STRAWBERRY SORTING AND CLASSIFICATION SYSTEM TO INCREASE THE SELLING VALUE AND TO FACILITATE THE PACKING PROCESS USING ARTIFICIAL INTELLIGENCE

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Abstract – *Implementation and post-harvest sorting system are the most essential parts in agriculture and plantations; they lead to the quality and quantity maintenance of agricultural products. Some crops need to do grading and sorting techniques. Sorting functions to filter the type and quality of plants with a grading system and this method has also been carried out on potato, coffee and citrus plantations. In Indonesia, the sorting system is processed manually; so that the time process takes time and causes long queues when packaging. In consequence, the plantation products would be stored longer and it causes rotting process to the plantation products. In some developed countries, the sorting system is conducted with the computerized-system-assisted through the aid of optics or lenses stored on a conveyor machine. As the help of computer sorting equips with artificial intelligence methods; so that the computer is able to calculate and trade the types of plants. The results of plantations and even the system would be possibly able to recognize the types of diseases in plants. This AI technique has been applied in the sorting system of strawberry. The agricultural products of this fruit have a high selling value, the grading process is used to classify strawberry sizes in order to increase sales results with grading value parameters with Oblate, Globose, Conic, long Conic, and Conic. The parameters are assessed by size and whether there are defects in the fruit, so that the selling value is high, AI techniques has been proven to facilitate the process of sorting which capable of detailing each object's texture and more precision with an accuracy of 95%.*

Keywords: *Sorting and classification system, Selling value, Artificial Intelligence,*

I. INTRODUCTION

     The grading and sorting process are essential in the strawberries as goods that have selling point. Since it will increase sales compared to the small size and greatly affect the sales value seen from the same size. The sorting process is not only the size but seen whether or not the defect or shape is imperfect strawberries, which will affect the price and packing process. Sometimes we can find rotten strawberries due to fungus on the packaging due to an invisible defect. Strawberry fruit size has high selling value and into the export category.

     Potential sales of fruit commodities will continue to increase due to the elevating value and consumer awareness of nutritious food, then quality fruits are needed and must be available in large quantities and in various types and variation. The application of post-harvest processes is important to determine quality of the fruit. One of the results of agriculture is the sorting process;

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this process can be in the form of separation of shape, weight, size and color, the most important parameter is to determine the color, because healthy and ripe fruits have their own attraction in determining food quality, color sorting process and the same size will increase sales value and simplify the packaging process [1].

A method to improve the sorting system is to increase sales results; in this method was created in term of sorting process apples. To classify commodity values   and determine based on standards and quality parameters in the market. The sorting itself is a process based on physical characteristics such as determination of the amount of water content, shape, specific gravity, texture, color and sorting of foreign objects. The definite sophisticated sorting system capable of detecting chemicals and biological attacks caused by insects [2].

The sorting system is also useful for determining the indicators of the smoothness in plants that can change the taste and shape; for example, the measurement of apples using a system of maturity detection and color classification index [3].

One of the sorting methods has also been made on tomatoes, this application works using the help of image processing technology. Image capture is done by making a computer connected to a camera that will be used as a recording device, the sorting system can be connected with a mechanical drive, the mechanics work by recording a sensor that records attached to the sorting tool [4].

II. THEORETICAL BACKGROUND

The process of detecting defects in plants can be seen in the leaves that have spots that can be seen in the cross section of the leaf. This shooting technic uses a smoothing technique or by smoothing the object image, this technique uses the Gaussian method, from this stage the edge detection process is performed, at this process image produces a binary image display with black and white categories this process helps filter out more detailed information of an object, this image operation is also called morphology or called closing operation and then enters into the closing process which functions to separate objects from the background back [5].

Each object has a gray degree value and this data is taken in an image that has been conditioned before. On the object there is an RGB color and then the conversion results will only be displayed with a color code with a gray degree value of 0 and 1. It can be seen in the formula below.

$$I_{greyscale} = \alpha I_{col}(n,m,r) + \beta I_{col}(n,m,g) + \gamma I_{col}(n,m,b)$$

..(6)

Each data is presented on a pixel and background with a pixel value of 0. [6]

Fruit maturity sorting system is done with a direct observation with the help of a computing system, this technique works by connecting computers with installed cameras and processed with image processing techniques, the classification process can be done with the LVQ method (learning Vector quantization). This system has the ability and classifies several sample data. [7]

In object shooting, the sharpening process is used to improve image quality and reduce noise that occurs when shooting enhancement techniques have several stages, namely resizing technique. In this technique standardization process is carried out the size of the image taken by reducing pixel size or leaf shape of the object under study eg 4272 x 2848 then the size is converted to 170 x 170 pixels. so that the size becomes ideal and makes it easier in the computational process. The grayscale process is then performed by calculating the RGB color size. This grayscale technique is carried out to help the color gradation process and distinguish the original object from the shadow. [8]

In an agricultural field, technical intelligence techniques are able to adapt quickly and bring down new concepts, these concepts and methods provide more value with the help of computer engineering that changes a new business process and concept in agriculture. The results of this AI technology are able to add and provide new colors. In agriculture, AI methods are able to increase efficiency and add extraordinary benefits and AI applications can be implemented on any platform. [9]

Recently, modern technology has been able to exchange information technology or known as (ICT) information and communication technology, which with the help of computer data can be sent in any form, and this method has also been applied in agriculture or known as E-Agriculture. [10]

In other modern agricultural systems, it uses the advantages of the concept of data mining that is applied to classify and create a system clustering. A data mining method used to predict an agricultural yield and predict the state of the weather, whereas for applications can use tools that are sold open source, with the application can be implemented by opening a map of the location where the farm is different. [11]

The implementation of three computerized techniques, together with combining computer vision and machine learning methods can be implemented in overcoming problems in the field of present applications. Which is used to predict and classify types of diseases in plants. [12]

III.   RESEARCH METHOD

At this stage is the grading process with the method of recognition system using image processing assistance. The grading system uses the help of AI, the application will display the grading and defects found during the sorting system, among other things.

1.   *Calibration*

At this point, the calibration process is performed on the camera system. This process is useful to determine the distance from the object under study so that the data and images that are processed are not different. It settings start from setting the number of pixels and the lighting system on the camera.

2.   *Acquisition*

This technique is necessary in determining the distance of the object under study with the background in the drawing area. It uses background by the same color and has been patented and the position of the camera in a static position which is not moving.

3.   *Grayscale*

By using this technique, the process of processing data from colored objects to greyscale the process is purposed to determine the presence of defective objects or not indicated by a different color.

4.   *Image Identification Recognition.*

The technique is the final process by identifying object types and the presence or absence of defective parts by comparing different datasets. The more training data used, the higher the level of accuracy in reading the system.
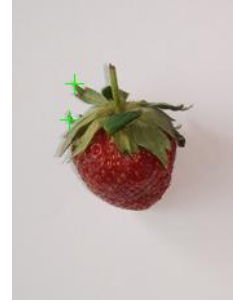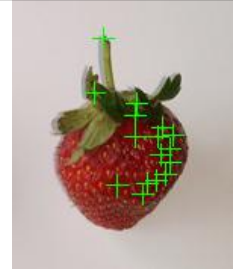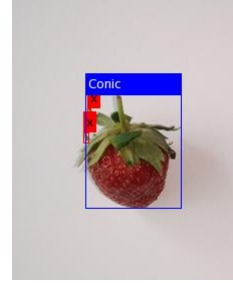
Table 1.1 Strawberry Variants

No.	Variants	Characteristics
1	*Oblate*	Smaller size and more rounded.
2	*Globose*	The size of a strawberry is more similar to the size of a circle.
3	*Globose Conic*	The size of the strawberries is classified as medium and the size becomes larger than Oblate and Globose.
4	*Conic*	The size of the strawberry goes into a large size with a slightly large shape.

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5	*Long Conic*	At this size, strawberries are classified into a large size and into type I grade.
6	*Necked*	This types included in the category of superior types and have a large size.
7	*Long Wedge*	This is categorized into large size strawberries and classified as export quality.
8	*Short Wedge*	Strawberry size is almost the same as oblate and into small sizes.

Table 1.2 System Testing

Proses Sortasi	Keterangan
	In this process, the system creates a color gradation technique by changing it to black and white. The process turns to classify into an image acquisition process so that the image capture size will be made. And the pixel size taken is the default setting.
	This process is identified as the greyscale process. This stage is the process of reading the main object; so it is not affected by background, and the value is converted into gray degrees that is 0 black and 1 to white.

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	The third process is the texture detection stage. It has function to analyze whether there is a defect by looking at changes in shape and color. The system will automatically provide marking.
	In the picture beside is a defect detection process on fruit objects. This detected system tries to detect color, size and shape.
	On the side is the final process of the sorting system, the system provides strawberry type labeling and gives a red mark if found defect.

IV.   IMPLEMENTATION AND TESTING

In this system testing, the testing process is carried out by using several strawberry samples that are used randomly.
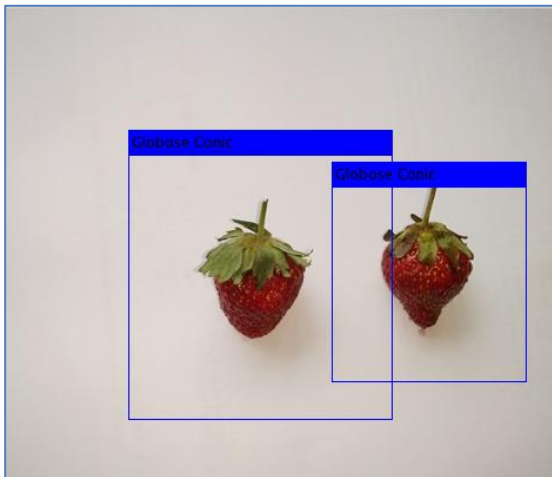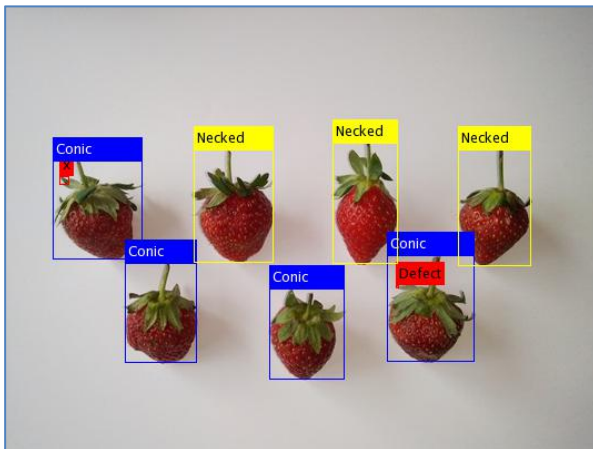

Information:

The picture above is the process of detecting strawberry using image processing techniques with the help of AI on a system displaying visual data type of *globoconic* with almost the same size and color
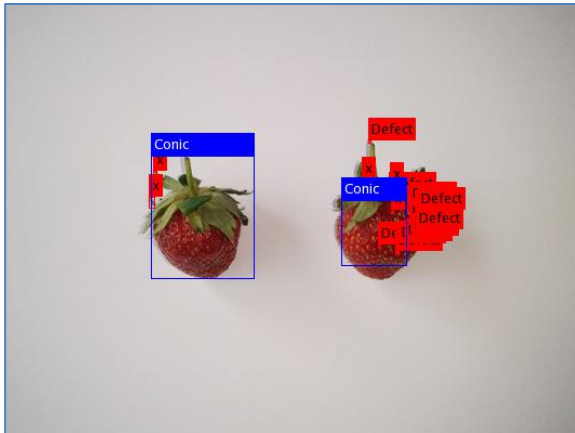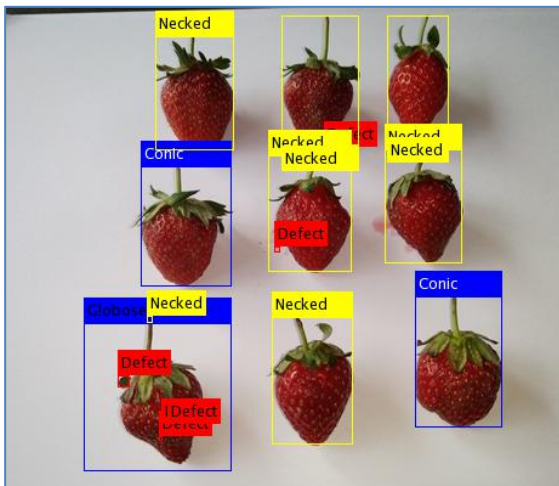

Information:

The picture shows the type of *conic* strawberries. In both fruits, there are several defects and classified into second grade.

Information:

The picture shows a random fruit detection process. The application is able to recognize the type of *conic* and *necked* strawberry. In the *conic* type found defects in the leaves and at the tips of the fruit.

Information:
In the picture above, testing on AI in a larger sample strawberry. The system is able to display three types of strawberry and find defects in some fruits caused by mold and rot; so that the appearance of the fruit is not perfect.

V.   CONCLUSION

Based on the experiment and research result, it can be concluded that the sorting system using Artificial Intelligent (AI) techniques and computer vision can be implemented and has a high accuracy value. The detailed equivalent system can display data visually from objects that are selected and can be applied to objects randomly and with the type of strawberries that are vary with accuracy between 80 - 95%. For further research, accuracy can be increased more by elevating the amount of training data used and using higher pixel resolution and better color sharpness.

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