Electronic Letters on Computer Vision and Image Analysis 18(2):4-7, 2019

Design and Development of a Computer Vision Algorithm and Tool for Currency Recognition in Indian Vernacular Langagues for Visually Challenged People

Vishwas Raval*

**Assistant Professor, Department of Computer Science & Engineering, Faculty of Technology & Engineering, The M S University of Baroda, Vadodara,India*

Doctoral Advisor: Prof. Apurva Shah

Date and Location of PhD Defense: 13th July, 2019, The M S University of Baroda

Received 25 November 2019; revised 29 November 2019; accepted 10 January 2020

Abstract

God created this universe and all living and non-living entities. Human is one of the best among His creations and in Human beings, eyes are the best gift of God to see His creations. As of now, humans are considered as the only developed creatures among God's creations and have developed themselves from Stone Age to the Computing Era. As the human civilizations grew up, the transactions have moved from barter system to currency. Every country has its own currency in terms of coins and paper notes. Each of the currency of Individual County has its unique features, colors, denominations and international value. We, all, having been given two beautiful eyes could recognize the currency easily but the same is not easy for blind people. The denomination can easily be recognized for a currency but it becomes difficult to identify a counterfeit currency from the real one. Especially for the blind people, it is a herculean task like finding a needle from haystack. The motive behind this work is to develop and test a robust computer vision algorithm(s) to identify the Indian currency, mainly paper-based currency, in Indian Regional languages.

Key Words: Computer Vision, Image Analysis, Bag of Words, ORB, Ant Colony Optimization, Color Histogram

1 Introduction and Motivation

The seeds for this work were sowed in late 2006, when one of us, was cheated by receiving a counterfeit currency of ₹500 and had to resolve that issue by destroying that currency. This made a loss of ₹500 but sparked a thought, that having been given two eyes, if a person could be cheated then any kind of financial cheating could happen to the blind people! From our own experiences, we learned that the currency, be it a coin or note, identification, is really a herculean task for the blind people. This laid down the foundation for our work.

In addition to this, since 2011, RBI put an end to manufacture the coins of different sizes and introduced coins of almost same size and weight. This made the identification of coins more difficult for the blind

Correspondence to: vishwas.raval-cse@msubaroda.ac.in

Recommended for acceptance by Dena Bazazian & Xim Cerda
ELCVIA ISSN: 1577-5097
Published by Computer Vision Center / Universitat Autonoma de Barcelona, Barcelona, Spain
DOI: https://doi.org/10.5565/rev/elcvia.1186

people. The mixture of old and new coins makes the task tougher. Following are the new size and weights for the different coins as per the new regulations of RBI.

₹5 23 mm 6 g ₹10 27 mm 5.62 g ₹2 25 mm 4.85 g ₹1 22 mm 3.79 g

The paper based currencies have also been changed in their size along with other features, especially after demonetization which made the life of blind people worse. Like ₹500 and ₹2000 notes are smaller in size than current ₹100 and ₹50 notes. Due to such minor variations in the size of the paper based currency and frequent addition of new features to enhance the security, the identification for the same becomes more difficult than the coins. And when the currency is counterfeit or torn out, the identification becomes, even more, difficult, for the blinds. Money is something for which people are, usually, being cheated. Especially, if the person is blind, there are more chances of him/her being cheated. India, according to WHO reports (March, 2017), has 12 million blind people which is 1/3rd of total of 39 million people all over the world. Also, in India, the currency recognition tools are available to the Banks only which are neither affordable nor handy to a common man! In order to prevent the cheating and to serve the unprivileged people of the society, visually impaired people, we thought to do this work.

2 Methodology

To achieve our goal, we divided our work into four phases, named, preprocessing, feature detection, classification and text-to-speech conversion. Following figure shows the outline of our work. In this work, a feature detector, ORB (Oriented FAST Rotated BRIEF) has been used. The reason behind use of ORB is the trade-off in performance of ORB. Among its category, ORB has been proved less accurate than its siblings SIFT and SURF in terms of feature detection, however, it is faster in terms of execution time than the others. As SIFT and SURF are patented technologies and ORB is free and open source, we opted to go with ORB to improve its performance in terms of recognition accuracy.

Any image recognition process contains three phases, mainly: Preprocessing, Feature Extraction and Classification. Through this research, we have contributed for each of the phase with some novel or hybrid approach. Following figure shows the approach of the work carried out.

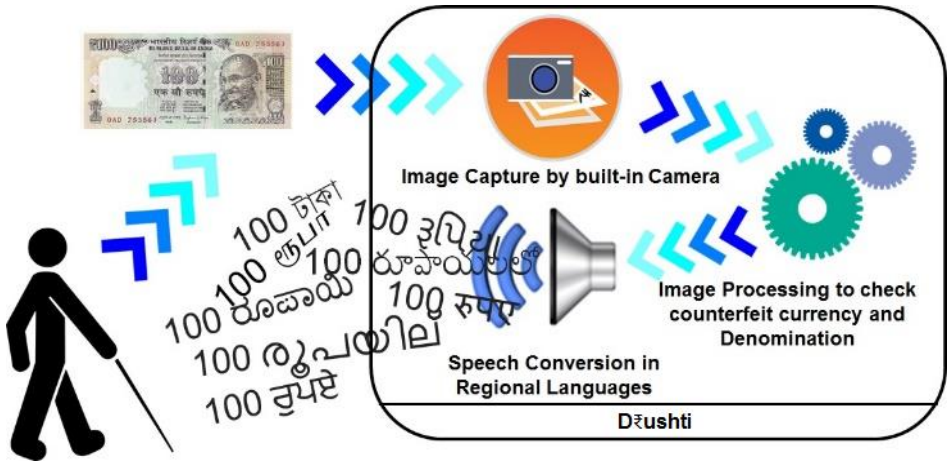

Figure 1: An overall view of our system

We designed, developed and tested the following algorithms for this work.

- A modified and improved Grab-Cut algorithm, cGrab-Cut (Compromised Grab-Cut), for background removal in pre-processing stage with 50% reduction in time consumption (Especially for Android devices). This algorithm can be used to remove background from the captured images as a part of preprocessing.

- A Histogram and ORB based a novel, generic and improved feature detector, named HORB, to detect image feature in order to improve performance of ORB. The performance of HORB seemed to be nice with an average increase of 12.862% against ORB and takes an average time of 2.336 seconds for image identification.

- In order to further improve the performance of ORB, a heuristic based approach through Ant Colony Optimization has been used. The novel, generic and ACO based ORB feature detector, ACORB, is developed and implemented. It has been tested profoundly to prove its competency and shows improvement in performance of ORB. This approach is really promising with an average increase of 13.249% accuracy, consuming less time of 2.174 seconds for image identification.

- To further improve the performance of the partially visible objects, a novel, generic and three stage hybrid image classifier using Histograms, ORB and Bag of Visual Features has been developed. It has been named as HORBoVF. Along with histograms and ORB feature detector, it uses a dynamic bag of visual features to classify the images. The performance of HORBoVF is outstanding with an average 91.541% accuracy taking 2.453 seconds and serves our motive of development of this algorithm.

- Since we were successful in applying ACO in feature detection using ORB, we deployed the same feature detector with our dynamic bag of visual features to develop another generic, novel and two stage classifier ACORBoVF. This approach uses the same dynamic bag of visual features. The final performance of the algorithm remains same as HORBoVF with little less time consumption of 2.287 seconds! Both, HORBoVF and ACORBoVF, can be used as generic classifiers for any kind of images, once the visual dictionary is created.

- Te₹₹ency, is a TensorFlow and CNN based trained model and classifier for Indian currencies. This has specifically been developed to evaluate the performance of our other two classifiers and to utilize the power convolutional neural networks, a neural network of millions of images, for image classification. This also gives a promising result of 87.215% accuracy taking 0.11 seconds for the mentioned purpose.

Apart from the above algorithm, to carry out the testing for our proposed approaches, a dataset has been created, for each category of Indian currency denomination, consisting of average 455 images for small dataset (total 4552 images) and 1504 images for large dataset (total 15042 images) for training purpose. For testing purpose, for each category of Indian currency denomination, an average 182 fully visible images (total 1819 images) and 228 partially visible images (total 2284 images) have been taken.

3 Testing & Results

The following figure shows overall accuracy of all our proposed approaches in comparison with ORB. It shows that all our proposed feature detectors outperform ORB with 13% more accuracy and our dynamic bag of visual features beats TensorModel with 4% higher accuracy.

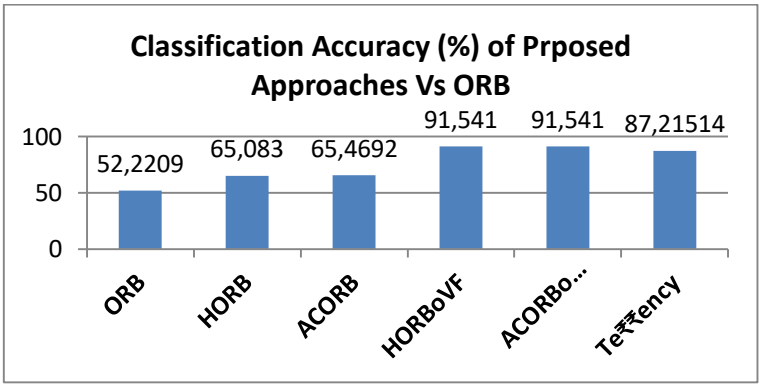

Figure 2: Image classification performance of proposed approaches against ORB

Figure 3 shows that all our approaches take almost double time (milliseconds) than ORB but this difference is compensated by higher accuracy of the algorithms.

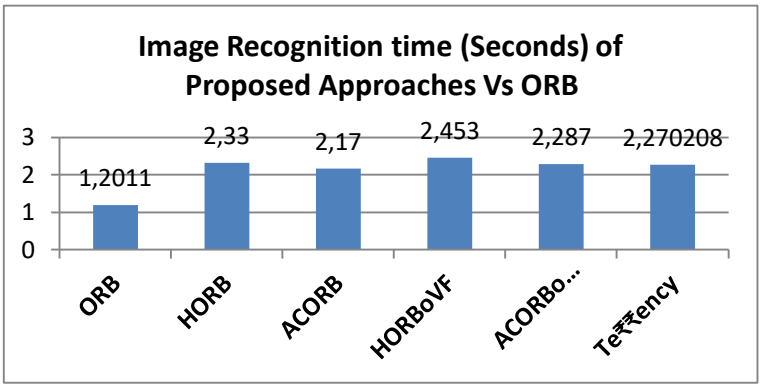

Figure 3: Time efficiency of proposed approaches against ORB

4 Conclusion

After going through an exhaustive testing and meticulous result analysis we draw the following inferences: First, "**Feature detectors independently can recognize fully visible images with higher accuracy but are not capable of recognizing partially visible images and gives poorest performance"**. Second, **"A classifier, be it a bag of words based or neural network based, can improve accuracy for partially visible images also"**. This work also infers that **"After certain level of clustering or training, the performance improvement in accuracy is not possible"** and **"For CNN based models, the larger the number of training images, the better the performance"**.

References

[1] Raval, Vishwas and Shah, Apurva. (2017, January). "iCu₹e – An IoT Application for Indian Currency Recognition in Vernacular Languages for Visually Challenged People." In proceedings of IEEE Confluence2017 (pp. 577-581, ISBN: 978-1-5090-3519-9, DOI: https://doi.org/10.1109/CONFLUENCE.2017.7943217).

[2] Raval, Vishwas and Shah, Apurva. (2017, February). "A Survey on Indian Currency Recognition Systems for Visually Challenged People." In proceedings of ICACCI-2017 published in the Journal of The Maharaja Sayajirao University of Baroda, 52(1), 1-11, ISSN: 0025-0422.

[3] Raval, Vishwas and Shah, Apurva. (2017, March). "A Comprehensive Study on Foreign Currency Recognition Systems for Visually Challenged People and a Feasible Solution for Indian Currency Recognition." In proceedings of SmartTech-2017 published in the International Journal of Computing and Applications, Serial Publications, 13(2), 275-284, ISBN: 0973-5704. Amity University, Jaipur, India.

[4] Raval, Vishwas and Shah, Apurva. (2018, February). "A Comparative Analysis on Currency Recognition Systems for iCu₹e and an Improved Grab-Cut for Android Devices." in Advances in Intelligent Systems and Computing (AISC), Springer Series.

[5] Raval, Vishwas and Shah, Apurva. (2018, April). "HORBoVF – A Novel 3-Level Image Classifier Using Histogram, ORB and Dynamic Bag of Visual Features" in Lecture Notes in Computational Vision and Biomechanics, Springer Series.

[6] Raval, Vishwas and Shah, Apurva. (2018, September). "ACORB – An ACO and ORB based Hybrid Image Feature Detector" in proceedings of IEEE ICACCI-2018. PES Institute of Technology, Bangalore, India. [1]

[1] Reference Link for Thesis: https://sg.inflibnet.ac.in/handle/10603/260677