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Apply Image Processing Technology in Product Classification Problem

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ABSTRACT
This article introduces the problem of product classification using image processing technology with the following main functions: first function, products are identified using image processing technology in AI (artificial intelligence). Second function, after being identified, products are classified and counted thanks to the combination of the ESP8266 microcontroller and the devices in the model.
Keywords: Image processing technology, ESP8266 microcontroller, Open CV.

I. INTRODUCTION

The application of science and technology is becoming more and more widespread, popular and highly effective in most economic and technical fields as well as in social life. The formation of flexible production systems, allowing high levels of automation based on the use of CNC machines and industrial robots. Image recognition technology has great potential for widespread adoption in various industries. One important step that affects product quality is product classification. Therefore, the application of image processing technology in product classification is necessary to meet the increasing needs of modern society.

IMAGE PROCESSING TECHNOLOGY

Image recognition or computer vision is a technique that seeks to automate all the work that a human visual system can do. Image recognition technology is a growing field. extend. Image processing is the core technique of computer vision, helping to develop many practical applications such as robots, self-driving cars and smart cameras, object detection, etc. Image processing allows converting and manipulating thousands of images at the same time, thereby extracting detailed and important information. Image processing has many stages. These include: image acquisition, image preprocessing, image segmentation, representation and tissue, recognition and interpolation.

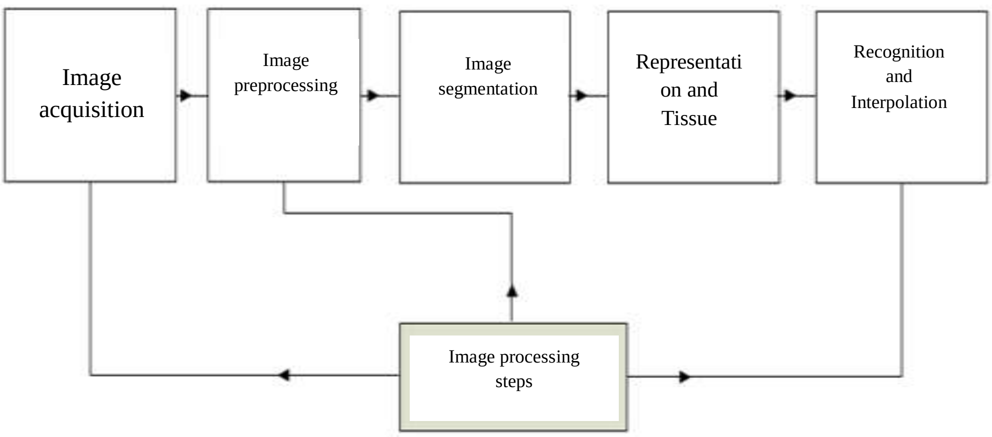

Figure 1.1: Image processing steps

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STEPS TO CLASSIFY PRODUCTS BY SHAPE

a. Acquire images

Image collection is the process where images can be acquired through the camera or can be taken from the system's memory.

b. Image preprocessing

Is the step of editing image quality, such as filtering noise or enhancing brightness, to improve image quality and convert images to grayscale for easy image recognition.

Gray image conversion: Suppose, your image is stored in RGB (Red-Green-Blue) format. This means that there are three gray matrices for the colors Red, Green, Blue, respectively. The job is to find a way to synthesize these three matrices into a single matrix. One of the popular formulas to do that is:

$$Y = 0.2126R + 0.7152G + 0.0722B \quad (1)$$

In which: Y: gray matrix to find; R: red-gray matrix of the image; G: green-gray matrix of the image; B: blue-gray matrix of the image.

Mean filtering: Suppose there is an input image with I(x,y) being the pixel value at a point (x,y) and a threshold θ.

Step 1: Calculate the sum of the components in the filter matrix (Kernel).

Step 2: Divide the average of the total elements in the matrix calculated above with the number of elements of the filtering window to get a value Itb(x, y).

Step 3: Calibration:

If I(x,y) - Itb(x,y) > θ then I(x,y) = Itb(x,y) (2)

If I(x,y) - Itb(x,y) <= θ then I(x,y)=I(x,y) (3)

Note: θ is a given value and may or may not be available depending on the purpose.

c. Edge separation and filling

Edge separation: is the process of eliminating unnecessary data to minimize resource use and ease computation. Edge separation is divided into steps: Noise reduction; Determine boundaries; Eliminate non-boundary data

Noise reduction: Since edge detection is susceptible to noise in the image, the first step is to remove noise in the image using a Gaussian filter:

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1	4	7	4	1
4	16	26	16	4
7	26	41	26	7
4	16	26	16	4
1	4	7	4	1

Figure 2.1: Gaussian filter

Determination of boundary: The smoothed image is then filtered with a Sobel kernel in both horizontal and vertical directions to get the first derivative in the horizontal direction (Gx) and vertical direction (Gy). From these two images, we can find the gradient and edge direction as follows:

$$Edge_{Gradient(G)} = \sqrt{G_x^2 + G_y^2} \quad (4)$$

After obtaining the gradient magnitude and direction, a full scan of the image is performed to remove any unwanted pixels that may not form an edge. For this, at each pixel, the pixel is checked if it is a local maximum in the neighborhood as per the image below:

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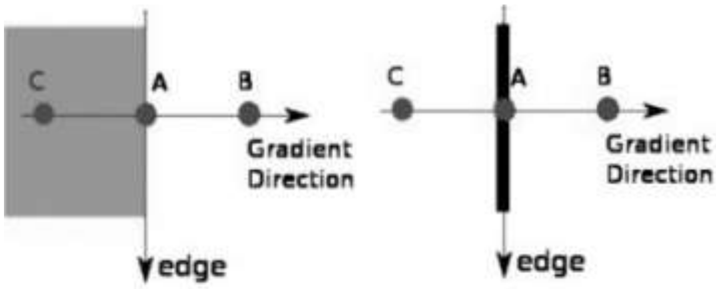

Figure 2.2: Determine the boundary

Points A, B and C in the direction of the slope. Therefore, point A is compared with points B and C to see if it is a maximum or not, if so then it belongs to the boundary.

Eliminate non-boundary data: This stage decides whether it is all edges, whether the boundary is really an edge or not. For this, we need two threshold values, minVal and maxVal. Any edges with an intensity gradient greater than maxVal are definitely edges, and edges below minVal are definitely non-edges, and are therefore discarded. Edges between these two thresholds are classified as continuous or discontinuous edges; if they are "definitely" connected to pixels, they are considered part of the edges. If not, they are also discarded.

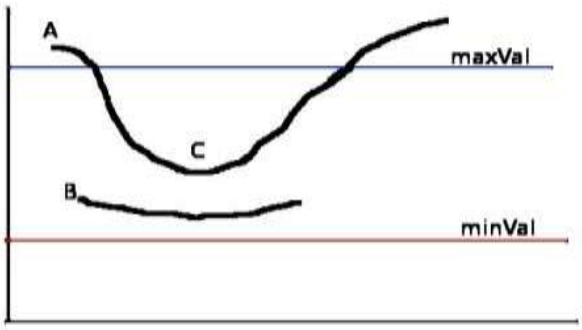

Figure 2.3: Border identification

Edge A lies on the maxVal value, so is considered a boundary. Even though edge C is below maxVal, it is connected to edge A, so is also considered a valid boundary and we get that full curve. But edge B, even though it is above minVal and in the same region as C's edge, it is not connected to any boundary on the maxval value so is not an edge hence it is removed.

Boundary filling: Is the process of filling closed boundaries, without interruption or breakage, to create a binary image with values 0 and 1. Level 1 is the value of the boundary filling shape, and inside The margin is considered to be the value 0

d. Product identification and classification

We identify the product based on the unique characteristics of each image, then we have the characteristics of the roof, the characteristics of the soup, and the characteristics of the radius. That is product identification. After obtaining the unique characteristics of each image as above. We can classify each product shape by comparing their unique characteristics. Let's compare each shape one by one, from square, to rectangle, to circle, to triangle. If the characteristics match the characteristics given before in any shape, we immediately conclude that the product has that shape.

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SELECTION OF EQUIPMENT IN PRODUCT CLASSIFICATION MODEL APPLYING IMAGE PROCESSING TECHNOLOGY

Main device: ESP8266 microcontroller, camera.

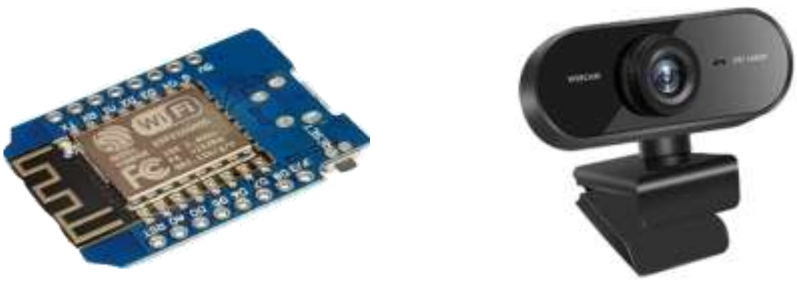

Figure 3.1: ESP8266 Microcontroller and Camera

Other devices: object sensor, servo motor, low voltage rectifier source, 12V DC motor, conveyor belt.

Figure 3.2: Other devices in the model

Working principle of the product classification system using image processing technology:

First, the product passes through the camera's capture area, where the product is photographed and undergoes the image processing step mentioned above, resulting in 3 different types of products.

Photos of each type of product are sent to the control computer, processed with PyCharm software, based on programming operations, signals are sent to the central microcontroller ESP8266.

At the central processor, the signal continues to be processed for each type of product. After processing the signal, the general manager will decide to send the signal to the sensor and Servo motor.

The round product will be pushed into the 1st tray.

The square product will be pushed into the second tray.

The triangular product will be pushed into the 3rd tray.

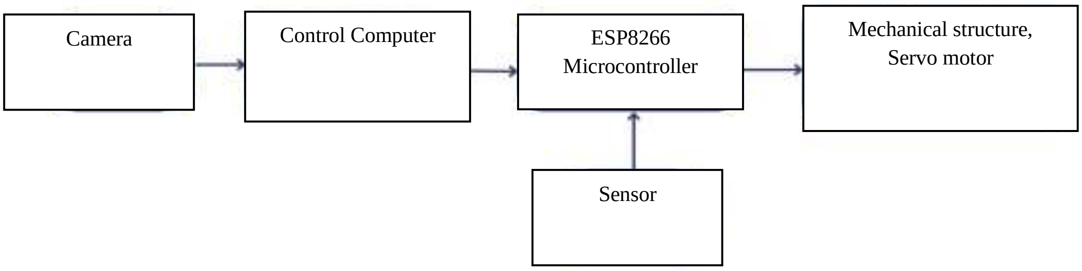

Figure 3.3: Working principle of the system

Design monitoring control software interface and actual model

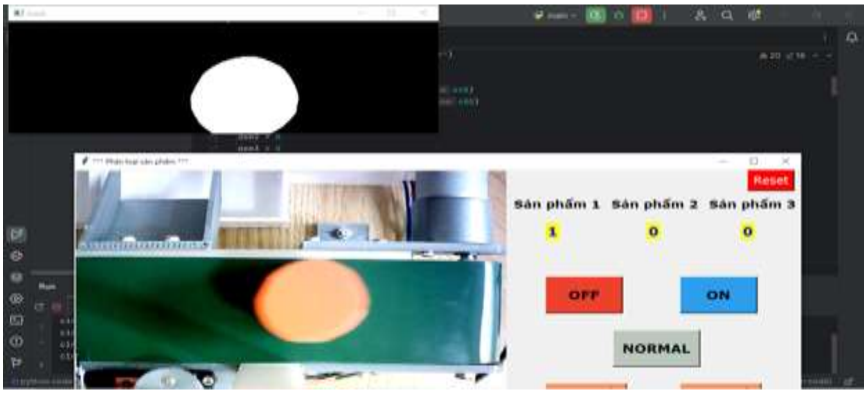

Figure 3.4: Monitoring screen interface with circular product

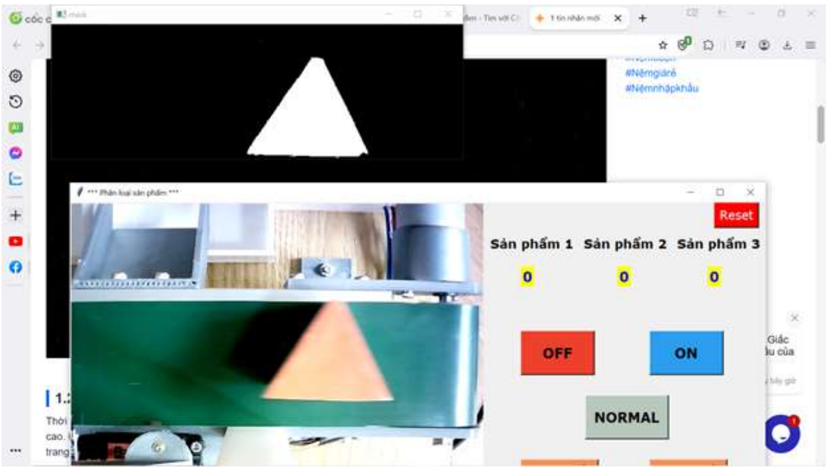

Figure 3.5: Monitoring screen interface with triangular product

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Figure 3.6: Monitoring screen interface with square product

II. CONCLUSION

After building the model and testing it, the hardware model worked well. Good identification of most proposed shapes of products, compact product count, easy installation, convenient for learning.

III. ACKNOWLEDGEMENT

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REFERENCES

[1]. **Nguyen Thanh Hai,** " Giáo Trình Xử lý ảnh"**, National University Press, Ho Chi Minh City, 2014**

[2]. **Doxygen,** "OpenCV-Python Tutorials"**, https://docs.opencv.org/, 2018**