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Product Sorting System In Checker Sorting Process Using The Template Matching Method

Joko Priambodo[1], Enny Indasyah[2], Fauzi Imaduddin Adhim[3]

[1-3] *Department of Electrical Automation, Faculty of Vocation, Sepuluh Nopember Institute of Technology ,Indonesia*
Jl. Teknik Kimia, Keputih, Kec. Sukolilo, Surabaya
[1*] joko.priambodo@its.ac.id, [2]enny_indasyah@its.ac.id, [3]fauzi@eea.its.ac.id

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Abstract

In supporting the production activities of a company, an infrastructure unit is needed that is capable of supporting the production activities of a company. Several companies that produce animal feed and processed food have problems related to the failure of the sorting process. The sorting process for checking packaged products is still carried out by human power, so errors often occur due to human negligence in sorting packaged products. Therefore a tool is designed to sort automatically and be able to distinguish differences from packaged products using image processing with the Template Matching method. Then, proceed with looking for accurate calculations using the Template Matching algorithm, which will help detect differences between packaging products A and B. The technique used in the method is the calculation of values using greyscale imagery and image segmentation with ten trials based on the labels on the template features used. After testing, the best accuracy results, namely 59% obtained on image segmentation.

I. INTRODUCTION

In one of the sorting checkers carried out by several companies, there were sometimes problems related to the failure of the sorting process, which resulted because there were several products that had differences in plastic packaging because the color and appearance were almost the same. Human power still carries out the sorting process for checking plastic packaging, so errors often occur due to human negligence in sorting plastic packages.

The process of sorting packaged products is still carried out by human labor, so errors often occur due to human negligence in sorting products. Packaged products in a confused state enter the distribution department, which disrupts product sorting and can cause losses because the sorting process is disrupted. It takes control of product sorting. Controlling a package is an effort to maintain the quality of the sorting produced to match the specifications set based on company policy. Technically, the control of a box aims to determine whether it is running according to plan, whether it has been carried out efficiently or not, and whether or not it is possible to make improvements.

[1] Corresponding author

Therefore, after the quality checker process, a sorting checker tool is needed to sort products based on color differences or images on the packaging. This tool can function as a sorting machine by sorting products in terms of color and physical packaging. Regarding packaging color, it can sort out products that enter into boxes and are ready to be sent to consumers.

II. RELATED WORKS

Previous research.

The author takes several references in the form of research that has been done before.

1. Journal entitled "Implementation of the Template Matching Method to Recognize Numerical Values on Scanned Banknote Images". Muria Naharul Hudan Najihul Ulum, Tibyani, and Sigit Adinugroho wrote this journal. It explains that humans already know paper money. Even computers have limitations in reading the image of money. The computer is an electronic one whose job is to receive and store input data, process it, and produce output stored in memory—cases of computers or robots that cannot recognize the numeric values of banknotes due to vision problems. The author provides a solution to support the application of banknote scanning tools using the template matching method. Template matching is an input image that matches the similarity of the test image. Based on the Template Matching Method designed by Data Training and Data Recognition. A series of tests used are Diagnostic Tests to calculate accuracy. So that the results average accuracy of 91% of the calculation of all Diagnostic Tests, therefore, outputting an error state in the face of the banknote. [1]
2. Journal entitled "Analysis of Using Template Matching Techniques in the Acquisition and Character Recognition of Vehicle Number Plate Image Characters". The journal written by Gurum Ahmad Pauzi, Warsito, Sri Wahyu Suciyati, and Sahtoni contains research on the acquisition and recognition system of characters on vehicle license plates is an application in computer science that can help process vehicle data processing systems. This system utilizes the image processing method, which is expected to improve the performance of the information system in the parking area. This character recognition system has several stages: taking plate images using a camera (capture), cropping, grayscale processing, threshold, negation, and scaling. The final process is introducing each character with the template matching method. [2]
3. The journal entitled "Defective Inspection System on Cans Using HSL Color Filters and Template Matching" was written by Budi Sugandi and Sintya Dewi, who discussed checking or inspecting cans for defects as an essential part of maintaining the quality of a product. Some of these inspections still use manual operators who depend on workers' eyesight with all their limitations. To overcome this problem, this article proposes a defect inspection process using HSL color filters and template matching based on contour analysis which is carried out automatically without operator assistance. The inspection process begins with taking RGB images with the camera. The RGB image is then converted to a gray-level image. The author uses a luminance filter from the HSL color space to detect defects. The template matching process is applied to each image by comparing the template image contour as a reference with the test image contour. [3]
4. The journal entitled "Application of the Template Matching Method in Color Images," written by M. Chair Solin, Garuda Ginting, Matias Julyus Fika Sirati contains research on determining color images that have resulted in an application that was initially thought to be difficult to become possible, such as encoding video sequences, video conferencing and facial recognition or identification. Although the determination of color images is easy to recognize by human vision, the automation of processing on a computer requires various image processing techniques. [4]

Basic theory.

Digital image processing

A design Image is a description of the object. Images have several color spaces, such as RGB, grayscale, YCbCr, HSV, and binary. This study only uses RGB and grayscale image types. Images are divided into

two, namely analog images and digital images. The difference between the two images is that the analog image needs to be converted first to a digital image, then processed by a computer, while a computer can directly process a digital image. Analog images are continuous images such as images on television monitors, X-rays, and ST scan results. At the same time, digital images are usually used in phone memory and laptops. Analog images are not equipped with a sampling system or quantization system.[5]

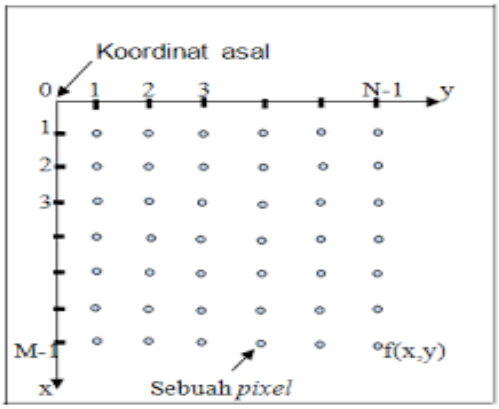

Fig. 1 Image Coordinate System

RGB image

RGB stands for the arrangement of the three main primary colors, namely red (R), green (G), and blue (B). RGB can be described as the computer's native color space for taking pictures and displaying them. In calculations in computer programs, the color model is represented by its component values. In RGB, each has a pixel value with a minimum value of 0 and a maximum value of 255 or 8 bits. The number of colors in an RGB image can be multiplied by the number of each component, namely R= 255 (8bit), G=255 (8bit), and B=255 (8bit), so that it can be called an image that has an intensity of 24 bits. Figure 2 is a representation of RGB images. [6]

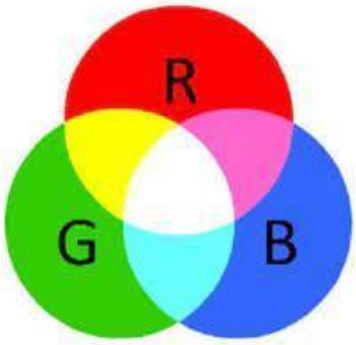

Fig. 2 RGB Image Coordinate System

Matching Templates

Template matching is a technique in digital image processing to find tiny parts of an image that match the template. Light energy from a shape hits the eye's retina and is converted into neural energy, which is then sent to the brain. Then there is a search among existing templates. If a template is found to match the pattern, then the subject can recognize the shape. After the match between the object and the template occurs, further processing and interpretation can occur. An example of template-matching processing can be seen in Figure 3.

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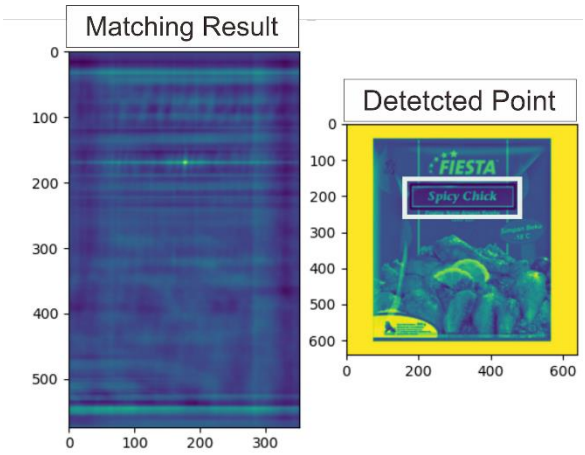

Fig. 3 Template Matching

The Template Matching Correlation Algorithm certainly has advantages and disadvantages. The advantage is that this algorithm is straightforward to implement into an application based on digital image processing. This algorithm also has a very high success rate of similarity. As for the weaknesses, the Template Matching Correlation algorithm has extensive calculations and data storage to match and get the desired results. As well as the Optical Character Recognition application requires quite a lot of training data to get maximum results because the more letters are trained, the greater the possibility of the similarity of the letters being matched.

The Template Matching Correlation algorithm will be described in the equation below.

$$r = \frac{n\sum XY - (\sum X)(\sum Y)}{\sqrt{(n\sum(X)^2 - (\sum X)^2)\,(n\sum(Y)^2 - (\sum Y)^2)}}$$

Where xi and xj are the averages of matrices i and j, which can be calculated by:

$$\bar{x}_i = \frac{1}{n}\Sigma_k^n = x_{ik}$$

$$\bar{x}_j = \frac{1}{n}\Sigma_k^n = x_{jk}$$

Information :

r = correlation value between two matrices
x_{ik} = the k-th pixel value in matrix i
x_{jk} = the k-th pixel value in matrix j
$\bar{x}_i$ = average pixel value of matrix i
$\bar{x}_j$ = average pixel value of matrix j
n = the number of pixels in a matrix

III. METHODS

The sorting machine for packaged products consists of a Raspberry Pi as hardware that is connected to the camera. Then the food product can be classified in quality. After that, it is displayed through the HMI on the laptop, which consists of all the components and a summary of how they work.

System planning.

This chapter will explain the process of designing and implementing an image retrieval system for packaged products and proceed to the template retrieval process. This design was carried out to ensure that the system can be appropriately used and to detect differences between product packaging A and B. The block diagram of the system in this study can be seen in Figure 4

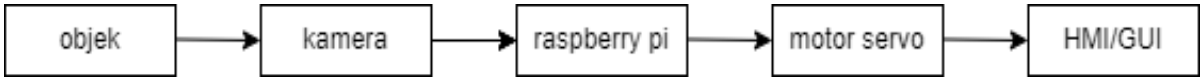

Fig. 4 Block Diagram Tool

System Prototype Design.

The design of the prototype tool using the SketchUp application.

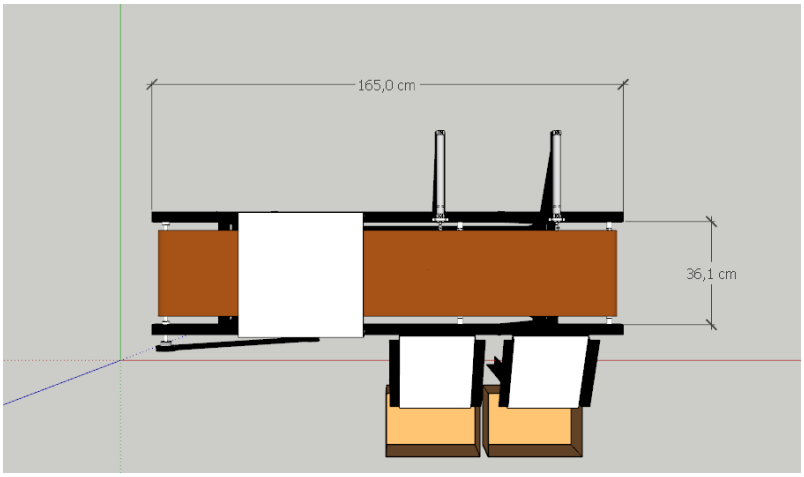

Fig. 5 Tool Design Top View

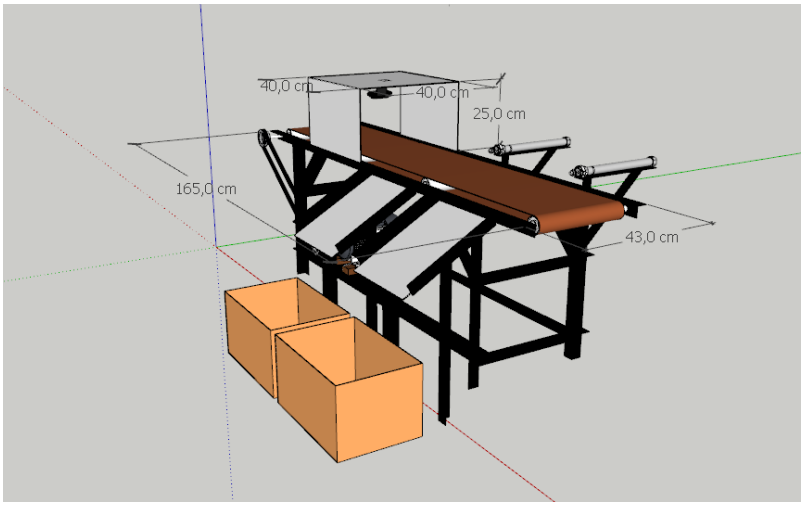

Fig. 6 Tool Design Side View

In the design of this tool, several components will be used, which will be directly installed on the conveyor, namely the camera, and the servo motor, which will be used as the actuator of the gate. In addition, there is a Raspberry Pi controller. There are conveyor belts. A camera is used to read the image of the packaged product, and there is an actuator in the form of a servo motor. And finally, there is a sorting box as a container for packaged products 1 and 2. The flowchart of the system can be seen in Figure 7.

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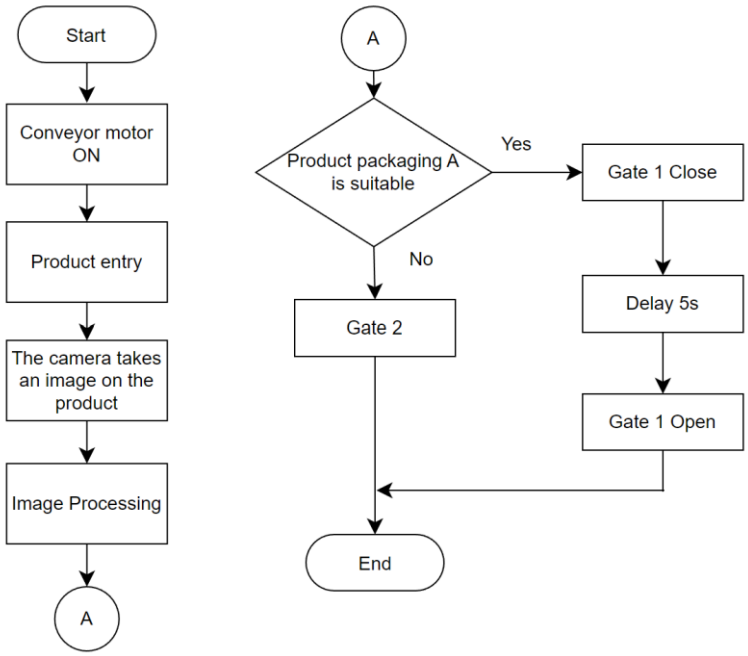

Fig. 7 System Flowchart

Tool working process:

1) Conveyor on
2) Packaged products enter the camera detection box
3) The camera takes a product image.
4) The results of taking the image of the packaging product will be processed and matched with the datasheet results in the datasheet file.
5) If the packaged product matches, the first gate will close to divert the packaged product into sorting box 1.
6) The gate will be closed for 5 seconds and then will open again.
7) And if the packaged product does not match gate 1 and remains open, then the packaged product will continue to go to gate 2 and be diverted into sorting box 2.

Software Design.

Software design will be carried out by programming the datasheet for sampling from the image of packaged product packaging. In software design, several discussions will be discussed. The first will discuss the creation of the main overall program on the system, in which the system can run well and produce the desired output results. Then in the next sub-chapter, namely the implementation of image capture on the datasheet.

Main Program Design.

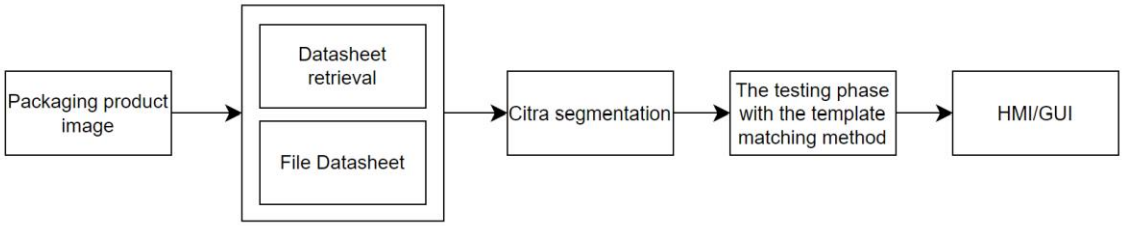

Fig. 8 Block Diagram Tool

This sub-chapter will describe how the overall process of the food product image processing system will be designed in the form of a block diagram. The early stages of creating the main program will begin with initializing the Logitech C270 camera. When these conditions are met, the initial step will be taking pictures, where the results will be converted into one datasheet file and continued at the pre-processing stage.

Pre-Processing Design.

The preprocessing stage takes the datasheet or initial data and labels each packaged product. Then character recognition will be carried out in the matching template.

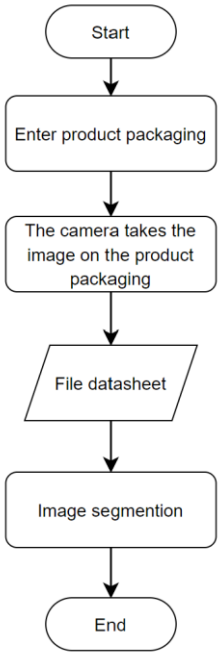

Fig. 9 Flowchart Pre Processing

Matching Template Design.

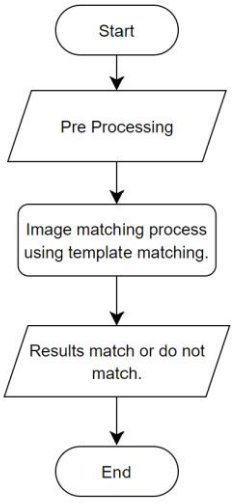

Fig. 10 Template Matching Flowchart

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This section is a crucial part of the success of product packaging matching.

System Prototype Implementation.

In the prototype implementation stage, the Product Sorting System Tool is the implementation of the prototype design stage.

Fig. 11 Implementation of Prototype Sorting Checker Machine

IV. RESULTS AND DISCUSSIONS

The results and analysis of the ten tests determine the calculated value of the suitability of packaged product A with packaged product label A on the template. The tests calculate the accuracy of two digital image processing, namely digital image processing using greyscale and digital image processing using background segmentation. This test is carried out by calling the image of the packaged product contained in the test data group, which has determined the features of the label to match it to the template—meanwhile, the image integration test takes results from acquisition through a Logitech camera in real-time.

Table 1. Greyscale Image Compatibility Testing

Non Segmentation			
No	Template	pengujian	Hasil
1			Hasil : Cocok Nilai Kecocokan : 0,618777036
2			Hasil : Cocok Nilai Kecocokan : 0,613974452
3			Hasil : Cocok Nilai Kecocokan : 0,631545662

The results of the accuracy test are the matching of the labels on the template and the values from digital image processing using greyscale.

Table 2. Test Results Using Greyscale Imagery

Template	Greyscale Testing	Result	Value
Label_NuggetStick1	NuggetStick_1.jpg	succeed	0.61
Label_NuggetStick2	NuggetStick_2.jpg	succeed	0.64
Label_NuggetStick3	NuggetStick_3.jpg	fail	0.13
Label_NuggetStick4	NuggetStick_4.jpg	succeed	0.61
Label_NuggetStick5	NuggetStick_5.jpg	fail	0.15
Result to match		rate	53%
		max	64%
		min	47%

Table 3. Test Results Using Image Segmentation

Template	Segmentation Testing	Result	Value
Label_NuggetStick1	NuggetStick_1.jpg	succeed	0.61
Label_NuggetStick2	NuggetStick_2.jpg	succeed	0.61
Label_NuggetStick3	NuggetStick_3.jpg	succeed	0.63
Label_NuggetStick4	NuggetStick_4.jpg	fail	0.19
Label_NuggetStick5	NuggetStick_5.jpg	succeed	0.69
Result to match		rate	59%
		max	69%
		min	47%

The results of the accuracy values obtained in Template Matching digital image processing use greyscale and segmentation with an average value of 53% and 59% by matching labels on the same template.

The accuracy in image processing for chicken nugget and nugget stick packaging products is very low, below 70%, with ten trials with labels on the same template caused by the factor of light reflecting on the plastic packaging products so that they are detected on the camera.

Comparison of Greyscale Image Accuracy and Image Segmentation.

A comparison of the performance results of Template Matching image processing using greyscale imagery and image segmentation with functions can be seen in the graph.

In this testing process, find out the comparison of results from chicken nugget packaging products and actual nugget stick test data and predictive results. Then the results are analyzed and taken to get the accuracy value of the system. Calculate the level of accuracy from the system calculation results using the equation below.

$$Accuracy = \frac{Appropriate\ Data}{Total\ Data} \times 100\% \quad (1)$$

The results of the accuracy using greyscale imagery for the accuracy of the detection of the compatibility of the two packaged products detect an accuracy of 53%. By using image segmentation, the detection accuracy on the compatibility of the two packaged products detects an accuracy of 59%.

V. CONCLUSIONS AND RECOMMENDATIONS

Conclusion

Based on the observation and testing of the tool as a whole or partially, the following conclusions can be obtained:

1. In testing the packaging of chicken nuggets and nuggets sticks, they only detect labels already available in the test data.
2. The best accuracy results were obtained from matching labels on chicken nugget and nugget stick packaging products, using image segmentation and getting a result of 59%.
3. The accuracy in image processing for chicken nugget and nugget stick packaging products is shallow, below 70%, with ten trials with labels on the same template caused by the factor of light reflecting on the plastic packaging products so that they are detected on the camera.

Suggestion

Based on the research that has been done, some suggestions are needed to help develop packaging product classification research for the future. The following are suggestions for this research that can be considered according to the author, namely:

1. Multiply the image capture test data on the object and create a label on the template that will be detected to match the results of the two images.
2. In future research, a processor with a larger capacity than the Raspberry Pi, such as the NUC, can be used. If you use a processor that has a larger capacity, it can result in faster computing times.
3. Light dramatically affects the testing process and accuracy, so use a closed box on the camera and make lighting such as adding lights so that the accuracy of the test results remains stable.

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