Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 11, November-2021

Currency Detector for Visually Impaired (Study of The System Which Identifies Indian Currency for Blind People)

Pratiksha Ganjave[1], Rushikesh Markad[2], Gaurav Rasal[3], Yash Kalekar[4]
Department of Computer Engineering
Pimpri Chinchwad College of Engineering Pune, India

Abstract: **-Currency is the medium of exchange. Money related transactions are an important part of our day to day lives. Along with technology the banking sector is also getting modern and being explored. In spite of the widespread usage of ATMs, Credit-Debit Cards, and other digital modes of payment like as Google Pay, Paytm, and Phone Pay, money is still widely used for most daily transactions due to its convenience.**
Currency recognition or bank-note recognition is a process of identifying the denominational value of a currency. It is a simple and straightforward task for the normal human beings, but if we consider the visually challenged people currency recognition is a challenging task. Visually handicapped people have a difficult time distinguishing between different cash denominations. Even though unique symbols are embossed on different currencies in India, the task is still too difficult and time-consuming for the blind.
This brings a deep need for automatic currency recognition systems. So, our paper studies about the systems in order to help the visually challenged or impaired people; so that they can differentiate between various types of Indian currencies through implementation of image processing techniques. The study aims to investigate different techniques for recognising Indian rupee banknotes. The proposed work extracts different and distinctive properties of Indian currency notes, few of them are the central number, RBI logo, colour band, and special symbols or marks for visually impaired, and applies algorithms designed for the detection of each and every specific feature. From our work the visually impaired people will be capable of recognizing different types of Indian Currencies while their monetary transactions, so that they lead their life independently both socially and financially.

Keyword: -Currency recognition, visually disabled, SIFT, ORB, FAST, SURF, Denomination, Image Processing, Feature Extraction, Pre-Processing, Edge Detection, Image comparison.

I. INTRODUCTION

Research work in the domain of image processing is evolving rapidly; specifically in the banking sector. Along with the evolving technologies and the growth of the banking sector; the requirement to precisely and efficiently detect currency and its denomination is also growing in parallel.

So, the necessity of a robust and efficient currency recognition system in applications like Cash Machines (ATMs), different vending machines, beverage and food dispensers, and being a helping hand for the blinds or visually impaired (in order to correctly differentiate between different denominations); is at apex.

The World Health Organization (WHO) had a survey over around 285 million people. The statistics showed that among the population under consideration while survey, 39 were visually impaired (i.e. blind or people having low vision). So, a desperate need of designing a system that will help these people in recognizing the currency; shows up.

Therefore, in order to help the visually disabled; we study different algorithms which can be implemented in a system for detection of Indian currency using image processing.

Generally, currency recognition is done using a camera or any image and the result is displayed on the screen and also an audio output can be provided. One of the difficulty for people with visual impairment is the inability to identify the paper currencies due to the approximation of paper texture and size between the different types of currencies.

II. LITERATURE SURVEY

A wide number of researchers have contributed to the development of currency recognition techniques in various ways. Because of the differences in features between coins and bills (notes), researchers approach the recognition problem differently for each of them. We will go over prior work done in currency recognition techniques in this section.

According to research in [1], authors have introduced an unsupervised algorithm for segmentation of synthetic aperture radar images which is rely on fuzzy clustering approach to beat the high time complexity of rich-performance clustering algorithms which analyze all pixels for image segmentation. Their algorithm selects a subset of key pixels supported by the rule of local extrema and performs segmentation on those.

Research in [2] proposes a system for recognizing fake currency notes of Indian currency. The system verifies the real images on the premise of image processing by extraction of varied security measures of Indian currency notes.

The analysis in [3] gives a dataset for the evaluation of change point detection algorithms which consist of 37 time series from different domains. By analyzing the consistency of human

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 11, November-2021

annotations, the dataset describes evaluation metrics for measuring the performance of algorithms.

The study in [4] has proposed three algorithms which are suitable for different BCs by combining the Augmented Lagrangian Method (ALM) and the symmetric Red–Black Gauss–Seidel (SRBGS) method. These algorithms are more efficient and precise than other models with L1 or L2 fidelity terms.

Many of the currency recognition systems are proposed. In [5], the author recognizes and classifies four different kinds of currencies through computer vision. The typical Accuracy rate was 93.84%. Also, in [6], the author proposed an Android paper currency recognition system that applied to Saudi Arabian papers. Recognizing paper currency methods that relies on some features and correlations between two currency Images.

Sungwook et al. defined an efficient and fast algorithm for differentiating multiple national bank currencies depends on size information and correlation matching of multiple templates [7]. As different bank currencies have different sizes so this information was regarded to be a vital feature. This method was tested using 55 currencies of 30 different classes from five countries like EUR, KRW, RUB, and USD.so, results of this method is 100%.

However, the above study has not solved the matter that the accuracy of the ORB algorithm is reduced/decreased when the dimension of the currency image of an oversized external environment change greatly. So, depend on the original ORB image registration method, Yanyan Qin et al. [8] combine the primary SIFT method with the ORB method and define the SIRB (SIFT and ORB) algorithm. SIRB solved the errors of ORB scale inconsistency while managing the merits of ORB in matching fast.

The performance evaluation of a feature matching algorithm is that the idea for judging the pros and cons of algorithm. Thanks to the various research areas, different needs, and different application scenarios of image matching, it's difficult to measure the performance of an algorithm with a unified standard. Therefore, it's usually necessary to use diverse indicators to process the results of image matching and comprehensively evaluate them, there by selecting an algorithm with superior comprehensive performance [9-10].

Mitsukura proposed a way to fashion a neural network (NN) using a simulated annealing (SA) and genetic algorithm (GA). The comparable traits of the pictures of coins (i.e., size, colour, weight, and pattern) reason hassle for forex recognition. The proposed scheme located numerous capabilities and additionally the recognition rate turned into about 98%. This approach desires an prolonged time and excessive computational power. That's why it requires more time on mobile phones [11].

Mirza and Nanda use 3 extracted functions from the banknote along with identity mark, watermark, and safety thread [12].

Using edge based segmentation features of currency are extracted using Sobel operator. An algorithm depends on local binary patterns (LBP) for recognition of Indian money. Results shows the system gives good performance for images with low noise with accuracy 99% [13].

Scale Invariant Feature Transform (SIFT) is applied specially for grayscale images. Many neighborhood capabilities can't be categorized effectively without colour information. Cui. Instead of the traditional SIFT, a substitute color space called the perception-based color space was used. The proposed method used the SIFT colour descriptors and additionally the end result showed that the coloured descriptor was more robust than the quality SIFT [14].

Van De Sande presented a comparison between the local colour descriptors with grey value descriptors. They use the evaluation framework of Mikolayzcyk and Schmid to the amount of local grey value invariants. The results show the strategy which mixes colour information and SIFT gives better results [15].

Herbert Bay and colleagues presented a new scale-invariant and rotation-invariant method of interest point detection and description [16]. The term SURF was coined by them. It is acronym of Speeded Up Robust Features. It not only approximates but substantially surpasses the techniques proposed before; corresponding to robustness, distinctiveness, and repeatability. Also, computations are much faster. The results in this paper, were held over imagery received with regards to a real-life object recognition application and a standard evaluation set. Both demonstrated SURF's superior performance.

Julien Rabin and colleague thoroughly studied and analyzed the details of SURF algorithm for local, compact and invariant representation of natural images [17]. This method (SURF) achieves a performance comparable to other new and modern algorithms used in image matching. Its usage is therefore of great interest for computer vision. Hence, the effectiveness and robustness of their algorithm was proved by results of their experiments.

YingLi Tian and colleagues came up with a component-based system using SURF [18]. They considered a dataset of hundred and forty (140) note images, which consisted of 20 images of each denomination [(dollar) U.S. currency ($1, $5, $10, $50, and $100)], chosen from a wide range of situations to simulate the real-world application environment. The algorithm attained 100% accuracy on the considered dataset. Hence, proved to be robust enough to operate over partial occlusions, worn or wrinkled notes.

Prashengit Dhar and colleagues presented a paper currency detection system. It is based upon combined features of LBP and SURF [19]. Detection is done on the basis of training of the system over different currencies. SVM classifier is trained and used for prediction. This system focuses only on Bangladeshi taka (currency of Bangladesh). In addition to currency detection, this system can also provide an output of

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 11, November-2021

the count of total cash in the image. Overall accuracy of this method 92.6%.

Despite of there being many algorithms still they have some disadvantages as in the SIFT and SURF algorithms. So, in order to address the issues with SURF and SIFT algorithms, Redna Almutlaq and colleagues proposed a new feature detection algorithm [20]. They proposed algorithm merged between the SITF and SURF algorithm in order to increase the speed and also have robust algorithm. They called their algorithm SR-SIFT; acronym of Speeded up Robust Scale Invariant Feature Transform algorithm. The results concluded that the SR-SIFT algorithm gave better performance (with increased speed and still being robust) than the SIFT and SURF algorithms.

The SURF descriptor matching technique paired with an improved FAST feature point was proposed by Aomei Lia and colleagues [21]. The experiments include the comparison of SURF algorithm and SIFT algorithm with the proposed algorithm. The extracted feature point were better than the FAST feature point in the identical situation. When compared to the traditional SIFT algorithm, proposed method proves to be two orders of magnitude higher in terms of matching speed. And when SURF was compared to it, increase of one order magnitude was seen in matching speed. This method hence proved to be good in order to achieve the aim of fast matching, and greater accuracy than SIFT algorithm.

III. METHODOLOGY

The steps of a currency recognition system based on image processing are as follows -

1. Image Acquisition
2. Pre-processing
3. Edge Detection
4. Image Segmentation
5. Feature Extraction
6. Comparison

and finally, the output is displayed as pop up or can also be given as an audio output for visually impaired.
The currency recognition always depends on the characteristics of the note belonging to certain country and the process of extracting different properties or features of currency note directly affects the ability of currency recognition.
Various algorithms based on image processing are been proposed over time to extract the features. These features consists of Security thread, Length/colour of note, RBI logo, identification mark and other security features.
Feature extraction plays main role in recognition of currency notes. Hence, different algorithms are used for feature extraction. In this paper we will study four algorithms used in feature extraction –

- FAST
- ORB
- SIFT
- SURF

We will also do comparative study of these algorithms.

IV. ALGORITHM

In this section we will be studying four algorithms used in feature extraction step of image processing-based currency recognition system.

A) FAST: -

FAST Algorithm is used for Image denoising which plays a very important role in the process of image processing. Features from accelerated segment test (FAST) could be a corner detection method. The purpose of the FAST algorithm was to develop an interest point detector to be used in real time like SLAM on a mobile robot, which have limited computational resources.

Algorithm: -

Step 1: Choose a pixel ‘a’ within the Currency image. Consider that the intensity of this pixel is IP. This is often the pixel which is to be identified as an interesting point or not.

Step 2: Set a threshold intensity value T1 (1/5 of the pixel During test).

Step 3: Choose a circle of 16 pixels around the pixel ‘a’.

Step 4: If the value T is greater than or equal to IP, the adjacent pixels have to be above or below the interest point.

Step 5: To create the algorithm fast, first compare the intensity of pixels 1, 5, 9 and 13 of the circles with IP. As evident from the figure above, at least three of these four pixels should satisfy the threshold criterion so that the interest point will exist.

Step 6: If three of the four-pixels aren’t above or below IP + T, then P isn’t a point. In that case reject the pixel p as a possible interest point. Else if three of the pixels are above or below Ip + T, check for all 16 pixels and check whether 12 adjacent pixels fall in the criterion.

Step 7: For remaining pixels within the Currency image repeat the above steps.

B) ORB: -

ORB Algorithm is to get the features of images because it may be a in no time algorithm regarding the time. In additionally, ORB is strong and efficient for getting binary descriptors. It basically depends on Oriented Fast and Rotated Brief Algorithm. The proposed application is implemented using the libraries of OpenCV run on the android platform. OpenCV libraries are having high speed in displaying results.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 11, November-2021

Algorithm: -

Step 1: Pre-processing

In this step, image processing operations are performed to arrange the currency image for the segmentation process.

Step 2: Segmentation

In this step, convert the currency image into a binary image that consists of two colours black and white.

Step 3: ROI Extracting

To extract the currency from the image, the two-pass connected component Algorithm is employed.

Step 4: Feature Extraction

In this step, the (ORB) Algorithm is employed to perform the subsequent operations for best performance:

1. A quick algorithm is employed to detect corners and interesting points in a currency Image.
2. Harris corner detector is employed to assign a score for each interest point supported the variation of intensities round the corner point.

3. Compute the vector direction and also assign it because the interest point orientation using the interest point and centroid.

Step 5: ORB Description

After getting those interesting points of the image within the detector stage, we'd like to extract the feature description for these interest points. For this purpose, a quick algorithm is employed to make the feature descriptors with relation to a neighborhood shape sort of a rectangle or circle.

Step 6: Matching

In this matching phase the best number of matches with the database informs that it matches with the currency. And also provides audio messages for blind people.

The accuracy of the proposed system is measured using the subsequent equation as below: -

Accuracy (%) = (Success tests/(Success tests+Failure Test))*100

C) SIFT: -

SIFT ?

- *It's a method for recognising steady, conspicuous feature points.*
- *It also gives a feature set for each such point that characterise a small image region around the point. These characteristics are unaffected by rotation or scale.*

Motivation
Image matching
Estimation of affine transformation/homography between images.

Estimation of the tracking, fundamental matrix in stereo structure from motion, motion segmentation.

Steps of algorithm

1. Determine scale and estimated location of prominent key points.
2. Refine their scale and location.
3. For each key point determine the orientations.
4. For each key point determine the descriptors.

Methodology
Scale Invariant Feature Transform (SIFT) algorithm. Using this algorithm needs classification and comparison of a number of key points.
SIFT is designed to be used on greyscale images. Color, on the other hand, gives important information for object description. Many objects can't be classified correctly unless they have colour characteristics. A coloured local invariant feature descriptor and a grey image local invariant feature descriptor are compared.

1. System design
A series of example images of Indian currency notes are employed as a training set for classification algorithms in the proposed system. The training data is utilised to assist the algorithm in correctly detecting Indian money. Our system is implemented on a mobile phone and consists of the phases listed below -

(1) The mobile phone captures images of currency.
(2) The image is pre-processed in the following way:
i) Using the discrete wavelet transform, it is cropped to remove its background in order to extract the regions of interest.
ii) Then image compression is done (to a size of less than 20 KB) using adjacent neighbourhood interpolation because SIFT computation is too expensive and this compression has little effect on precision.
iii) If the technique is a colour SIFT approach, the images are transformed to grayscale.

(3) Key-point detection:
Identifies points in an image where the pixels are the maximum or minimum from their neighbour.

(4) Key-point description:
Each region surrounding a detected key point is turned into a more compact and stable descriptor that can be compared to other descriptors.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 11, November-2021

2. A SIFT descriptor with colour characteristics

2.1. Image pre-processing :
A pre-processing step is used to improve the identification of descriptive features and ensure that the system has effective recognition. To reduce processing time and improve RAM efficiency, image samples are compressed (to size less than 20 KB). The image is then automatically cropped from its background in order to detect boundaries of the image.

2.2. Image main colour extraction :
Because the images are subject to the surrounding ambient lighting, extracting banknote colours is a difficult operation. A collection of five images with varying lighting is used to identify the colour that represents each banknote. The image is then converted to bitmap format to extract the three major colours for each image. Bitmaps are made up of regular rectangular cells known as pixels, each of which has a different colour value. Only two criteria are used to describe them: the number of pixels and the colour depth per pixel.

2.3. Using SIFT descriptors :
Scaling and rotation have no effect on the key points extracted by SIFT. The key-point detection and descriptor creation are the most important stages of this algorithm.
The steps of the SIFT algorithm are as follows -

(1) Constructing scale-space:
By generating blurred pictures from the original image, the scale-space can be constructed. The original image is then resized to half its original size. It also creates a series of blurred images again, producing an octave (vertical images of the same size).

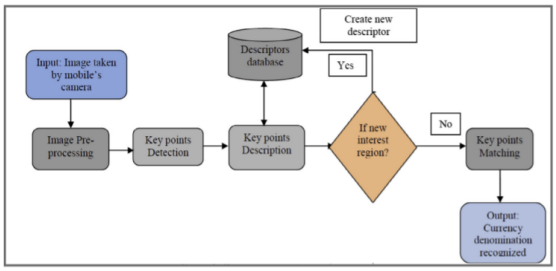


Figure 1. Overview Of Currency recognition system.

(2) Laplacian of Gaussian Approximation:
Calculation of the difference between two consecutive scales for the image is done by the Laplacian of Gaussian technique. The difference of Gaussians (DOG) is an algorithm of improvement in features. Its computation is done by subtracting one blurred version of the original image from a less blurred version of the same image.

(3) Finding Key-points:
The major key points for matching are detected in the image. Usually, these key points are chosen by analysis of the blobs, corners, edges, or even ridges. The step one of figuring out the image key points is finding the minimum and maximum pixels from all of its neighbours.

(4) Eliminate edges and low contrast regions:
The elimination of the edges is must. This is the reason why Harris corner detector concept is used. A Hessian matrix (H) of size 2 x 2 helps in computing the principal curvature. Whenever this ratio becomes greater than the threshold, that key point is eliminated.

(5) Orientation Assignment:
Each key point is assigned the orientation to achieve invariance for rotation of image. The greatest peak in the histogram is utilised to determine the orientation and any other peak higher than 80% of the histogram is taken into consideration. Calculation of the orientation and magnitude is done for all the pixels surrounding the key point.

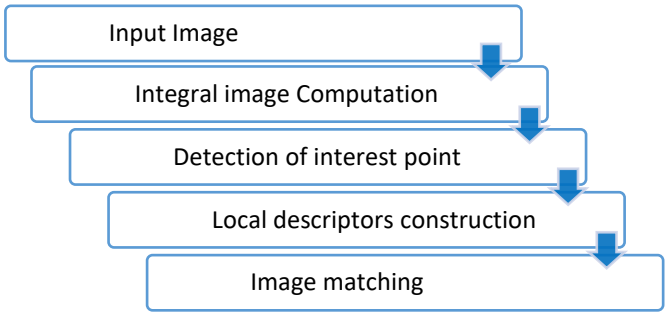
(6) Key-point Descriptor:
After detection of a key point, creation of a descriptor is must and done by taking a 16 x 16 neighbourhood around the key point taken.

3. Key-point matching

Many strategies can be used to represent the best reference image descriptors of each type of banknotes. The most basic is a method for calculating the total key-points of five training images for each class to reflect the principal class features that will be stored in the internal database. These characteristics are the best image descriptors for each class. The Euclidean distance between the test image key-points and reference image descriptors present in the database is then computed. This computation helps in determining whether the two images belong to the same key point or not. The results of this technique shows that there were just 20 common features shared amongst the images.

D) SURF :-

SURF is an acronym for Speeded Up Robust Feature. It is more advanced version of SIFT (Scale Invariant Feature Transform). Moreover, SURF is a patented algorithm. SURF was first presented by Herbert Bay, Luc Van Gool and Tinne Tuytelaars at ECCV ("European Conference on Computer Vision"), Zurich in 2006 [16].
SURF algorithm consists of major two steps namely feature detection (or extraction) and feature description



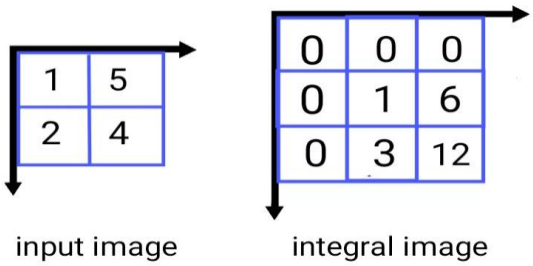
1. Feature detection -

SURF uses integral images. Using integral images, rectangular characteristics can be computed very fast which results in fast computations. They are used for fast convolution computation.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 11, November-2021

Integral image at pixel (x, y) contains sum of pixel itself and pixels above and left to it.

$$I_{\Sigma}(x) = \sum_{p=0}^{p \le x} \sum_{q=0}^{q \le y} I(p, q)$$



The Hessian matrix is a square matrix. It consists of elements with second order partial derivative.

For a pixel at location (a, b) , the Hessian matrix is

$$H\left(f(a,b)\right) = \begin{bmatrix} \frac{\partial^2 f}{\partial a^2} & \frac{\partial^2 f}{\partial a \partial b} \\ \frac{\partial^2 f}{\partial a \partial b} & \frac{\partial^2 f}{\partial b^2} \end{bmatrix}$$

For point $X(a, b)$ in image at scale σ, the Hessian matrix is

$$\mathcal{H}(\mathrm{x}, \sigma) = \begin{bmatrix} L_{aa}(\mathrm{x}, \sigma) & L_{ab}(\mathrm{x}, \sigma) \\ L_{ab}(\mathrm{x}, \sigma) & L_{bb}(\mathrm{x}, \sigma) \end{bmatrix}$$

Where convolution (or result function) of the Gaussian second order derivative in point X is $L_{aa}(\mathrm{x}, \sigma)$ and same for $L_{ab}(\mathrm{x}, \sigma)$ and $L_{bb}(\mathrm{x}, \sigma)$.
It is used to characterize the level of surface curvature of the image. The Hessian matrix is used in key point detection. Good performance time and accuracy is the reason why SURF uses the Hessian matrix. DoH (Determinant of Hessian matrix) are used in the IPD (Interest Point Detection) process. Box filters are used in approximation of DoH. The local maxima of the DoH is used to select the interest point. Hessian matrix based Blob Detection is used in the IPD process.

2. Feature description -

SURF feature description describes the pixel intensity distribution based on scale independent neighbourhood. Interest points neighbouring pixels are divided into subregions. Each subregion's Haar wavelet response is used. Every key point has its Haar wavelet responses computed in a circular neighbourhood of interest points, and its orientation is also calculated. It produces a feature vector of only 64 dimensions.
In the detection the sign of the Laplacian is already computed. It is utilised for underlying interest points. The differentiating factor between bright blobs on dark backgrounds (derived from the reverse case) is the sign of the Laplacian. In case of matching, only the features with same sort of contrast (i.e. based on sign) are compared, resulting into faster feature matching.
When comparison is done it is proved that SIFT is several times slower than SURF. Against different image transformations SURF is more robust than SIFT. It also has low dimensionality as compared to SIFT. Low computational cost of SURF makes it a preferable method over SIFT. But we also have some disadvantages of the SURF algorithm. SURF is not stable to the rotations and also it doesn't work properly with the illumination.

V. EXPERIMENTAL ANALYSIS

1. ORB:-

Table 1.1:

currency	# of samples used for each currency		# of success currencies each Alg. detects		# of failure currencies each Alg. detects		Accuracy %	
	CRS System	Proposed System	CRS System	Proposed System	CRS System	Proposed System	CRS System	Proposed System
10 RS	-	25	-	23	-	2	-	92
5 RS	20	30	18	29	2	1	90	96
100 RS	20	30	17	28	3	2	85	94
20 RS	20	30	20	30	0	0	100	100
50 RS	20	25	16	24	4	1	80	96
200 RS	20	25	17	24	3	1	95	96
500 RS	20	20	19	20	1	0	85	100

As shown in the above table, the proposed method i.e ORB Algorithm achieved a very less time for processing the input currency image and getting the result unlike the other method and the overall accuracy for proposed method is 96% while the CRS system accuracy is 89%.

Table 1.2: Runtime and average Accuracy between proposed and ORB method:

Methods	Proposed Method	CRS
Runtime/Seconds	0.682	12
Overall Accuracy	96 %	89 %

2. SIFT :-

Table2.1: Euclidian distance and matching result of two different images.

Threshold	*Image1 features*	*Image2 features*	*Min (f1,f2)*	*Number of matches*	*Matching percent*
10	365	456	365	0	0
50	365	456	365	1	0.27 %
100	365	456	365	21	5.75 %
150	365	456	365	53	14.52%
200	365	456	365	221	60.54%

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 11, November-2021

Table 2.2: Correct recognition average and processing time average for colour SIFT approach.

Banknote type	*Average correct recognition*	*Average processing time (s)*
Paper Currency	0.71	72.9
Coin Currency	0.25	78.2

Table 2.3: Correct recognition average and processing time average for gray SIFT approach.

Banknote type	*Average correct recognition*	*Average processing time (s)*
Paper Currency	0.53	72.4
Coin Currency	0.20	80

3. SURF: -

Performance of SURF was evaluated for matching key points of INR (Indian Rupee) notes.

A dataset of images of different notes (Rs. 5, Rs. 10, Rs. 20, Rs. 50, Rs. 100, Rs. 500) was gathered [22]. Dataset consisted of almost 200 notes. Images for the dataset were collected in different situations like scaling , rotation, different illuminations and different viewpoints. Reference images considered were image of obverse (front) and reverse (back) of Indian Rupee notes. Therefore, dataset had approximately fifteen (15) reference images.

According to the experiment conducted [22], notes of all denominations were matched with different regions of different notes. By determining the minimal distance between descriptors, the key points detected in query image and reference image were matched.

For SURF descriptor,

Table 3.1: Minimum distances matched -

Denominational Value (in Rs.)	**5**	**10**	**20**	**50**	**100**	**500**
5	1	0.19	0.27	0.17	0.29	0.14
10	0.24	1	0.22	0.33	0.12	0.26
20	0.33	0.26	1	0.27	0.25	0.31
50	0.14	0.31	0.34	1	0.28	0.17
100	0.23	0.15	0.31	0.30	1	0.28
500	0.16	0.20	0.35	0.19	0.29	1

Less the matching distance, more is the probability of the results to belong to same note as in the input image, and vice versa.

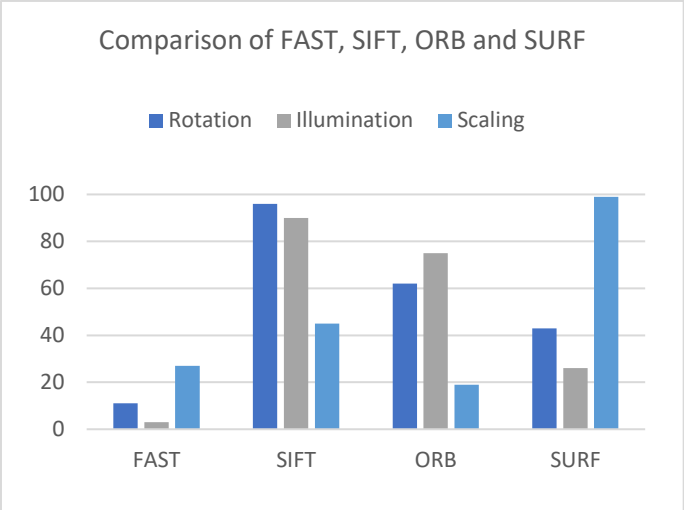
Table 3.2: Overall performance of SURF -

Denominational Value (in Rs.)	*Processing Time (in sec)*	*Space Requirement(in MB)*	*Percentage Accuracy (in %)*
5	0.1647	3.2	94
10	0.1936	3.5	93
20	0.1782	2.7	94
50	0.2161	3.5	96
100	0.2013	3.4	97
500	0.1845	1.9	96

VI. COMPARATIVE STUDY

According to the experimental analysis section above; comparison between FAST, SIFT, ORB and SURF based on rotational, illumination and scale invariance –

Algorithm	**FAST**	**SIFT**	**ORB**	**SURF**
Rotation	Bad	Best	Good	Common
Illumination	Bad	Best	Good	Common
Scaling	Common	Good	Bad	Best



VII. CONCLUSION

Day by day, the research in the field of image processing is increasing and different algorithms are implemented in order to gain more accurate results.

In this paper we studied image processing based currency recognition system and four different algorithms (SIFT, FAST, ORB and SURF). These algorithms are used in feature extraction and matching. The paper specifically focuses on Indian Currency notes. After studying the algorithms, it is observed that each algorithm has its advantages and disadvantages. So, rather than selecting best algorithm for image processing it is better to select appropriate algorithm as per systems demand. Also, these algorithms can be combinedly implemented to get better results.

We intend to use our research, to develop an efficient currency recognition system for visually challenged people.

VIII. ACKNOWLEDGEMENT

We would like to express our heartfelt gratitude towards our guide, Mr. Shailesh Hule for his consistent guidance and remarks throughout reasearch. We are also grateful to the department of Computer Engineering of PCCOE for their support and guidance.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 11, November-2021

IX. REFERENCES

[1] Ronghua Shang, Yijing Yuan, Licheng Jiao, Biao Hou, Amir M. Ghalamzan E, and Rustam Stolkin - "A Fast Algorithm for SAR Image Segmentation Based on Key Pixels -Oct 2017"

[2] Anwar Wanjara, Priyanka Satija, Nikita Patil, Samiksha Chindhalore, Shubham Gaulkar, Prof. A. D. Gotmare - "Counterfeit Currency Detection System"

[3] Gerrit J. J. van den Burg, Christopher K. I. Williams - "An Evaluation of Change Point Detection Algorithms - May 2020"

[4] Xiaole Zhanga, Yuying Shi a, Zhi-Feng Pangb, Yonggui Zhu - "Fast algorithm for image denoising with different boundary conditions"

[5] Jyothi, Ch Ratna, Y. K. Sundara Krishna, and V. Srinivasa Rao. "*Paper currency recognition for colour images based on Artificial Neural Network*." In Electrical, Electronics, and OptimizationTechniques (ICEEOT), International Conference on, pp. 3402-3406. IEEE, 2016.

[6] Sarfraz, et al. "*An intelligent paper currency recognition system.*" Procedia Computer ScienceJournal, Vol. 65, pp. 538-545, 2015

[7] Youn, S, Lee, C , Chulhee Lee "Efficient multi currency classification of CIS banknotes" Elsevier Neurocomputing, Vol. 156, pp. 22-32, May 2015.

[8] Qin Y , Xu H , Chen H . Image feature points matching via improved ORB[C]// International Conference on Progress in Informatics & Computing. IEEE, 2014.

[9] Mikolajczyk K , Tuytelaars T , Schmid C , et al. A Comparison of Affine Region Detectors[J]. International Journal of Computer Vision, 2005, 65(1-2):43-72.

[10] Mikolajczyk K , Schmid C . A performance evaluation of local descriptors[J]. IEEE Transactions on Pattern Analysis and Machine Intelligence, 2005, 27(10):1615-1630.

[11] Mitsukura, Y., 'ukumi, M., Akamatsu, N., 2000. Design and evaluation of neural networks for coin recognition by using GA and SA. In: Proceedings of the IEEE-INNS-ENNS International Joint Conference on Neural Networks, 2000, vol. 5. IJCNN, pp. 178– 183.

[12] Mirza, R., Nanda, V., 2012. Design and implementation of Indian paper currency authentication system based on feature extraction by edge based segmentation using sobel operator. Int. J. Eng. Res. Dev. 3 (2), 41–46.

[13] Sharma, B., Kaur, A., Vipan, 2012. Recognition of Indian Paper Currency based on LBP. Int. J. Comput. Appl. 59 (1), 24–27.

[14] Cui, Y., Pagani, A., & Stricker, D. (2010, September). Sift in perception-based colour space. In Image Processing (ICIP), 2010 17th IEEE International Conference on (pp. 3909–3912). IEEE

[15] Van De Sande, K.E., Gevers, T., Snoek, C.G., 2010. Evaluating colour descriptors for object and scene recognition. IEEE Trans. Pattern Anal. Mach. Intell. 32 (9), 1582–15

[16] Herbert Bay, Luc Van Gool and Tinne Tuytelaars. SURF: Speeded Up Robust Features. Proceedings of the 9th European conference on Computer Vision (ECCV) - Volume Part I, July 2006

[17] Edouard Oyallon1 and Julien Rabin. An Analysis of the SURF Method. Image Processing On Line (IPOL), 2015

[18] Xiaodong Yang, Faiz M. Hasanuzzaman,and YingLi Tian. Robust and Effective Component-based Banknote Recognition by SURF Features. IEEE, 2011

[19] Md. Burhan Uddin Chowdhury, Prashengit Dhar and Tonoy Biswas. Paper Currency Detection System Based on Combined SURF and LBP Features. 2nd International Conference on Innovations in Science, Engineering and Technology (ICISET), October 2018

[20] Almutlaq, Suha, Daliyah S. Aljutaili, Redna A, A. Alharbi and Dina M. Ibrahim. International Journal of Computer and Information Engineering, Vol:12, No:6, 2018

[21] Weihua Yuana, Aomei Lia, Wanli Jianga, Dehui Daia, Siyu Zhanga and Zhe Weia. An Improved FAST+SURF Fast Matching Algorithm. 7th International Congress of Information and Communication Technology (ICICT), 2017.

[22] Dhanashri Mulmule-Shirkhedkar and Ajay R. Dani. Comparative Study of SURF and FREAK Descriptor on Indian Rupee Currency Notes. 5 International Conference on Information Processing (ICIP), Dec 2015