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Project Title: SERIAL NUMBER EXTRACTION OF CURRENCY NOTES IN CASH DEPOSIT MACHINE USINGPYTHON 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 CDM'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.

INTRODUCTION

Feature extraction of images is a challenging work in digital image processing. Feature extraction of Indian currency notes involves the extraction of features of serial numbers of currency notes. This is extraction from the raw data the information which is most relevant for the identification purpose, during which the dimensionality of the data gets reduced. This is almost and always necessary due to technical limit in memory and computational time. A good feature extraction scheme should maintain and enhance those features of the input data which make distinct pattern classes separate from each other. At the same time the system should be immune to variations produced due to human using it and the technical devices used in the data acquisition. In the recent years, along with the accelerative developments of the world economics incorporation course, the start of euro area, and the increase of Asia economics, frontier trade and personal intercourse of various countries are frequently increasing. Travelling people always take many countries of paper currency. Probabilities that the paper currencies of various countries are properly interleaved together therefore rises increasingly. It is a challenge for conventional paper currency system. However, the focus of most of the conventional currency recognition system and machines is recognizing counterfeit currency. It is not enough for practical businesses. The reason is that in most banks, especially the international banks, there are large quantities of cash belonging to many different countries needed to be processed and it is possible that all of them are real cash.

Optical character recognition (OCR) is a process of converting a printed document or scanned page into ASCII characters that a computer can recognize. Computer systems equipped with such an OCR system improve the speed of input operation, decrease some possible human errors and enable compact storage, fast retrieval and other file manipulations. The range of applications includes postal code recognition, automatic data entry into large administrative systems, banking, automatic cartography and reading devices for blind. Accuracy, flexibility and speed are the main features that characterize a good OCR system. Several algorithms for character recognition have been developed based on feature selection. Some of them have been found commercially viable and have gone into production like Omni Page, Word scan, Type Reader etc. The performances of the systems have been constrained by the dependence on font, size and orientation. The recognition rate in these algorithms depends on the choice of features. Most of the existing algorithms involve

extensive processing on the image before the features are extracted that results in increased computational time.

Objective:

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.

Motivation:

The serial numbers are the unique alpha-numerical identifiers (IDs) of the banknotes. Each sheet has its own serial number. Correctly and fast recognizing these numbers is very important mainly due to three reasons.

1. There is a need for proper statistics by the national treasuries and the banks.
2. There is a need for reprinting of the destroyed banknotes.
3. There is a need for the diagnosis of the crimes by the public police.

A system is being proposed can Extract the serial numbers on the Indian currency notes during transactions in ATM's & CDM's and saves the data, thus by matching those data of the note we can achieve the above three reasons.

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. Color plane extraction to convert the 32-bit color image into an 8-bit grey scale image.
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. OCR session to train the software to identify the set of characters.
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.

RESULTS

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

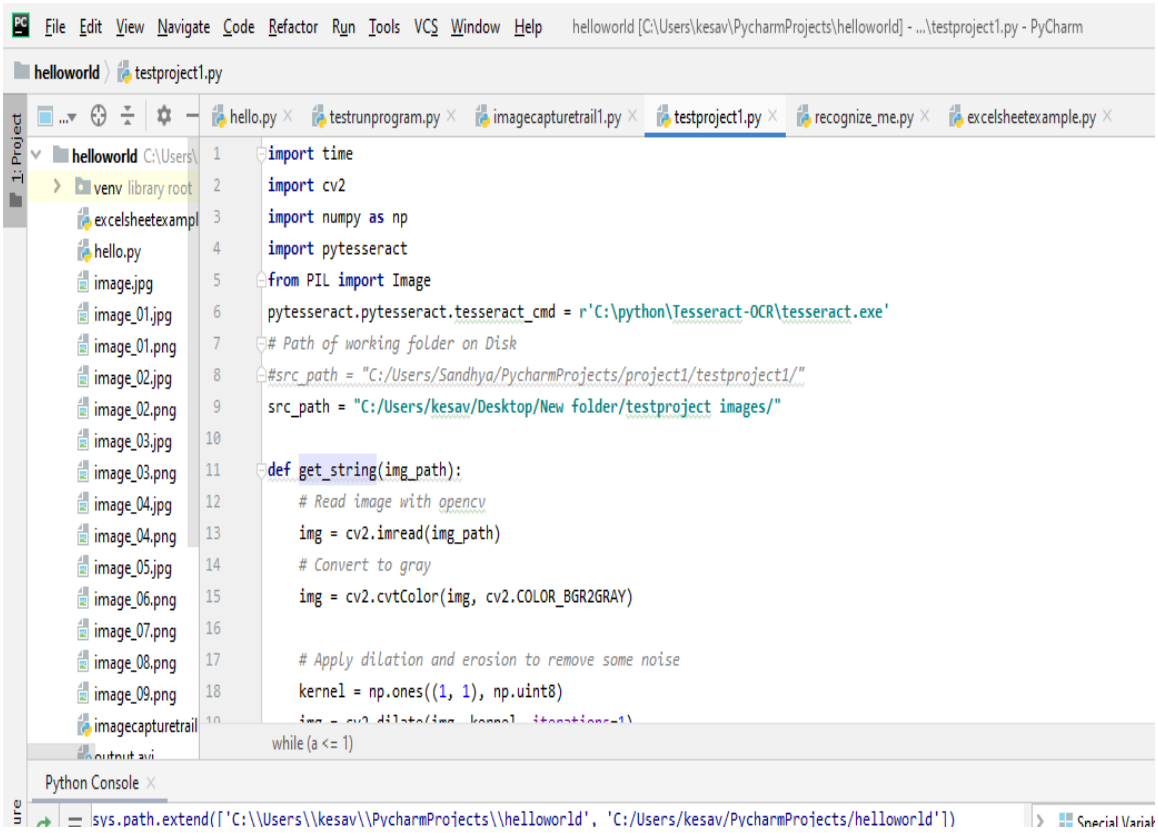


Fig. 6.1 Program in PyCharm IDE (Python)

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.

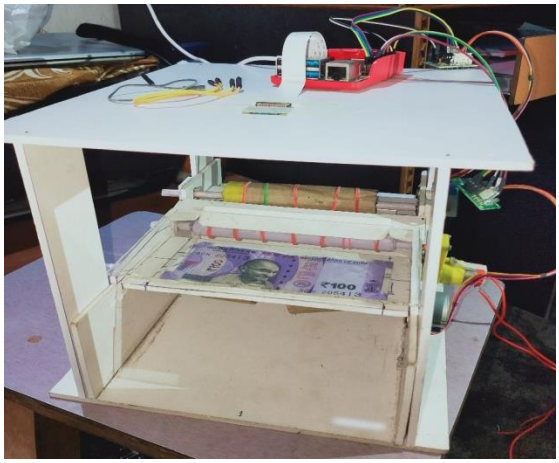


Fig.6.2: Hardware prototype of the system

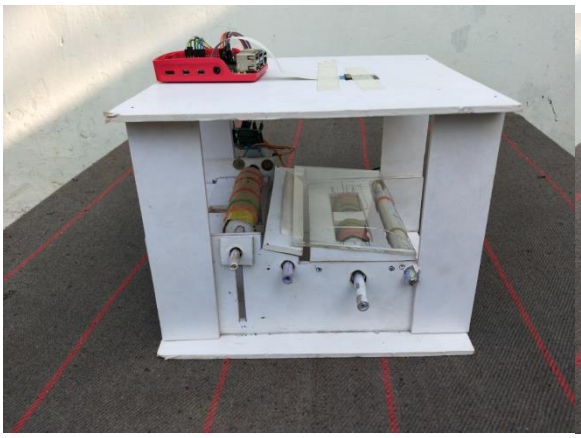


Fig.6.3: Left side View

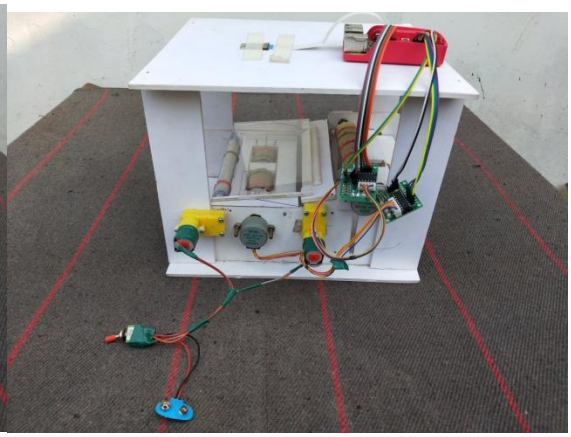


Fig.6.4: Right side View

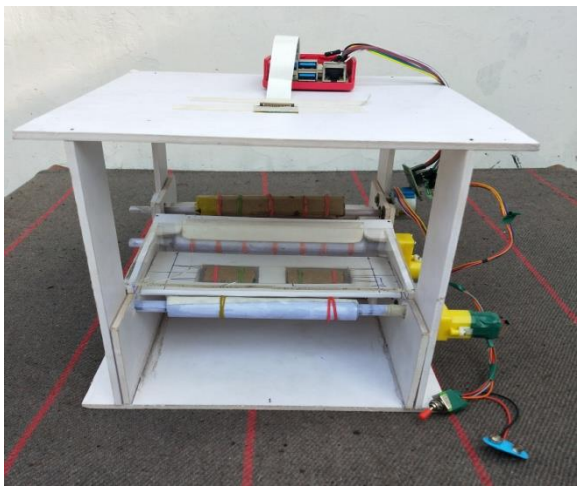


Fig.6.5: Front View

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.

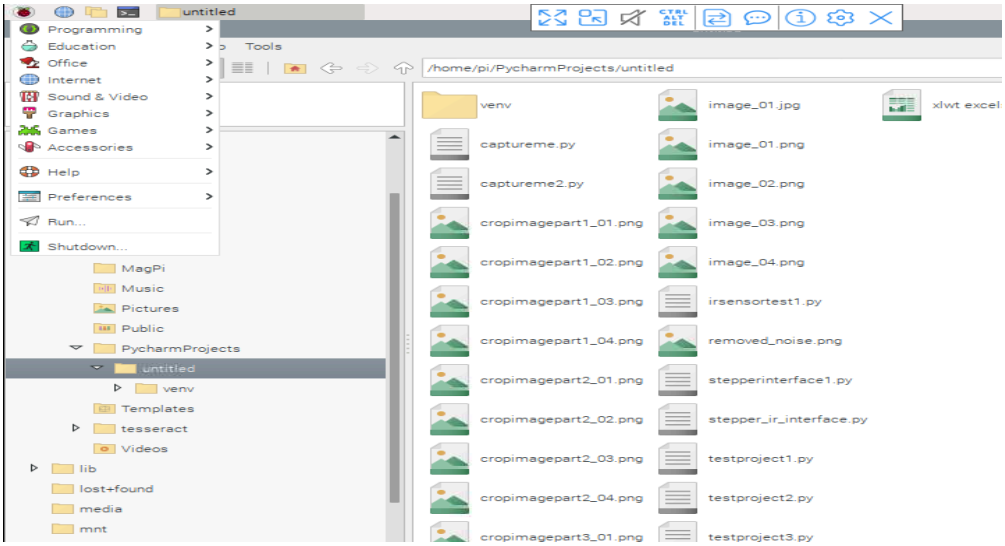


Fig. 6.6: stored Location of the images

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

Fig. 6.7: Rs.50 note image captured using picam

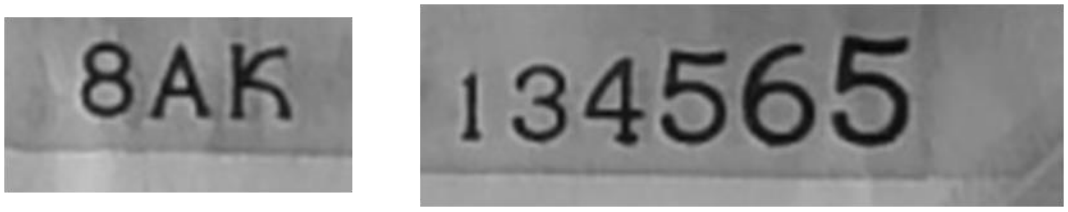


Fig. 6.8: Rs.50 note cropped images during the process

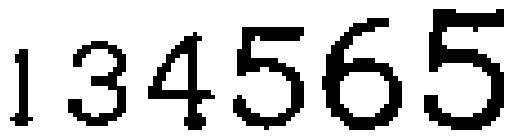


Fig. 6.9: Rs.50 note threshold image of the cropped image

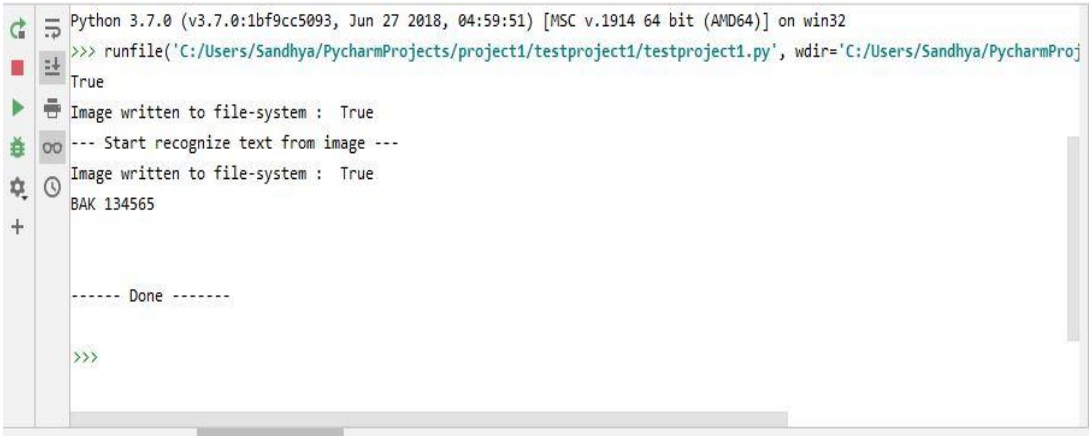


Fig. 6.10: Rs.50 note Serial number extracted using tesseract

Fig. 6.11: Rs.10 note image captured using picam

Fig. 6.12: Rs.10 note cropped images during the process

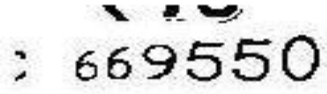


Fig. 6.13: Rs.10 note threshold image of the cropped image

Fig. 6.14: Rs.100 note image captured using picam

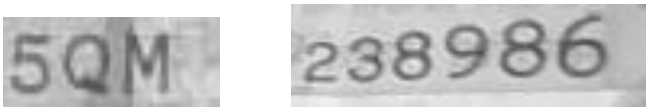


Fig. 6.15: Rs.100 note cropped images during the process

Fig. 6.16: Rs.100 note threshold image of the cropped image

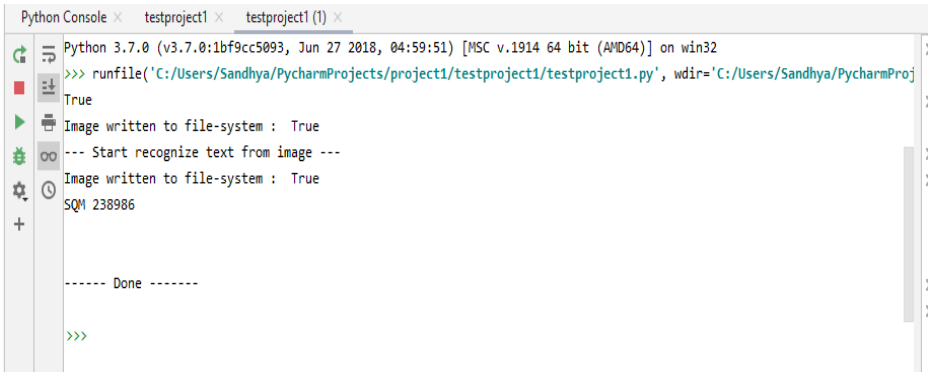


Fig. 6.17: Rs.100 note Serial number extracted using tesseract

Fig. 6.18: Rs.500 note image captured using picam

Fig. 6.19: Rs.500 note cropped images during the process

Fig. 6.20: Rs.500 note threshold image of the cropped image

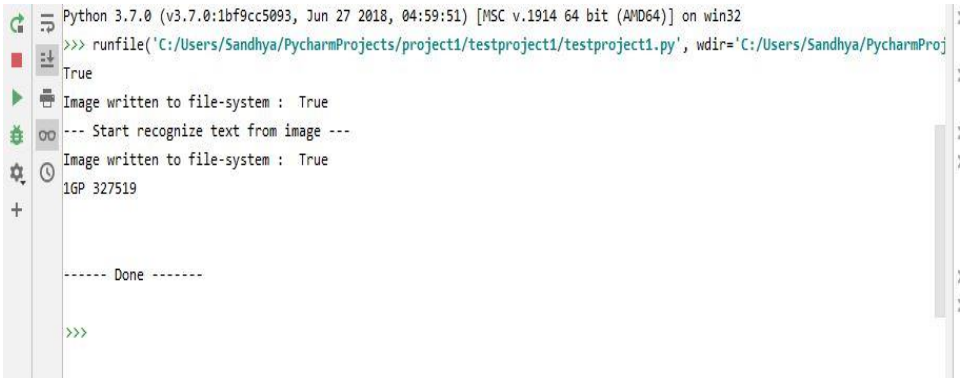
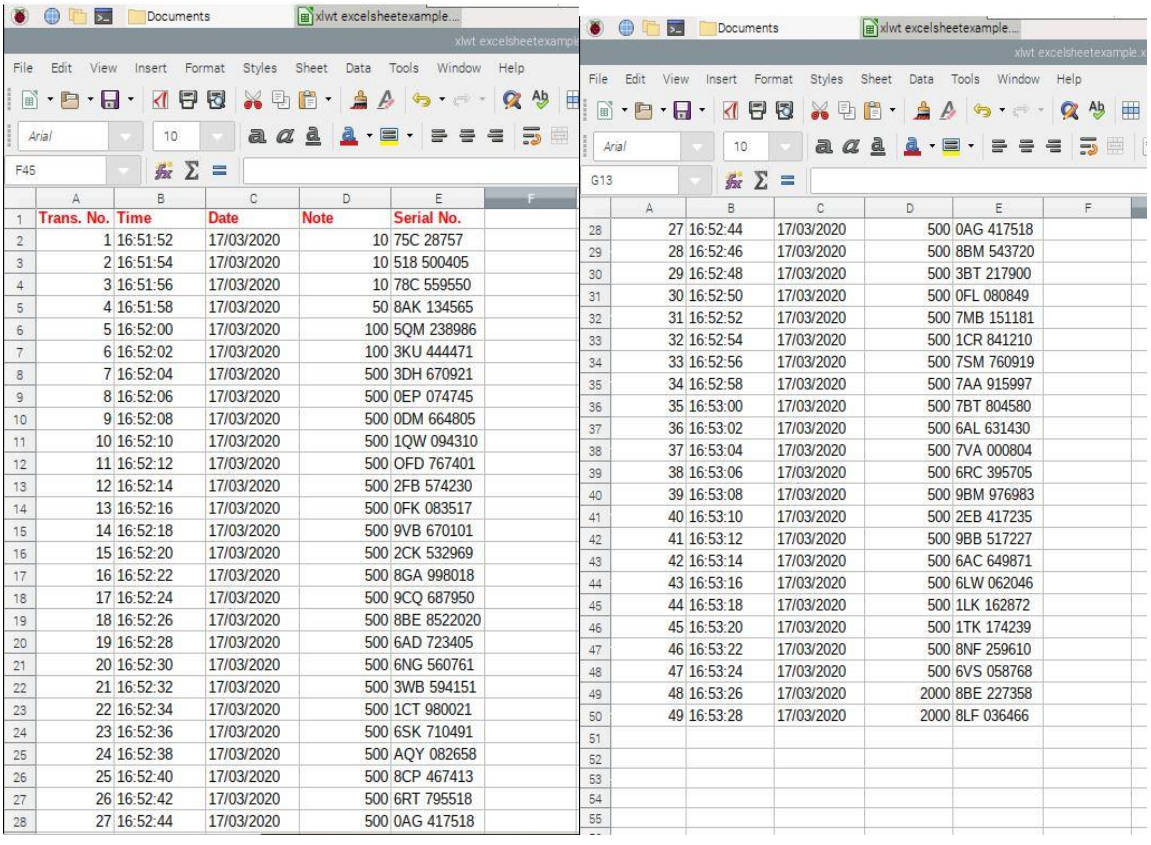


Fig. 6.21: Rs.500 note Serial number extracted using tesseract

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	16:51:52	17/03/2020	10	75C 28757
2	16:51:54	17/03/2020	10	518 500405
3	16:51:56	17/03/2020	10	78C 559550
4	16:51:58	17/03/2020	50	8AK 134565
5	16:52:00	17/03/2020	100	5QM 238986
6	16:52:02	17/03/2020	100	3KU 444471
7	16:52:04	17/03/2020	500	3DH 670921
8	16:52:06	17/03/2020	500	0EP 074745
9	16:52:08	17/03/2020	500	0DM 664805
10	16:52:10	17/03/2020	500	1QW 094310
11	16:52:12	17/03/2020	500	OFD 767401
12	16:52:14	17/03/2020	500	2FB 574230
13	16:52:16	17/03/2020	500	0FK 083517
14	16:52:18	17/03/2020	500	9VB 670101
15	16:52:20	17/03/2020	500	2CK 532969
16	16:52:22	17/03/2020	500	8GA 998018
17	16:52:24	17/03/2020	500	9CQ 687950
18	16:52:26	17/03/2020	500	8BE 8522020
19	16:52:28	17/03/2020	500	6AD 723405
20	16:52:30	17/03/2020	500	6NG 560761
21	16:52:32	17/03/2020	500	3WB 594151
22	16:52:34	17/03/2020	500	1CT 980021
23	16:52:36	17/03/2020	500	6SK 710491
24	16:52:38	17/03/2020	500	AQY 082658
25	16:52:40	17/03/2020	500	8CP 467413
26	16:52:42	17/03/2020	500	6RT 795518
27	16:52:44	17/03/2020	500	0AG 417518
28	16:52:44	17/03/2020	500	0AG 417518
29	16:52:46	17/03/2020	500	8BM 543720
30	16:52:48	17/03/2020	500	3BT 217900
31	16:52:50	17/03/2020	500	0FL 080849
32	16:52:52	17/03/2020	500	7MB 151181
33	16:52:54	17/03/2020	500	1CR 841210
34	16:52:56	17/03/2020	500	7SM 760919
35	16:52:58	17/03/2020	500	7AA 915997
36	16:53:00	17/03/2020	500	7BT 804580
37	16:53:02	17/03/2020	500	6AL 631430
38	16:53:04	17/03/2020	500	7VA 000804
39	16:53:06	17/03/2020	500	6RC 395705
40	16:53:08	17/03/2020	500	9BM 976983
41	16:53:10	17/03/2020	500	2EB 417235
42	16:53:12	17/03/2020	500	9BB 517227
43	16:53:14	17/03/2020	500	6AC 649871
44	16:53:16	17/03/2020	500	6LW 062046
45	16:53:18	17/03/2020	500	1LK 162872
46	16:53:20	17/03/2020	500	1TK 174239
47	16:53:22	17/03/2020	500	8NF 259610
48	16:53:24	17/03/2020	500	6VS 058768
49	16:53:26	17/03/2020	2000	8BE 227358
50	16:53:28	17/03/2020	2000	8LF 036466

Fig. 6.22: Data stored in excel sheet

CONCLUSION

The Raspberry Pi is an amazing piece of hardware because of the combination of the features of a traditional computer and an embedded device. Supporting computer operating system like Linux and providing simple input/output lines i.e. GPIO makes it perfect for controlling almost anything. Programming the GPIO is much easy and intuitive then a traditional FPGA or microprocessor.

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 robbery was 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 note in the database.

FUTURE SCOPE

- This project can be further developed by making the machine to extract more serial number of notes in one minute instead of 30 notes.
- An UI application has to be developed to send the details to the bank servers and the users.
- Counting the no. of notes can be also done at the same time of the extraction process.
- The accuracy of the machine can be increased by the analysis of the OCR algorithms and synchronization between the camera module and the stepper motors.

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