Circle Hough Transform (CHT) method applied to coin identifier and recognition based on computer vision and android developer

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Abstract. The coin recognition system is a very important role in currency processing systems which is aims to minimize human miscalculation and time to calculate coin values. The coin identifier and recognition to calculate the value of Indonesian coins based on android developer presented in this paper. The two coin parameters are used for coin recognition which are radius and colour of the coins. The Circle Hough Transform (CHT) method with gray scaling and erosion process as pre-processing image used to calculate radius parameters, based on android developer and computer vision. After the radius value is obtained then the average RGB value of the coins is detected to determine the colour parameters. By calculating the diameter and determining the colour, the coins can be recognized and the total value of the coins in the input image can be known. The experimental results show that the system has been obtained indicate that the system successfully recognized coins based on determined algorithm. That is mean the application using computer vision can recognition coin and count the value of coins.

1. Introduction

The currency coins have a very important role in the economic field and are very essential need on human life transaction [1,2]. In the process of counting coins it is very time consuming and can be a very tedious activity. This system was created to automate the process of calculating coin. This system usually authenticates coins based on electromagnetic, mechanical, image processing methods [3,4]. Although all of these approaches offer a significant degree of accuracy, the coin counting through object recognition techniques with the image processing advantage of offering auditable records from each calculation session [3]. In this study, the image processing in order to recognize the coins as object. The recognition of the objects identify an object that are processed in a digital image to find out the characteristics. The Identified objects have different perspectives such as colors, sizes, and shapes in various sizes [5,6].
Furthermore, developing a coin identification and recognition system has been developed based on Android to determine the value of coins. In this work, the coins that will be processed focus on Indonesian currency coins. There were five types of coins used, namely 100, 200, two types of coins 500, and 1000. Where each coin has different characteristics. The characteristics of the coin include diameter and color. Types of Indonesian coin used are shown in Figure 1 and the characteristics of coins which include the diameter and color of the coins are shown in Table 1.

![Figure 1. Indonesian coin type.](image)

| Coin Type | Diameter (mm) | Colour |
|-----------|--------------|--------|
| 1000      | 24           | Silver |
| 500       | 27           | Silver |
| 500       | 24           | Gold   |
| 200       | 25           | Silver |
| 100       | 23           | Silver |

Recently the camera are embedded in smartphone, this system uses the camera to take pictures which will be processed using OpenCV. By using OpenCV, the system can detect the color and radius of the coin using Circle Hough Transform (CHT). So that coins can be identified in order to calculate the total value.

2. Literature review

2.1. Computer vision

Computer Vision is a mathematical technique for converting three-dimensional (3D) shapes into a very reliable image to accurately calculate 3D objects and can describe the objects in one or more image [7]. Also, computer vision is an automatic processing that consists of several large processes which are used for image processing, an image acquisition, a recognition and the decision makers. An object image can be interpreted so that humans can find objects that appear in the eye so that a decision can be taken from the results of the interpretation [8].

OpenCV is an open source computer vision library written in C and C++ languages [9-10]. OpenCV is designed for computational efficiency and focus on real time applications [9]. OpenCV provides functions that are used to process an image or video containing a combination of low level image processing and high level processing such as face detection, feature matching, and tracking [11].

2.2. RGB to grayscale transformation

The original image has three colors information including Red, Green, and Blue (RGB) which are parameters that cannot be processed. So that the image is changed to grayscale. The process of changing the grayscale is equivalent to converting RGB color information to a gray scale one-dimensional scale that only has information on the intensity of light and the position of pixels. Grayscale processing may
improve the visual effects of images and the clarity of the image that are useful in computer processing. The gray scale value in the image matrix represents the light intensity in each pixel position [12].

2.3. Circle Hough Transform (CHT)

The Hough Transform (HT) was first introduced by Hough to find traces of the particles in bubble chamber imagery. The Hough Transform can be used to determine the parameters of a geometric object such as lines, circles, and ellipse in an image [13], [14]. This approach is used due to of the strength of this method on images that contain noise, occlusion and various variations of illumination [1].

The Circle Hough Transform (CHT) is one of development of Hough Transform and designed to find circles with characterizing centers (a, b) and radius \( r \) in parameter space [1,13,15]. The following is described in mathematical formulas.

\[
\begin{align*}
    r^2 &= (x - a)^2 + (y - b)^2 \\
    x &= a + r \times \cos(\theta) \\
    y &= b + r \times \sin(\theta)
\end{align*}
\]

Where \( x \) and \( y \) are circle points in the image. In the parametric form, the circle equation is explained in Figure 2.

3. Method

In this study, using the Android developer and OpenCV library to recognize and calculate value of coins by implementing the Circle Hough Transform (CHT) method. The following steps for image processing that have been done are shown in Figure 3.
The first step is taking the image in the smartphone gallery. In this study the image used is RGB colored image where the value of red, green, and blue each pixel has a value of 0 to 255. The image format used .jpg.

After the image have been inputted and then preprocessing the image. This preprocessing used image repair. The preprocessing stages are carried out, namely the grayscaling process and morphology. The erosion process is one type of morphological process used in this process. The grayscaling process is used to simplify the image, so that the time needed to do the next process runs faster. The erosion process used to help separate objects from the background on the image. These grayscaling process used as input image for detection circle using Hough Transform.

Indonesian coins have different characteristics of diameter and color. The 500 gold coin has the same diameter as the 1000 silver color coin. So that the color detection process needed to distinguish the coins from the two coins. The process carried out by taking the RGB value of the gold coin. Next calculate the mean of the RGB gold coin value as a color feature of the coin.

The Circle Hough Transform is implemented in the image resulting from grayscaling and erosion process. The purpose of using this method is to detect edge of circle coins to calculate diameter within an image. Output in this process is an image marked around a circle and determining diameter of each coins.

After knowing the color and diameter of each coin detected, coins can be classified according to the characteristics of each coin. So that the value of the coin can be known. The coins recognized by the system can be calculated by summing the value of the coins detected. Total value of coins can be known by the system in the display of the android application after the calculation process.

4. Results and discussion

Image data retrieval is done 90 time the test image with three conditions. The first condition used silver coins, the second condition used gold coins, and the third condition used silver and gold coins in one image. Where each image is taken 30 times the test image. The following results of data retrieval can be seen in Table 2.

| Condition of Coins | No. of Coin Tested | No. of Coin Recognition | Recognition Ability |
|--------------------|--------------------|-------------------------|---------------------|
| 1<sup>st</sup> condition | 30 | 26 | 86.67% |
| 2<sup>nd</sup> condition | 30 | 23 | 76.67% |
| 3<sup>rd</sup> condition | 30 | 23 | 76.67% |
| Average | | | 80% |

Table 2 shows that each coin condition has very good accuracy. In the first condition, the accuracy value was 86.67%, the second condition was 76.67%, and the third condition was 76.67%. The average accuracy of all coins was 80%. The errors that occurred in the coin recognition that were not exactly the diameter circle of the coins detected. It means the recognized value of the coins does not match with real value of coins.
Figure 4. Graph of total value accuracy.

Figure 4 shows the level of accuracy of the system in calculating the nominal value of coins contained in the input image. In this figure, horizontal axis shows number of data sample and vertical axis shows accuracy of each data sample. It can be seen the level of accuracy of the system in calculating the total value of the coin nominal is very good with the average accuracy rate of 89.94%.

Circle Hough Transform has been used to detect and count circle objects with accurately results [15]. This method also has been successfully implemented in this study. Error in calculating currency coins due to an error coin recognition. So the total value of coins issued does not match with real total value of the coin.

5. Conclusion
Based on the data retrieval that has been done can be concluded that the system can identify and recognize in order to calculate coin values with excellent accuracy. In retrieval of coin identification data carried out with three conditions where each condition using 30 test images obtained an accuracy of 80% and the calculation of the value of coins using the system carried out as much as 90 times the test image obtained an accuracy of 89.94%.

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References
[1] Bradski G and Kaehler A 2011 Learning OpenCV: Computer Vision with the OpenCV Library
[2] Shaker S H and Alwan M G 2018 Paper Currency Detection based Image Processing Techniques 
Journal of AL-Qadisiyah for computer science and mathematics 1-8
[3] Farooque G, Sargano A B, Shafi I and Ali W 2016 Coin Recognition with Reduced Feature Set 
SIFT Algorithm Using Neural Network International Conference on Frontiers of Information 
Technology
[4] Pulli K, Baksheev A, Kornyakov K and Eruhimov V 2012 Real-Time Computer Vision with 
OpenCV
[5] Roomi M S and Rajee J R Coin Detection and Recognition Using Neural Network International 
Conference on Circuit, Power and Computing Technologies [ICCPCT]
[6] Tajane A U, Patil J M, Shahane A S, Dhulekar P A, Gandhe S T and Phade G M 2018 Deep 
Learning Based Indian Currency International Conference On Advances in Communication and 
Computing Technology 130-134
[7] Shi J, Yang Q, Sima W, Liao L and S H 2013 Space Charge Dynamics Investigation Based on 
Kerr Electro-Optic Measurements and Processing of CCD Images Transactions on Dielectrics 
and Electrical Insulation
[8] Sooruth T and Gwetu M V 2018 Automatic South African Coin Recognition through Visual
Template Matching International Conference on Advances in Big Data, Computing and Data Communication Systems (icABCD) 1-6

[9] Szeliski R 2010 Computer Vision: Algorithms and Applications

[10] Wang Y M, Li Y and Zheng J B 2010 A Camera Calibration Technique Based on OpenCV The 3rd International Conference on Information Sciences and Interaction Sciences 403-406

[11] Umer S and Dhara B C 2015 A Fast Iris Localization Using Inversion Transform and Restricted Circular Hough Transform Eighth International Conference on Advances in Pattern Recognition (ICAPR)

[12] Wijaya T A and Prayudi Y 2010 Implementasi Visi Komputer dan Segmentasi Citra untuk Klasifikasi Bobot Telur Ayam Ras Seminar Nasional Aplikasi Teknologi Informasi

[13] ZiHe Q, Shi P, Pan D and Zhong D 2016 Coin Detection and Recognition in the Natural Scene IEEE Advanced Information Management, Communicates, Electronic and Automation Control Conference (IMCEC)

[14] Yazdi M and Mohammadi M 2017 Metal Artifact Reduction in Dental Computed Tomography Images Based on Sinogram Segmentation Using Curvelet Transform Followed by Hough Transform Journal of Medical Signals and Sensors 145-152

[15] Ni J, Khan Z, Wang S, Wang K and Haider S K 2016 Automatic Detection and Counting of Circular Shaped Overlapped Objects Using Circular Hough Transform and Contour Detection World Congress on Intelligent Control and Automation (WCICA) 2902-2906