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Image Based Fake Indian Coin Detection

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***Abstract*—** Nowadays, illegal counterfeit coins are considerably affecting the financial transactions in society. This work proposes an efficient image based fake coin detection, which can be applied to ensure the authenticity of coins. Although several types of fake currency detectors are already existing, fake coin detection still remains as a challenging problem. Image based approach have benefits in terms of cost and ease of usage. The fake coin detection uses a vector space approach, termed as dissimilarity space. It is a vector space constructed by measuring the dissimilarity between the coin image and the prototype. Dissimilarity between the coin images is obtained using the combination of Difference Of Gaussian (DOG) detector and Scale Invariant Feature Transform (SIFT). The proposed system adapts to coin rotation and scaling. In this work, one class learning method is used, so for training the classifier, only genuine Indian coins are needed.

***Keywords*—** Fake coin, Fake coin detection, One class learning, Dissimilarity space

I. INTRODUCTION

Coins are widely used in our daily life such as telephone booths, vending machines and parking meters etc. Compared to commonly used paper currency, coins benefit their resistance against corrosion and other damages. More than being used as a currency, people use coins for numismatics. Some coins have great values and give an insight to the history. However, a lot of illegal activities are going on with the coins, which cause great damage to the society, especially in the field of numismatics. Forensic experts are employed to examine the authenticity of coins, but it is unrealistic in the case of huge quantities. So this work proposes an image approach to examine the authenticity of coins.

Compared with paper currency, coins have much resistance to abrasion. Counterfeit detection still remains as a challenging problem. There exists many fake currency recognition systems, but not much research has been developed in this area. So there exists a need for a high precision image based fake coin detection system. The main advantage of this work is that even with the help of the coin image itself we can verify the authenticity of the suspected coin. Fortunately some techniques make use of the visual aspects of the coin, but the approach exploiting the dissimilarity space is the key motivator of this work.

II. RELATED WORK

In early ages, the coin parameters like coin diameter, shape, weight or thickness may be used to distinguish between the genuine and fake coins in patents [1], [2]. These works are based on the coin's physical properties. Since fake coins exhibit great resemblance to genuine coin, it is difficult to distinguish between genuine and fake coins through these methods.

In patent [3] electronic method of fake coin detection has been discussed. In this, at one side of a coin passage magnetic field from a primary coil is fixed. This is allowed to excite by a signal at a fixed frequency. While the secondary is allowed for the field from the secondary side, the primary and secondary are electromagnetically coupled. In order to determine the authenticity of the coin, it is allowed to pass through; the attenuated voltage signal from the secondary is used to determine the genuineness of the coin.

In [4], in addition to above method, the magnetic properties of the coin is exploited. [5], [6] proposed to use X-ray diffraction and X-ray fluorescence to detect fake coins, the differentiation between the real and fake coin is based on the raw materials used to make the coins.

There exist many methods which exploits the image based fake coin detection approach. These methods can be used as it or in relation with another method. These image based approach has the advantageous of ease of use and cost effectiveness. In the smart phone boom it is highly desired if one can ensure the authenticity from an image captured by the smart phone. Afterwards some pattern recognition techniques have been applied to the set of captured coin images. [7] Proposed to detect two-Euro fake coins, captured by optical mouse sensor based on the images of the coin, with each image representing a small area of the coin. From

the two- Euro genuine coins, some genuine samples are selected forehand for reference.

Also this method was not adapted to coin rotation. Based on their image characteristics [8] detected fake Danish coins, but the dataset was small which consists of only 16 coins. Fake coin detection problem had also been resolved by using their images as discussed in papers. Coins may be identified in terms of their denominations, issuing countries etc. [9] Proposed to recognize coin images in terms of their countries of origin and denominations. In this study, the problem of coin recognition along with fake coin detection has been studied. The important concern in coin recognition is to reduce the sensitivity to the variations among the coins.

High quality fake coins are classified as single class as their genuine counterparts under the coin recognition pattern. These variations are important in the coin recognition problem. Fake coin detection problem is very challenging since the coin may get damaged due to its frequent use.

In these days, local key point detectors and descriptors are used to describe an image. Generally, we first detect the key point by difference of Gaussian (DOG) detectors and then described using the scale invariant feature transform (SIFT) descriptor [10].

III. METHODOLOGY

In order to build the dissimilarity space, the suspected coin is compared with the preselected prototype coin images. People normally compare a coin for genuine counterparts to ensure the authenticity. Minimum dissimilarity images are chosen as the prototype coin images. This work uses one class learning, since number of fake coins in real life is very limited. Here one class SVM is used, so it needs only genuine coins for the training purpose. A block diagram of the proposed approach is shown in block diagram 1.

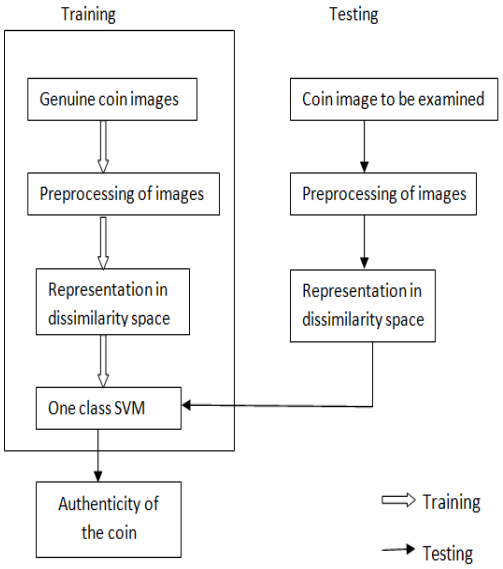

Figure 1. Block Diagram of Work

A. *Representing Coins in Dissimilarity Space*

By comparing the considered image and the preselected prototype, the dissimilarity space has been created. Number of prototype images defines the dimension of the dissimilarity space. Each dimension measures the dissimilarity between the suspected coin images with the prototype. Formally the set of prototype images were selected from the set of coin images and a mapping is defined. After that the dissimilarity is measured between two coin images.

a) Coin image dissimilarity measure

The first stage of the dissimilarity measure is to extract the coin images from the image background. Normally the coins are in circular shape, except some ancient coins, which are not considered here. When the image is not captured well, it may appear as an ellipse. So, we apply Hough transform for ellipse detection. Afterwards the captured elliptical coin image is normalized to a circle. The local detectors and descriptors analyze the key points of the coin images. The DOG detector first detects the key points using the SIFT descriptor. The combination of DOG detector and SIFT descriptor performs well in many applications. For the two coin images their dissimilarity can be obtained from the number of matched key points. Lesser the number of matched key points, more dissimilar the images will be. Since there are many key points in a coin image, searching the closest neighbour is computationally expensive. In order to alleviate this problem we exploit the polar coordinates over Cartesian coordinates since coins are in the circular shape. Thus we represent the key point on an image by (r, θ) in polar coordinates, where r represents its normalized radius, obtained by dividing its distance from the centroid of the coin by the coin radius. θ represents its polar angle.

Figure 2. Real coin image samples from the dataset

b) Prototype seletion

In order to represent the coin images in the dissimilarity space, the prototype selection must be done beforehand. Since we employ one class learning we need only genuine coins for the testing purpose. Normally people have a tendency to compare a suspected coin with an original coin for similarity. The prototype selection methods can be of

- Random selection from a set of genuine coin images
- Clustering based selection: It exploits the clustering approach using K-medoids, is applied to set of real coin images. The coin image with minimum dissimilarity to all other images in the cluster is treated as medoid of that cluster.

B. Fake Coin Detection Based on One Class learning

There will be an imbalance between the number of real and fake coins in real life. It is much difficult to obtain the fake coins compared with the genuine coins. Since we are using genuine coins for the training purpose it is not necessary to collect variety of fake coins. Fake coins may be different from each other so that it can cheat the existing counterfeiting techniques. But we categorize all fake coins into single class only. If we want to test the authenticity of a coin, we will compare its genuineness with original coin. If it shows great resemblance with original coin, it is treated as real, otherwise fake. The comparison is basically done by the SIFT, by the number of matched key points. We employ one class SVM here. One class SVM was proposed by Scholkopf et al. it is considered as a natural extension of support vector machine to the case of unlabelled data. With real coins as training samples we enclose these samples into a hyper plane, which is the idea of the one class SVM Radial Basis Function kernel is used to map the input data to some feature space.

IV. RESULTS AND DISCUSSION

For the fake Indian coin detection work, the data set has been created using the Indian 10 rupee coins. The sample images from the data set have been shown in figure 2. The coin images are captured and converted into the grey scale format. The experiments are done using Indian coins. From the extracted coin images from the background, the training has been done using the real coin images. The dissimilarity space value shows the dissimilarity between the coin images. From the dissimilarity values prototype has been selected for minimum dissimilar values. Testing has been done using the fake coins; SVM classifier gives an indication about the authentication of the coin, whether the coin is real or fake.

The whole work has been interfaced through GUI as shown in figure 3. This work shows an accuracy of 82%, and the Receiver Operating Characteristics has been shown in fig 4.

Figure 3. Graphical User Interface for Coin Authentication

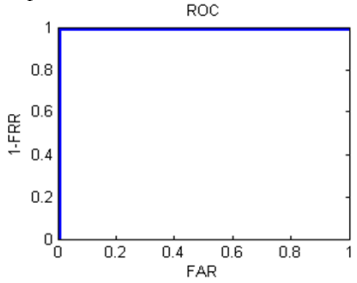

Figure 4. Receiver Operating Characteristics

V. CONCLUSION AND FUTURE SCOPE

Counterfeit coin detection by using the coin image characteristics is proposed here. The captured image of the coin is represented in the dissimilarity space. By comparing the considered image and the preselected prototype, the dissimilarity space has been created. Number of prototype images defines the dimension of the dissimilarity space. The combination of DOG detector and SIFT descriptor is used to identify the key points in the image there by creating the dissimilarity space. In order to remove the mismatched key points, a post processing method is also used. In real life, due to the lack of fake coin in all the cases we employ one class SVM classifier. This needs only real coins for the training purpose. Since negative samples are not used for the training purpose it can classify all the varieties of fake ones into a single class which is the advantage of one class SVM.

In spite of the advantages offered by this method, it has many shortcomings. As stated, it is necessary to obtain the real coins to ensure the authenticity for a variety of coin. For some ancient and rare coins it is not easy to obtain enough real coins.

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