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Classification of Fertilizer Using OpenCV Based on Color Characteristic

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Abstract. The agricultural industry is one of the most important sectors for a country because its supports food production. One of the agricultural industries that can increase food productivity is the fertilizer industry. Fertilizers have many varieties. The variant of a fertilizer can be identified by its color. There are 3 types of fertilizers such as NPK fertilizer, Calcium fertilizer and Potassium fertilizer. These fertilizers have different colors. NPK fertilizer has blue color, Calcium fertilizer has yellow color and Potassium fertilizer has red color. Red, Green, Blue (RGB) color spaces and Hue, Saturation, Value (HSV) color spaces are used as extraction of color features on fertilizers which used as fertilizer color features. The color characteristic of the fertilizer is used to classify fertilizer. This paper aims to classify fertilizer based on its color. Fertilizers that have been successfully classified are displayed on the monitor screen. There are 75 fertilizer samples which consists of 3 types of fertilizers and 25 samples for each type of fertilizer used in this paper. Test results show that fertilizer can successfully identified 3 types of fertilizer based on its color. The value accuracy is obtained 100% in the RGB color with the range of RGB color are (40,60,70) to (120,160,170) for NPK fertilizer, (140,120,20) to (210,210,100) for Calcium fertilizer and (20,50,0) to (150,180.20) for Potassium fertilizer.

1. Introduction

Fertilizers are any organic or inorganic material of natural or synthetic origin (other than liming materials) that is added to a soil to supply one or more plant nutrients essential to the growth of the plants [1]. Based on the source of the ingredients, fertilizer can be divided into 2 types, namely organic fertilizer and inorganic fertilizer. Organic fertilizers are derived from natural sources (e.g., livestock and poultry excreta, plant residues, biogas residue, and agricultural by-products), and their usage can have a positive impact on pollution [2]. Inorganic fertilizer is fertilizer mined from mineral deposits or manufactured from synthetic compounds [3]. Inorganic fertilizers more practical and easier than organic fertilizers so that the agricultural industry uses more inorganic fertilizers [4]. In general, there are inorganic fertilizers often used namely : Nitrogen Phosphor Potassium (NPK) fertilizer, Calcium fertilizer and Potassium fertilizer. NPK fertilizer, Calcium fertilizer and Potassium fertilizer have different characteristics based on the color. NPK fertilizer has a blue color, Calcium fertilizer has a yellow color and Potassium fertilizer has a red color.

Nowadays, the development of the industrial has entered the Industrial Revolution 4.0. Industrial Revolution 4.0 allows machine work automatically and communicate with each other [5]. Automation in the agricultural industry, especially in the classification of fertilizers can be solved by applying artificial intelligence. Artificial intelligence is one of the computer disciplines that always undergoing renewal [6]. With the application of artificial intelligence, a machine can be modified to recognize certain types of fertilizers. The field of artificial intelligence that trains computers in interpreting and understanding visuals is computer vision.

Computer vision is the image processing that associated with image acquisition, processing, recognition, classification and decision making from image identification. Image processing is digital manipulation and interpretation of images with the help of computers. The purpose of computer vision is to duplicate the ability of human vision into machines [7]. In this paper, the processing module command the camera to take a fertilizer image, then the fertilizer image is proceed by processing module by applying image processing techniques. The results of image processing are displayed on the monitor screen in real time. Types of fertilizer referred to NPK fertilizer, Calcium fertilizer and Potassium fertilizer.

2. Theory

2.1. NPK, Calcium and Potassium Fertilizer
Fertilizers used in this paper are NPK Mutiara fertilizer, Calcium Karate Plus fertilizer and Potassium Murriate of Potash (MOP) fertilizer. Mutiara's NPK 16-16-16 fertilizer contains 16% nitrogen, 16% phosphor and 16% potassium. This fertilizer color is blue and used as a basic fertilizer for all types of plant. Calcium Karate Plus fertilizer contains 26% calcium oxide. This fertilizer color is yellow and serves to strengthen the cell walls of plant. Potassium Murriate of Potash (MOP) fertilizer contains 60% potassium. This fertilizer color is red and serves to accelerate the process of flowering and fertilization in plant [8].
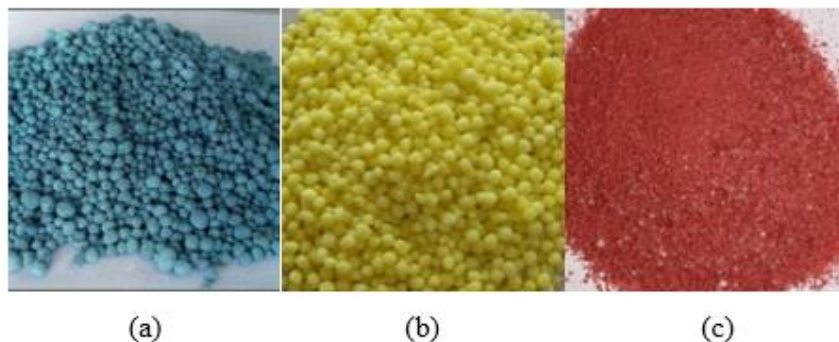
Figure 1. Fertilizer Color (a) NPK Fertilizer (b) Calcium Fertilizer (c) Potassium Fertilizer

2.2. Image Processing
Image processing is a study how an image is formed, processed and analyzed to produce information that can be understood by humans. The purpose of image processing is to improve image quality, recognize patterns and identify objects. Image processing changes the image to another image, the input is in the form of an image and the output is a better image than the input image [9].

2.3. Computer Vision
Computer vision is an image processing that associated with image acquisition, processing, recognition, classification and decision making from image identification. The purpose of computer vision is to duplicate the ability of human vision into machines. Computer vision supports machine to independently see and retrieve information in an image [10].

2.4. Open Source Computer Vision (OpenCV)

Open Source Computer Vision (OpenCV) is a library of programming functions for real time computer vision. OpenCV uses the Berkeley Software Distribution (BSD) license and its free for both academic and commercial used. OpenCV can be used in C, C ++, Python, Java and others [11]. OpenCV can be used on varieties of operating systems. This paper used OpenCV 3.4.6.27.

2.5. Raspberry Pi 3 Model B

Raspberry Pi 3 Model B is a single board computer with a dimension of 120mm × 75mm × 34mm which has a clock speed, its quite high at 1.2 GHz and already supports wireless connectivity. Raspberry Pi 3 Model B is used as a processing model in this paper. Raspberry Pi 3 Model B has a Broadcom BCM2837 chip system, GPU VideoCore IV and 1 GB RAM, 40 GPIO pins, 4 USB ports, Local Area Network (LAN) port, 3.5 mm stereo jack, HDMI port, and micro USB port [12].
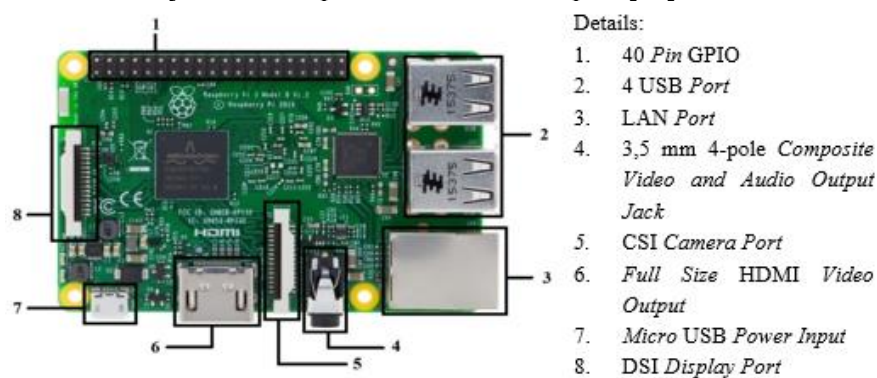

Details:
1. 40 Pin GPIO
2. 4 USB Port
3. LAN Port
4. 3,5 mm 4-pole Composite Video and Audio Output Jack
5. CSI Camera Port
6. Full Size HDMI Video Output
7. Micro USB Power Input
8. DSI Display Port

Figure 2. Raspberry Pi 3 Model B

3. Results and Discussion

In this paper, the data of fertilizer classification are obtained from 75 fertilizer samples which 3 types of fertilizers and 25 samples for each type of fertilizer. The classification based on RGB color is divided into 3 channel color range. The notation of RGB channel can be written as (R,G,B) value. There are 4 groups of RGB color range for each fertilizer. The result of NPK fertilizer color range is shown in Table 1. The result of Calcium fertilizer color range is shown in Table 2. The result of Potassium fertilizer color range is shown in Table 3.

Table 1. Result of NPK Fertilizer Color Range

No.	Total Fertilizer	Type of Fertilizer	Color Range (RGB)			Percentage	
			Red	Green	Blue	Success	Failed
1			40-60	60-85	70-95	0%	100%
2	25	NPK	40-80	60-110	70-120	88%	12%
3			40-100	60-135	70-145	96%	4%
4			40-120	60-160	70-170	100%	0%

Based on the data result in Table 1, the lowest accuracy of fertilizer detection at 0% with RGB color range (40,60,70) to (60,85,95). However, the highest accuracy of NPK fertilizer detection is 100% with RGB color range (40,60,70) to (120,160,170).

Table 2. Result of Calcium Fertilizer Color Range

| No.	Total Fertilizer	Type of Fertilizer	Color Range (RGB)			Percentage	
			Red	Green	Blue	Succes	Failed
1			140-148	120-143	20-40	0%	100%
2	25	Calcium	140-155	120-165	20-60	0%	100%
3			140-163	120-187	20-80	20%	80%
4			140-210	120-210	20-100	100%	0%

Based on the data result in Table 2, the lowest accuracy of fertilizer detection at 0% with RGB color range (140,120,20) to (148,143,40) and (140,120,20) to (155,165,60). However, the highest accuracy of Calcium fertilizer detection is 100% with RGB color range (140,120,20) to (210,210,100).

Table 3. Result of Potassium Fertilizer Color Range

No.	Total Fertilizer	Type of Fertilizer	Color Range (RGB)			Percentage	
			Red	Green	Blue	Success	Failed
1			20-53	50-83	0-5	0%	100%
2	25	Kalium	20-85	50-115	0-10	0%	100%
3			20-117	50-147	0-15	52%	48%
4			20-150	50-180	0-20	100%	0%

Based on the data result in Table 3, lowest accuracy of fertilizer detection at 0% with RGB color range (20,50,0) to (53,83,5) and (20,50,0) to (85,115,10). However, the highest accuracy of Potassium fertilizer detection is 100% with RGB color range (20,50,0) to (150,180,20).

Test results show fertilizer can be identified accurately 100% in the RGB color range (40,60,70) to (120,160,170) for NPK fertilizer, (140,120,20) to (210,210,100) for Calcium fertilizer and (20,50,0) to (150,180.20) for Potassium fertilizer. The test result is succeed if there is a square shape on the contour and it is colored on the contour. Examples of success test can be seen in Figure 3. And examples of failed test can be seen in Figure 4.

(a)   (b)   (c)
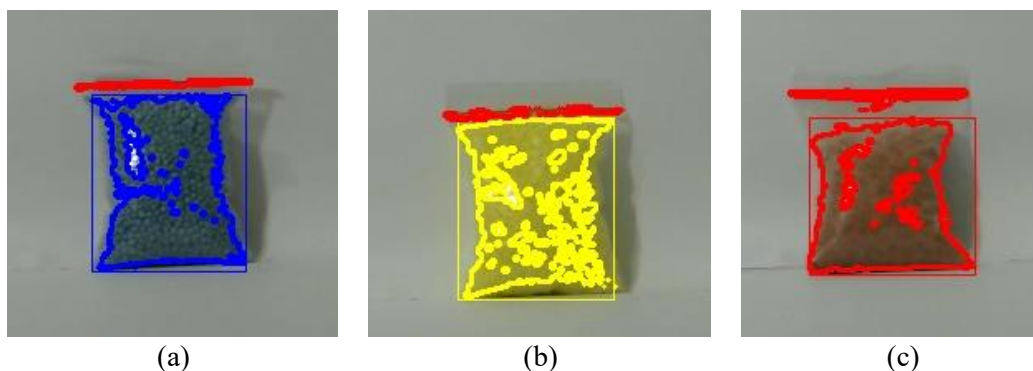
Figure 3. Success Test (a) NPK Fertilizer (b) Calcium Fertilizer (c) Potassium Fertilizer

(a)   (b)   (c)
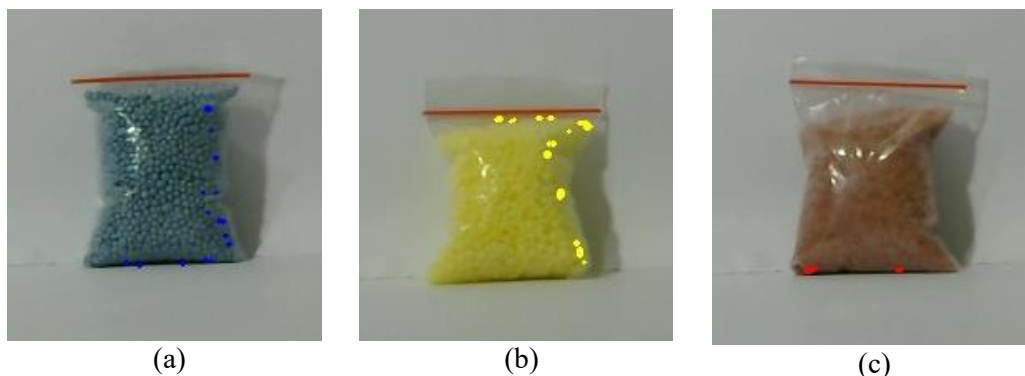
Figure 4. Failed Test (a) NPK Fertilizer (b) Calcium Fertilizer (c) Potassium Fertilizer

4. Conclusion

Computer vision techniques have been applied in industrial to support the automatic system production. This paper showed that computer vision can be obtained to support the food production industry to automatically classified 3 types of fertilizer. The fertilizer is classified based on the color that is detected through camera and the image is proceed by Raspberry Pi with computer vision technique program applied in the Raspberry Pi. Each fertilizer has a different color range of RGB channel. Based on the data result, the fertilizer can be identified accurately 100% in the RGB color range (40,60,70) to (120,160,170) for NPK fertilizer, (140,120,20) to (210,210,100) for Calcium fertilizer and (20,50,0) to (150,180.20) for Potassium fertilizer. This technique can be developed to a real time system with a conveyor to create an automatically fertilizer packaging in the term of Industrial Revolution 4.0 machine to machine communication.

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