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INDIAN CURRENCY RECOGNITION FOR BLIND PEOPLE

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Abstract *Identification of various denominations of currency is not an easy task for visually impaired people. In India though there are special symbols embossed on different denominations, still the task is tedious for blind people. The lack of identification devices motivated the need of a handheld device for segregation of different denominations .In this project, Features of the images are compared with all the reference images of the currency, if the difference is less than the threshold then the numeric part of the currency is extracted and compared if it matches then the matched currency denomination is recognized. Indian currency denomination like 50, 100, 500, 2000, 20, 10 currency are recognized.*

Key Words: Image processing, Brute force matcher, ORB algorithm, Raspberry Pi, Visually challenged, Currency denomination.

1. INTRODUCTION

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 project presents progressive efforts for developing an assistive technology for visually impaired so that they can lead their life independently both socially and financially.

1.1 Problem statement

Post demonetization, the sizes of the Indian currency notes have drastically changed. For example, the new Rs.100 and Rs.200 notes similar physical dimensions. Though the colour of such notes is very contrasting, this difference is beneficial only to those blessed with eyesight. The population of the visually challenged in India is a staggering 36 million. These people have a hard time identifying these new notes (even the Braille and small dots and holes on these notes seem to fade away with prolonged usage). This project aims to relieve some of their problems using assistive technology.

1.2 Objective

Development of Real Time Paper Currency Identification and Audio Output System using open source hardware(Raspberry Pi) and software(Python), for the visually challenged, thus allowing them to autonomously deal with new Indian banknotes, particularly while accepting their money back during their day to day activities.

2. LITERATURE SURVEY

The need for systems that processes currency without human intervention has become inevitable for various applications. However, the varying features in each notes and the security aspects involved in different currencies make this task extremely difficult. Various systems have been proposed in the past that take into account different features as mentioned in papers [1] [2] [3].

An approach to the Portable camera based assistive text and product label reading from hand-held objects for blind persons is performed in [4]. Another approach to the efficient banknote recognition based on selection of discriminative regions with one-dimensional visible-light line sensor is mentioned in [5]. In another approach [6], Currency recognition using a smartphone and Comparison between colour-SIFT and grayscale SIFT algorithms.

As previously discussed, there have been various systems with image processing that have been proposed in various papers [7] [8] [9]. However, one can learn from their results that none of the systems proposed is completely efficient and that taking into account a single parameter for this problem statement is not helpful. In the papers [10] [11] the classification model is created using artificial neural network. Our approach is based on [3] but the differentiation of currency starts with first confirming that it is original Indian currency and then identifying the denomination. First various features are extracted as specified in the above papers and finally machine learning classifier algorithms are employed with these obtained features.

3. THEORETICAL BACKGROUND

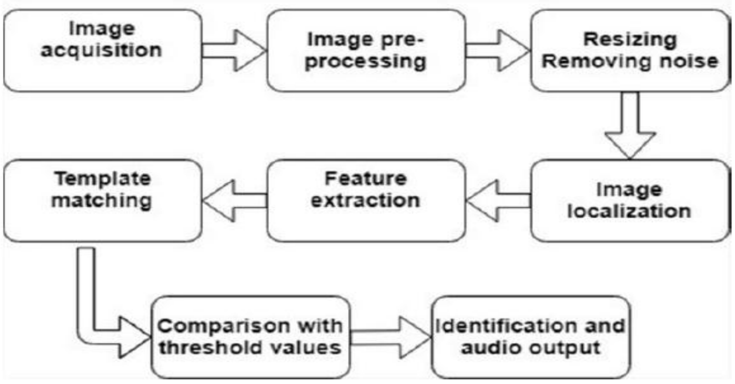

Fig. 1: Basics of image processing

3.1 Basics of image processing

The figure 1 details the flow of any basic image processing algorithm. These basic steps are used in both Brute Force Matcher as well as Convolution Neural Network algorithm. However, the CNN algorithm further does some classification which makes it suitable for applications where a very large size of training set is required.

3.2 Feature extraction

The SIFT and SURF key point detector and descriptor, although comparatively old, have proven remarkably successful in a number of applications using visual features, including object recognition, image stitching, visual mapping, etc. However, it imposes a large computational burden, especially for real-time systems. A computationally efficient replacement to SIFT and SURF that has similar matching performance, less affected by image noise and capable of being used for real-time performance is called ORB.

ORB is a good alternative to SIFT and SURF in computation cost and matching performance. ORB is basically a fusion of FAST key point detector and BRIEF descriptor with many modifications to enhance the performance. First it uses FAST to find key points then apples Harris corner measure to find top N points among them. It also uses pyramids to produce multiscale-features.

3.3 FAST key points

Feature Detection using FAST - Features from Accelerated Segment Test algorithm

Select a pixel P in the image which is to be identified as an interest point or not. Let its intensity be Ip.

Select appropriate threshold value t.

Consider a circle of 16 pixels around the pixel under test.

Now the pixel P is a corner if there exists a set of n contiguous pixels in the circle (of 16 pixels) which are all brighter than Ip+t, or all darker than Ip-t. (Shown as white dash lines in the below image). n was chosen to be 12.

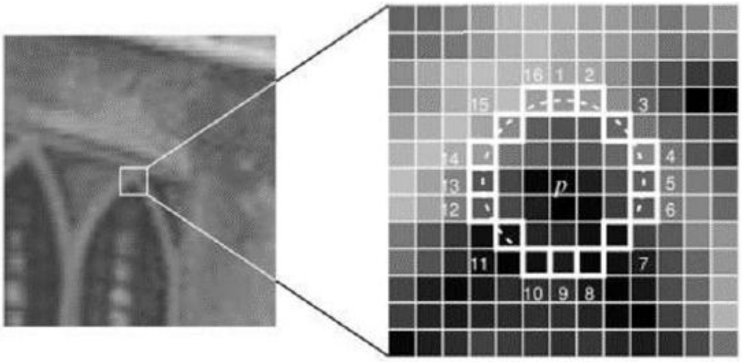

Fig. 2: Features from Accelerated Segment Test algorithm

FAST does not compute the orientation. To account for this drawback, a new modification to the existing algorithm was made. It computes the intensity weighted centroid of the patch with located corner at centre. The direction of the vector from this corner point to centroid gives the orientation.

3.4 BRIEF descriptors

BRIEF reduces the memory consumption by providing a shortcut to find the binary strings directly without finding descriptors. It takes smoothened image patch and selects a set of nd (x, y) location pairs in a unique way. Then some pixel intensity comparisons are done on these location pairs. For e.g., let first location pairs be p and q. If

$I(p) < I(q)$

Then its result is 1, else it is 0. This is applied for all the nd location pairs to get and -dimensional bit string. Since BRIEF is a feature descriptor, it does not provide any method to find the features. So some other feature detectors like SIFT, SURF, ORB etc. have to be used.

4. IMAGE CLASSIFICATION ALGORITMHS USED IN THE PROJECT

4.1 Brute Force Classification

The descriptor of one feature in first set is matched with all other features in second set using a distance calculation and the closest one is returned as the most matched one. For any two images it calculates the hamming distance using the descriptors and returns the point with minimum hamming distance. The following key point/descriptor mapping was obtained.

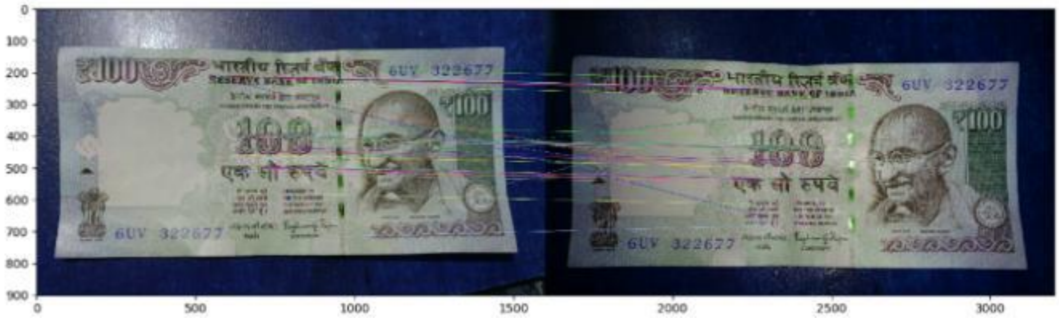

Fig. 3: Brute Force Classification

5. METHODOLGY

The system is divided into two parts. The first part is to identify the currency denomination through image processing. The second part is the oral output to notify the visually impaired person about the denomination of the note that he/she is currently having.

The development of this device is based on a webcam integrated with Raspberry Pi microcontroller and a speaker for sound output. The real time bank notes are captured and processed through different image processing techniques like edge detection, segmentation, and feature extraction and classification.

Here Raspberry Pi is used as a processor which processes the image of the currency note captured by the web camera. The controlling code for web camera is written and stored in processor. Captured image is stored in memory. Now Raspberry Pi will process the image to identify the denomination of the currency. The processing algorithms and codes are written in PYTHON OpenCV. The reason for selection of the said hardware and software is that, this paper intends to make this product as a cost efficient model using open source hardware such as Raspberry Pi, so that it may favour future advanced improvements from people all over the world thus benefitting the end user.

6. BLOCK DIAGRAM

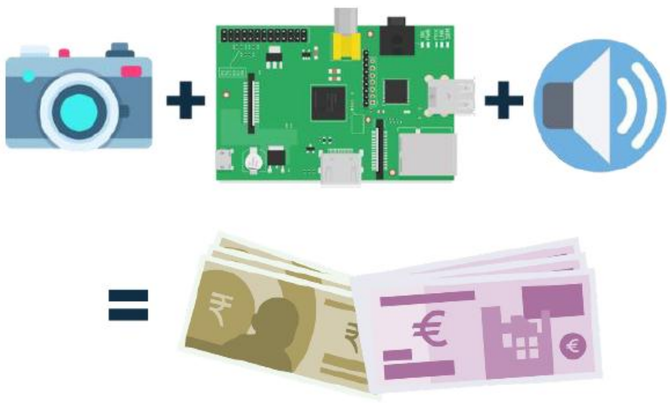

Fig. 4: Block diagram

7. TIME SCHEDULE

Table 1: Time schedule

Week	WORK DESCRIPTION
1	Data Collection for development of the image processing code.
2	Development of the image processing code using Brute Force Matcher algorithm in Python.
3	Development of Python Code for interaction with the Raspberry pi camera and external speaker.
4	Integrating Raspberry Pi circuit with the Raspberry pi camera -Speaker circuit and running the system as a whole.
5	Integrating the power supply unit and testing the whole circuit running independently.
6	Testing and debugging (if any) of the project.

8. HARDWARE IMPLEMENTATION

8.1 Specification

Table 2: Hardware Specification

S.no	Component - Required	Quantity	Amount	requirement
1.	Raspberry pi camera	1	200	To scan the note for its denomination
2.	Raspberry Pi	1	3000	To do all the image processing activities.
3.	Speaker	1	200	To give the oral output of the currency note's originality and denomination.
4.	Computer with Open-Cv and Python software.	1		Used for developing the image processing python code for Raspberry Pi.
5.	Usb wire	1	RS. 100	For powering up the external circuits like Raspberry Pi, Speaker and the Webcam.

9. A. PYTHON OpenCV CODE: USING ORB ALGORITHM (COMPLETE WORKING CODE)

```
#Calling the necessary library

import os

from picamera import PiCamera

from time import sleep

import cv2

from utils import *

#Importing the necessary library functions

import subprocess

import numpy as np

#Image acquisition using RasPi camera

camera = PiCamera()

camera.start_preview()

sleep(5)

camera.capture('test.jpg')

camera.stop_preview()

max_val = 8
```

```
max_pt = -1
max_kp = 0
orb = cv2.ORB_create()
#Importing the captured image into this program
test_img = cv2.imread('files/test.jpg')
original = resize_img(test_img, 0.4)
display('original', original)
(kp1, des1) = orb.detectAndCompute(test_img, None)
#Declaring the training set
training_set=['files/train_020_1.jpg',
 'files/train_050_1.jpg',
 'files/train_100_1.jpg',
 'files/train_100_2.jpg',
 'files/train_100_3.jpg',
 'files/train_500_1.jpg'
 ]
for i in range(0, len(training_set)):
 # train image
train_img = cv2.imread(training_set[i])
 (kp2, des2) = orb.detectAndCompute(train_img, None)
 # brute force matcher
 bf = cv2.BFMatcher(cv2.NORM_HAMMING)
all_matches = bf.knnMatch(des1,des2,k=2)
 good = []
 # if good then append to list of good matches
 for (m, n) in all_matches:
 if m.distance< 0.789 * n.distance:
good.append([m])
 if len(good) >max_val:
max_val = len(good)
```

```
max_pt = i
max_kp = kp2
print(i, ' ', training_set[i], ' ', len(good))
if max_val != 8:
 print(training_set[max_pt])
print('good matches ', max_val)
 note = str(training_set[max_pt])[6:-6][6:]
print('\nDetected denomination: Rs. ', note)
os.system('aplay /home/pi/Desktop/project/'+str(note)+'.wav')
```

10. HARDWARE SETUP

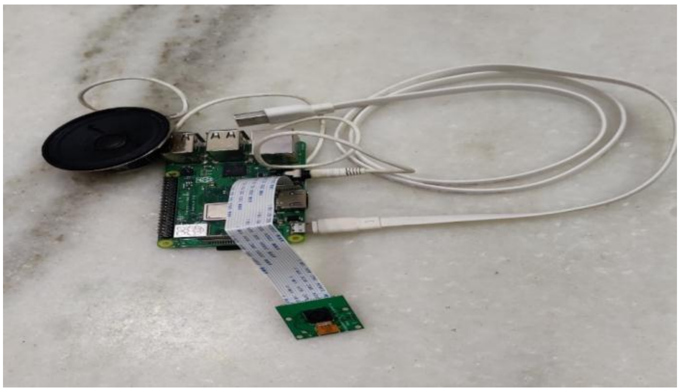

Fig. 5: Hardware setup

11. RESULTS OBTAINED

ORB algorithm of image processing have been carried out and following result is obtained: Average time for processing is 9 seconds.

12. CONCLUSIONS

The developed model detects the denomination of Indian currency with the help of basic image processing algorithm.

The developed product is a Multi-Purpose Module and can be implemented in Real Time Applications such as automating vending machines, automatic ticket counters etc. This module can further be developed into identifying Counterfeit Currency also. This requires an additionof few more pre-processing techniques and a slight modification to the existing hardware to incorporate UV light.

Moreover the current system has a poor accuracy for identifying coins due to the reflective nature of the material. A suitable lighting source like UV can be used to prevent this problem in the future.

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