafar, Dr. Lalita Gupta [2018] proposed a methodology that text detection is carried by using canny edge detectionalgorithm and MSER based method along with theimage enhancement which results in the improvedperformance in terms of text detection.

T. Gnana Prakash, K. Anusha [2017] proposed a methodology to extract the text by applying various pre-processing techniques like desk wing,binarization etc. and algorithms like Tesseract torecognize the characters and gives the finaldocument.

Number recognition system based on CIS and DSP is proposed by Liu Li,YeYu-tang, XieYu, PuLiang [2010]. Here, the hardware of the system is composed of CIS and DSP which are used to control image acquisition and process. The software used here is composition of image acquisition, character correction & recognition. The authors proposed an approach for character feature extraction which is based on statistics and fuzzy membership.

Chirag Patel, AtulPatel, Dharmendra Patel [2012] proposed an Open Source OCR tool Tesseract, an architecture of the system and the experimental

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result of OCR which are performed by Tesseract on different types of images. In this paper by the comparative study of this specifictool with the other commercial OCRtool Transym OCR by considering the vehicle number plate as the input based on various parameters.

S.Shiyamala, S.Suganya [2019] proposed a connected component method which is used to extract the text from background. In this, horizontal and vertical projection profiles,geometric properties of text, image binarization and gap filling method are used to extract the text fromscene images. Then histogram based threshold is applied to separate text background of the images. Finally, text is extracted from images.

Tellapavani, DVR Mohan [2019] proposed aLicense Plate Recognition system that recognizes any digital image automatically on the number plate. which has been implemented in K-NN algorithm and python programming language. This system includes various operations such as taking pictures, localizing the number pad, truncating characters and OCR from alphanumeric character using the Open Computer Vision Library.

JasvinderKaur1, Monika Aggarwal [2013] proposed a system can detects the theft of Indian currencynotes by corresponding to the serial number of the currency note. Here, the proposed serial number extraction system consists of three major parts: Currency note Image acquisition, serial number extraction o the currency note and the Optical characters recognition (OCR). Colorplane extraction andbrightness control methods are used for extracting the serial number. The OCR system can recognize the each and every character in the serial number of the currency note. The serial numbersof the missing notes can be saved as the data base will be comparedwith the serial number of each and every note available.

III. Methodology

The serial number extracting system is also an application of embedded technologies in which the Raspberry Pi 4 is used to process and control the entire unit.

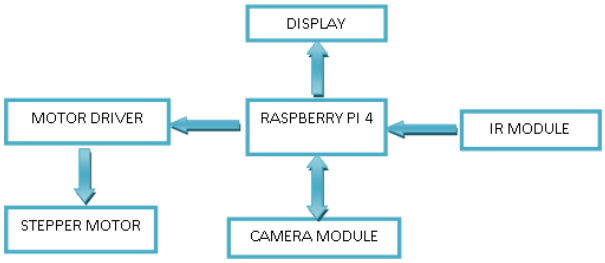

Fig.3.1: Block Diagram of Serial Number Extraction System

3.1 Algorithm:

1. START
2. Rotate stepper motor for 1 complete cycle to take 1 note from the chamber.
3. Capture the note using camera module and store the image in the raspberry pi.
4. The 32-bit color image can be converted as an8-bit grey scale image by the Color plane extraction.
5. Now apply Dilation and Erosion for removing the noise from the image.
6. Crop the selected part of an image for processing.
7. Resize the cropped image for equal distribution of pixels.
8. To identify the set of characters OCR can train the software.
9. If the no. of characters in number from OCR session equal to 9.
10. Store it in the file and set FLAG to 1 and increment N.
11. Else set FLAG to 0.
12. If Flag equals to 1 and n not equal to 60 jump to step 2.
13. Else if Flag equals to 0 and n not equal to 60 jump to step 3.
14. Else terminate the process.

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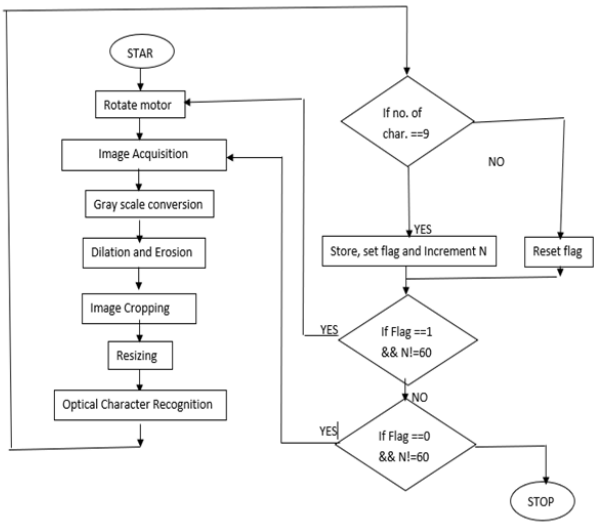

Fig.3.2: Flow Chart Representation of Serial Number Extraction System

3.2 System Architecture:

1. The currency notes placed in the chamber 1 is detected by the IR module and triggers the raspberry pi to run the program.
2. Then a single note is moved to the chamber 2 with the help of stepper motor rotation.
3. The motor driver gives the 4-bit data for to complete 512 steps for the complete rotation.
4. The Rotation of stepper motor for 1 complete cycle helps to take 1 note from the chamber 1 and to place the note in chamber 2.
5. In chamber 2 the Capturing of the note using camera module is done and stores the image in the raspberry pi.
6. Then the 32-bit color image can be converted as an8-bit grey scale image by the Color plane extraction.
7. Now apply Dilation and Erosion for removing the noise from the image.
8. Crop the selected part of an image for processing and resizing the cropped image for equal distribution of pixels which helps in OCR Session.
9. To identify the set of characters OCR can train the software.
10. If the no. of characters in number from OCR session equal to 9.
11. Store it in the Excel file and send note to the exit point.
12. Else move to note to the lower chamber to avoid false data.
13. Then redo the same process from step 2 until the IR module detects no notes in chamber 1
14. Once no notes are in chamber 1 save the excel file and display it in the main screen.

IV. Working of the Proposed System

The proposed model consists of 3 chambers namely Chamber 1 (where the bunch of notes are kept for the serial number extraction.), Chamber 2 (in which the capturing of the image takes place.), Chamber 3 (which is the lower chamber to hold the defect notes.)

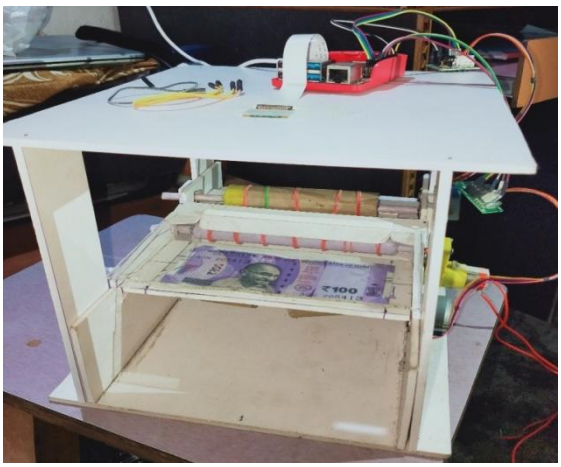

Fig.4.1: Prototype of proposed system

Whenever the bunch of currency notes placed in the chamber 1, these are detected by the IR module and triggers the raspberry pi to run the program. Then the motor driver gives the 4-bit data to the motor to complete 512 steps for the complete rotation of the shaft which holds single note at a time. Then that note is moved from chamber 1 to chamber 2 with the help of stepper motor rotation.

In chamber 2 the Capturing of the note using camera module is done and stores the image in a particular location of the raspberry pi. Thus to access these images for the further processing purpose. Then the 32-bit color image can be converted as an8-bit grey scale image by the Color plane extraction and to remove the noise the Dilation and Erosion is applied.

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In dilation a pixel of image is chosen as 1 only if all the pixels below the kernel is 1 thus increase the white region and size of the foreground objects of the image. In erosion a pixel of image is chosen as 1 only if all the pixels under the kernel is 1, else it will be eroded so all the pixels near the boundary will be discarded and thickness of the foreground objects decreases.

The images that are eroded and dilated are Cropped using the Numpy crop function with the default distance value of the selected region of an image for processing. The resizing the cropped image is done for equal distribution of pixels which helps in OCR Session. Once the resizing of the image is done it is send through the OCR to identify the set of characters OCR can train the software.

The Optical character recognition system transforms a 2D image of the text, which could contain the handwritten text or machine printed from the image representation into a machine-readable text. In this project we used Tesseract-OCR engine which is an open source text recognition engine. It supports a wide variety of language trained data sets.

Once the text is extracted from the image, the text is verified whether the no. of characters in number from OCR session equal to 9 then it stores the number in the Excel file and send note from the chamber 2 to the exit point. Else the note is moved to the lower chamber by the 2nd stepper motor to avoid false data.

This entire process is continued till there are no notes present in the chamber 1 and then the excel sheet is saved and displayed on the screen.

V. Results

After setting the all the hardware and opening up the program as show in the picture below

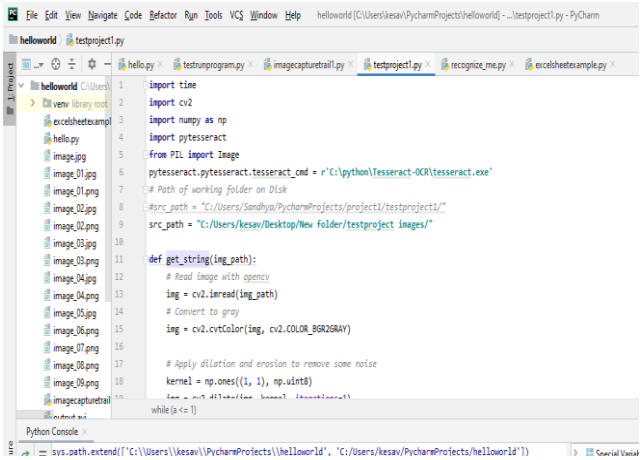

Fig. 5.1 Program in PyCharm IDE (Python)

Then insert the bunch of notes in the notes cabin of the system and start the program to extract the serial number of the system.

Then the Picam starts capturing the images of each note and sends to the raspberry pi which stores in a particular location for further process.

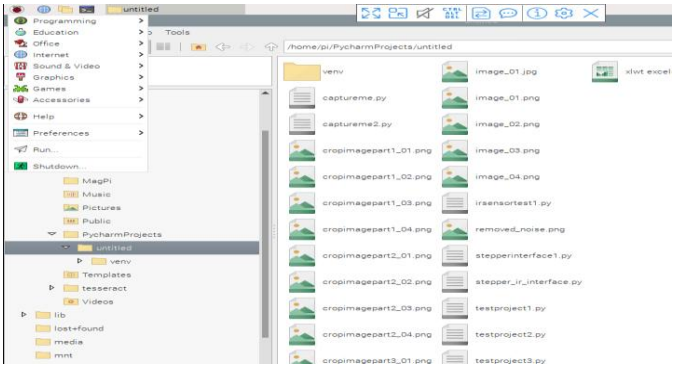

Fig. 5.2: stored Location of the images

Once the image is captured, it is processed to remove noise then sends to the tesseract to extract the number from the image

Fig. 5.3: image captured using picam

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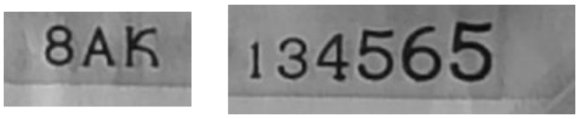


Fig. 5.4: cropped images during the process

Fig. 5.5: threshold image of the cropped image

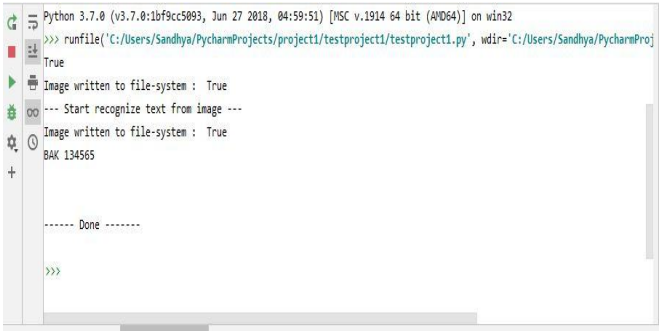
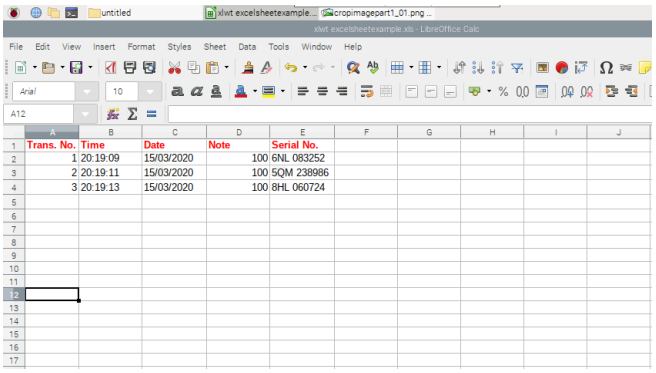


Fig. 5.6:Serial number extracted using tesseract

Then the serial numbers that are extracted using the tesseract are stored in an excel sheet with the time, date, value of the note, etc.



Trans. No.	Time	Date	Note	Serial No.
1	20:19:09	15/03/2020	100	6NL 083252
2	20:19:11	15/03/2020	100	5QM 238986
3	20:19:13	15/03/2020	100	8HL 060724

Fig. 5.7: Data stored in excel sheet

VI. Conclusion

In this project, the Raspberry Pi is used, which is a type of hardware like the combination of the features of an embedded device and a traditional computer. This supports a operating system like Linux which provides the simple input/output lines i.e. GPIO which can makes it perfect for the controlling almost anything. The programming the GPIO is easy and intuitive then a traditional microprocessor or the FPGA.

Thus, we designed a low-cost serial number extracting system using the Raspberry Pi as the main processing unit, which captures the images of the currency notes one at a time using the camera module interfaced to the PI and extracts the serial number from it. These details are stored in the form of excel sheet with the details like, transaction time, date, etc.Which is further used for tracking the notes whenever a transaction is being done at the banks and ATM's or a robberywas done at bank. There we can use these details to track the notes that where these notes have been used or deposited. We can also use these serial numbers to detect the counterfeit notes by comparing the serial number of that currency note in the database.

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