ABSTRACT

The God has created this universe with all living and non-living entities. Human is one of the best among His creations. For human beings, eyes are the best gift of the God to see all His creations. As of now, human beings are considered as the only developed creatures among the God's creations and have developed themselves from Stone Age to the Super Computing Era. As the human civilizations grew up, the day-to-day transactions moved from the barter system to the currency, the banknotes. Today, every country has its currency in terms of coins and paper notes. Each of the currency of individual country has its unique features, colors, denominations and international value. The life moves on this currency only. We, all, having been given two beautiful eyes could recognize the currency easily, but the same is not easy for the blind people. Though the denomination of a currency can easily be recognized to differentiate between counterfeit currencies from the real one is a Holy Grail. Especially for the blind people, it is a herculean task like finding a needle from a haystack. Since money is the cause of any cheating, if the person is blind, the chances of him being cheated are more. There are many tools available all over the world for the currencies of other developed countries. But, in India, there are no specific robust and handy tools that can help the blind people to recognize the Indian currencies in their mother tongue. For that reason, the main motive of 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.

To go ahead with this research, along with the other image matching techniques, the ORB (Oriented FAST Rotated BRIEF) has been used as a feature detector. The reason behind the use of the ORB is the trade-off in the performance of the ORB. In its category, the ORB has been proved less accurate than its siblings the SIFT (Scale-Invariant Feature Transform) and the SURF (Speeded-Up Robust Features) in terms of feature detection and hence accuracy. However, the ORB is faster in terms of execution time than the others. As the SIFT and the SURF are patented technologies and ORB is the free and open source, this work attempts to improve the performance of the ORB in terms of recognition accuracy. In this direction, first, for preprocessing, the time performance of GrabCut algorithm has been improved (An algorithm which is used to remove the background from the images) for Android-based devices, named as *cGrab-Cut*. The output of this algorithm can be used for further processing of the image. For feature detection, two hybrid approaches have been developed to improve the

performance of the ORB, named as *HORB* – A Histogram based ORB and *ACORB* – An ACO based ORB. In order to provide the best performance for image classification, this work lastly proposed, developed and tested two classifiers: a three-stage hybrid classifier, the *HORBoVF* which is based on the Histograms, ORB and Bag of Visual Words, and a two-stage ACO, ORB, and Bag of Visual Words based classifier, the *ACORBoVF*. All the proposed algorithms have been developed in such a way so that they can work in constrained environments like low memory and slow processors as well as for any images, not limited to Indian currencies only. Along with the two classifiers, a Transfer learning based image classifier, *Te₹₹ency (Tensor Currency)*, has also been trained and tested to see the performance of convolutional neural network using TensorFlow technology and compare it with the two proposed classifiers. To test the effectiveness of all the proposed approaches, Python and Android-based test programs and tools have been developed. The results prove that all the proposed approaches serve the aforementioned motive and are much better as compared to the sole ORB. Thus, taking the advantage of faster execution of the ORB, this work tried to improve the performance of the ORB with different approaches for correct image identification.