Journal of Multidisciplinary Engineering Science and Technology (JMEST)
ISSN: 2458-9403
Vol. 6 Issue 6, June - 2019

Identification and Clasification of Plastic Color Images based on The RGB Method

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Abstract—Plastic is one of the accessible materials as a recycled product. In the process of recycling plastic, sorting by type of plastic is very important because contamination in the recycling of one type of plastic with other types of plastic can cause an increase in cross-contamination and industrial operating costs. Thus, this paper presents a method of classification automatic sorting systems in plastic bottles based on the color intensity of plastic bottles. The classification method of plastic bottles using the RGB method is calculated based on the image of plastic bottles that have been characterized by the scale of the image object. The results showed that the RGB method proved accurate in classifying types of plastic bottles with an accuracy value of 86.67%.

Keyword—color images; Classification; plastic bottle; RGB

I. INTRODUCTION

Plastics are a part that cannot be separated from human life, especially in countries with rapid economic growth. One of the uses of plastic that is very often found in life is the use of drinking bottles and chemical bottles [1]. That causes the plastic material to contribute most of the chemical waste produced. Plastic is a solid waste that can damage the environment because it takes approximately 500 years to decompose completely. It makes the recycling of plastic bottles as the right step to manage and reduce waste, especially plastic waste. In developing countries, for example, Colombia, most of the people are aware of the recycling process, even in a secondary school, there is automatic teaching of waste classification technology [2]. However, in other developing countries, such as Indonesia, plastic recycling has problems in the technical, financial, environmental, institutional, and social aspects associated.

In recent years, recycling plastic bottles has a big challenge in the sorting process. Without an effective and efficient waste plastic sorting system, recycling becomes a critical problem in the waste treatment process [3]. Moreover, the first step in the recycling of plastic bottles is the sorting process. Automatic and inexpensive sorting of plastic bottles can be added value and save recycling costs. However, the sorting process on plastic bottles often has problems because it is difficult to sort out each type of plastic bottle. The types of plastic bottles consist of 7 types including polyethylene terephthalate (PET), high-density polyethylene (HDPE), polyvinyl chloride (PVC), low-density polyethylene (LDPE), polypropylene (PP) and polystyrene (PS), indicated by number 1 up to 6 in each type. There is one other plastic bottle to indicate plastic other than the previous six type, it marked with the code 7 "other" [4]. For example, waste management is having difficulty sorting bottles between PVC and PET types, in the process, sorting must be done before the process after because when PVC bottles mix with PET bottles, then PVC can produce hydraulic gas release and reduce the quality of all batches existing [5, 6].

Sorting on waste is the first step in the recycling process. Many methods can be used to sort plastic bottles. Some manual to automatic systems is used to classify plastic bottles. However, along with the development of science and research, manual classification has slowly been abandoned, and digital image classification technology has become an effective and efficient automatic product sorter.

Image classification is an essential method for most remote sensing applications. Image classification consists of two types, namely pixel-based image classification and object-oriented image classification. The pixel-based image classification method is the most widely used image classification for remote sensing applications [7]. Pixel-based image classification can classify remote sensing images based on radiometric information in images by classifying "pixel by pixel" images.

As technology developed, the creation of algorithms in the classification of object-oriented images began to appear [8]. Remote sensor data classified as "segment by segment". The advantages of object-oriented image classification are high spatial resolution images, and it can take into account the shape of textures, and take into account spectral information in each segment and makes the classification of object-oriented images better than pixel-based classifications.

Dou (2015) conducted a study to detect landslides using object-oriented classification methods [9]. In this research, Jie Dou stated that object-oriented methods are more accurate than the classification of pixel-based images. Linder et al (2015), underlines that it is

vital to characterize objects by choosing the best features and local thresholds [10].

Basically, computer vision aims to take pictures, standard lighting systems, and as software for image processing and analysis using digital cameras [11]. Some studies that use computer vision as a technology for assessing the quality of a product, such as Benalia et al [12]; Jackman et al [13]; Ercisli et al. [14]. These studies reveal that computer vision is an accurate technology, not damaging, consistent, fast, cost-effective, and efficient.

There are many images processing method for classifying plastic bottles. However, in this work, researchers used the RGB method as a method of classification based on computer vision. RGB method is an image processing technique that can determine the type of plastic bottle parameters so that it can improve the quality of sorting. RGB is an optical based automatic sorting method by separating plastic bottles based on color. This detection system is a system with advanced technology that can automatically sort plastic bottles based on resin type, color, and shape or both. Yani et al. (2008) identified a sorting system using one type of beverage can image category, namely the side of beverage cans [15], whereas, Yani et al. (2013) identified two types of categories of beverage cans, namely sides and shapes beverage cans [16].

Several researchers use the RGB method in the classification process, Hayat et al (2016) conducted a study for face recognition from low-quality Kinect images obtained by various head poses, lighting, facial expressions, sunglass disguises and hand occlusion [17]. In addition, using RGB for this method has been widely adopted especially in various foods such as classifying manga in 3 maturity classes [18], beef [19,20], fish (Dowlati et al., 2012) [21], pork meat (Chmiel et al., 2011) [22], dates [23], citrus fruits [24], and potato chips (Pedreschi et al., 2011) [25]. Colour image systems that have treatment outside of natural treatment can be done to increase the accuracy of the results of each color value in RGB. It has been done by Mustafic and Li (2014) by classifying six types of botany and seven types of non-botanical foreign objects under ultraviolet (UV) and light emitting diode (LED) blue light [26]. This study combines the RGB and HSV methods (hue, saturation, value). This study shows that imaging is successful in classifying the main types of cotton and foreign matter.

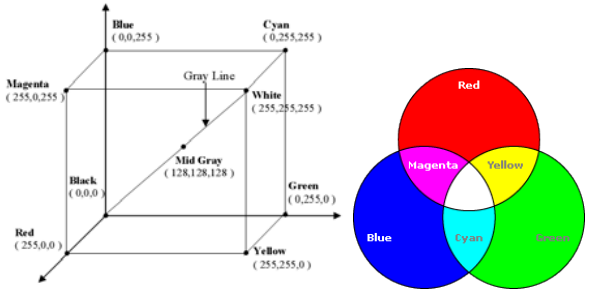
In computer vision, segmentation is the process of partitioning digital images into several sets of pixels. Segmentation aims to simplify and change more important representations to be more practical and easy to do analysis [27]. Image segmentation is generally used to find objects and boundaries in the form of lines and curves in the image. The result of image segmentation is a set of contours extracted from the image or often called the edge detection system. The results of image segmentation can also take the form of a set of regions that collectively cover all images. The problem that often arises in image extraction is one of the images produced from the image [28]. The shadow causes a loss of even some information in the area to be investigated, causing the process of classification and detection of objects to be biased or failed [29,30].

In this work propose a new technique for the classification of plastic bottles that utilize intelligent computer vision systems. The method used is the RGB color method by doing image segmentation steps. The characteristics to be determined are the types of bottles based on the type of PET and HDPE.

II. METHODOLOGY

In this work, the first step is taking pictures on plastic bottles using a 720-pixel webcam that is installed with a distance of 56 cm from the location of the plastic bottle. The webcam is set to take colors with a size of 320 x 240 pixels. After the webcam detects the object, the image is automatically taken and sent directly to the PC. Images of plastic bottles taken are stored in jpg format. The JPG format is a compression scheme on bitmap files that can compress large-sized images into smaller images. It makes it possible to store extensive data on limited storage media.

Then the image is saved in order to create a database. Databases are formed by extracting features based on color images using the RGB method. The RGB method consists of three basic color elements, namely red (R), green (G), and blue (B). In the RGB system, the value of each color base is 0 to 255, so that the colors obtained are 256 x 256 x 256, equal to ± 16.7 million colors. Illustration of RGB was using three-dimensional system, as shown in figure 1 (a). If the basic color is combined, it will get certain colors, as shown in figure 1 (b). Processing on the RGB method is done by reading the values of red, green, and blue in a pixel.



(a) (b)

Fig. 1.Color model: (a) System of RGB color space, (b) RGB color model

Databases are based on color characteristics in the form of red, green, and blue in general in each bottle image. This value is obtained by using the RGB method that has been collected from images taken previously. The results of the red, green, and blue values are searched for by the formula:

Average red = total red / frequency value

Average green = total green / frequency value

Average Blue = total blue / frequency value

The important steps to create database is setting a template. Template settings are done by cropping the image then the image size becomes 5 x 5 pixels according to the desired feature. Feature extraction plays an important role in the identification and verification of images. In the feature extraction phase, only important features are needed then classification can be implemented in smaller feature spaces. Feature extraction converts data into a simpler form, and it is easier for the system to learn the concept of targets, resulting in a simpler hypothesis. The choice of feature extraction method is an important factor in achieving high recognition performance in pattern recognition systems.

Several factors, such as lighting conditions, camera reinforcement, contrast and brightness, camera height above the object, can significantly affect the quality and sharpness of the final image of the experiment to find the optimal configuration.

After the primary database has been determined, the testing process for identifying plastic bottles is done by taking a webcam image. The results of the identification are graphs of red, green, and blue values that will be processed for the classification process of the types of plastic bottles.

III. RESULT AND DISCUSSION

A. System Description

The system description consists of two main components, namely a webcam and a computer system. The webcam is used to take digital pictures automatically from an object that passes through the inspection zone. Digital images taken by a webcam are then processed by a computer system to find the level of similarity with a predetermined database.

B. Database System

The process of creating a digital object database is a basic frame of work to develop an integrated automatic sorting system. Database creation includes feature extraction, consisting of the cropping and extracting process of each image, where the trimming process consists of matching templates and window features. The extraction process consists of edge extraction and color extraction. Finally, the results of the classification present the similarities between the measured features and the values stored in the database.

C. Image Pre-Processing

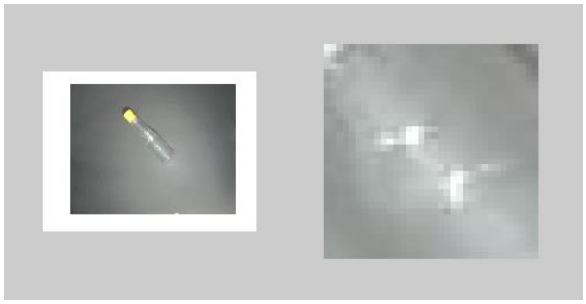
The first step in image pre-processing is taking pictures. Taking these images is the process of initial raw data retrieval from each sensing device. Satisfactory images in high quality will affect the quality of raw data, and quality raw data will affect overall system performance. In this work, the image was taken using a digital webcam as a sensing device because the image sensor on a digital webcam will create images with high quality and low noise.

Based on the system created, the image is set with 24-bit color, and 320 x 240 resolution is taken using a webcam and stored in the jpg file format. The quality of the images taken is checked. The database only contains useful quality templates to increase system accuracy. Taking pictures in this work has a quality picture without any images being rejected because the researchers took pictures by positioning plastic bottles in a predetermined position.

Fig. 2.Photo of a plastic bottle

D. Features Extraction

Trimming parameter space and any trimming solutions may require the calculation of its composition features. In the solution room, many parts can be easily removed because there are still identifiable backgrounds. The removal of parts makes the identification process more accessible, because it does not require the calculation of the composition features, and the image area exception feature only needs to be counted once for images. The template settings in this work are carried out using cropping command [200 150 120 120] so that the size of the image results becomes 5 x 5 pixels. The results of the image after extracting features can be seen in Figure 3.



(a) (b)

Fig. 3.(a) Original image (b) Cropping image

E. Rgb Value Results

After identifying all plastic bottle samples using the RBG method, the red, green, and blue values were obtained for each plastic bottle, that can be seen in Figures 4, 5, and 6.

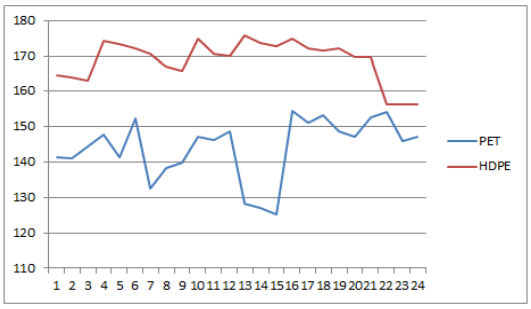


Fig. 4.Graph of red values on plastic bottles A and B using the RGB method

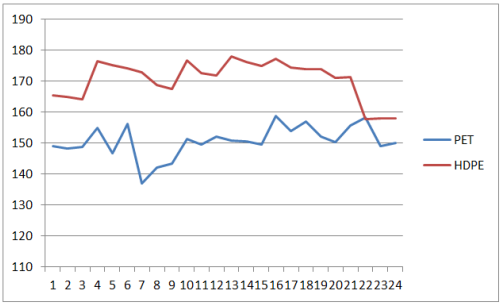


Fig. 5.Graph of green values in plastic bottles A and B using the RGB method

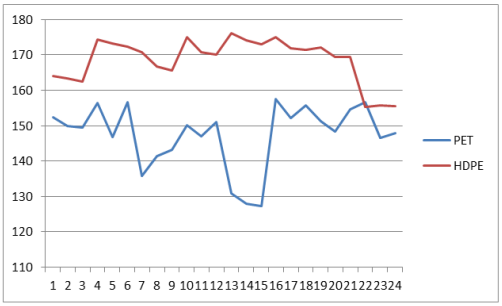


Fig. 6.Graph of blue values in plastic bottles A and B with the RGB method

Based on the graph, bottles with type PET have a maximum red value of 154.60 and a minimum value of 108.14 while the green value is maximally 159.53 and a minimum value of 129.38, for a blue value a maximum of 158.85 and a minimum value of 114.94. Conversely, bottles with HDPE type have a maximum red value of 175.73 and a minimum value of 156.18 while the maximum green value is 177.88 and a minimum value of 157.78, for a maximum blue value of 176.20 and a minimum value of 155.32. Comparison between bottle A and bottle B, type A bottle has a value of red, green, and blue value smaller than the type of bottle B. Based on these results, there are differences in values that are likely to be able to distinguish the types of each bottle more accurately.

Based on the average value, bottles with PET type have a red average of 144.98, a green average of 150.50, and a blue average of 146.58. Whereas for bottles with HDPE type has a red average of 168.80, the green average is 170.55, and the blue average is 168.66.

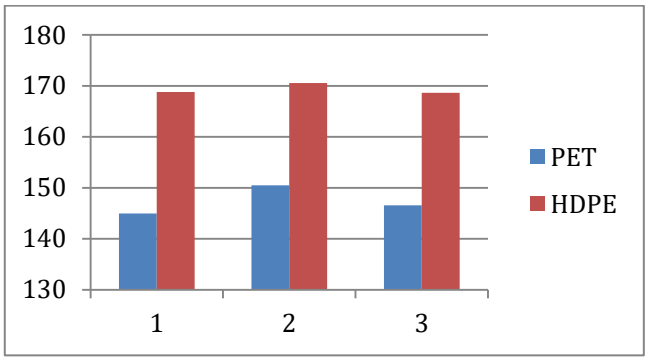


Fig. 7.Graph of comparison of average color of PET bottles and HDPE bottles

Based on the average value, the average ratio of red between PET and HDPE bottles is 23.82, the comparison of the average green between PET bottles and HDPE is 20.05, and the comparison of the average blue between PET bottles and HDPE is 22, 08. Based on this comparison of values, it can be stated that there are significant color image differences between PET and HDPE bottles.

IV. CONCLUSION

This work presents the process of identification and classification of plastic bottles in two types, namely PET and HDPE plastic bottles. Identification and classification are carried out using the RGB method with a database consisting of image pre-processing, feature extraction, and classification of color images in images of plastic bottles that have been taken previously. Setting the template in this work is done by cropping with the size of image to be 5 x 5 pixels. The identification results in bottle A and B are that types A bottles have red, green, and blue values smaller than type B bottles. The average ratio of red between PET bottles and HDPE is 23.82, the ratio of the average green between PET bottles and HDPE is 20.05, and the comparison of the average blue between PET bottles and HDPE is 22.08. Based on the comparison of these values, it can be stated that there are significant color image differences between PET bottles and HDPE. The accuracy of sorting plastic bottles using the RGB method is 86.67%. It can be stated that the RGB method is an excellent method to be used in the process of identifying and classifying plastic bottles based on their type.

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