Image Processing Based an Olive Separation Machine

M. Kuncan*, H. M. Ertunç*, G. Küçükyıldız*, H. Ocak*, S. Öztürk**

*Kocaeli University, Dept. of Mechatronics Engr. Umuttepe Campus, Kocaeli, Turkey, 41380, E-mail: melih.kuncan@kocaeli.edu.tr
**Kocaeli University, Dept. of Electronics and Telecommunications Engr. Umuttepe Campus, Kocaeli, Turkey, 41380

Abstract

In this study an image processing based olive separation machine was developed. Mechanical and electronic of the machine was designed such this purpose. In mechanical design, air valves were used for separation of olives. The air valves were controlled with a designed electronic card according to results of the image processing algorithm. Position of detected olives was switched with air. U-eye UI-3240-CP C camera was integrated to the system for image processing. Image processing algorithm was developed and optimized in Visual Basic 6.0 environment. Results of image processing algorithm were sent to electronic card via serial port. Developed image processing algorithm could process 30 frames per second. Based on the image processing algorithm the system could separate 30 olives per second which is satisfactory for real time operation.

KEY WORDS: image processing, real time operation, olive separation, industrial agriculture, HSV Color Space.

1. Introduction

By developing technology, necessity of new applications in industrial agriculture was occurred during years. Technological devices, which can process more effective than labor force, were developed for this application area. Many different type of automation systems were developed for the requirement of varying application areas, in industrial agriculture. Automation systems have many advantages such as high precision, high process capability, non-contact detection etc. Image based systems became popular at industrial agriculture in recent years [1-3].

In Turkey olive is farmed mostly in Aegean region because of its geological position. After the harvest, olives are separated by labors according to their color. About one ton of olives could be separated by five labors in a day. The developed system can separate about 30 tons of olives in a day. On the other hand, hygiene is very important in food sector for human health. The developed system offers a more hygienic and fast solution to olive separation process than un-reliable manual separation of olives. Developed system gets more accurate results than a human based system.

In literature various image processing based system was developed. Shah Rizam M. and his team developed a watermelon ripeness detection system based on image processing and ANN. They used YCbCr Color space instead of RGB color space. After the pre-processing of the images, they determined the sum of each color chrominance (Cb and Cr) as a feature. They detected ripeness of watermelon with % 86 accurate [4]. Yanzu Zahoo and his team developed image processing based pear external quality system. They developed an image processing algorithm for detecting shape, color and surface defect. They used HSI color space instead of RGB color space for detecting color. They used histogram of Hue value of each images for detecting the color [5]. Xu Yuanfang and his team developed an image processing based system which monitors maize leaf nutrition [6]. As a pre-processing operation they used a median filter (3*3 template) for smoothing the images. After median filtering, they used white balance algorithm for white background restoring image’s white background into pure white. For color detection, they used the mean and standard deviation of each color channel (R, G, B) for a feature. After the feature extraction, they used regression analysis for detection of maize leaf nutrition.

In this study, olive separation was examined. A set-up was designed for that purpose and the developed image processing algorithm was tested with the set-up in real time. It was observed that the algorithm performed successfully and detected the olives.

2. Design of system

In this study, olive separation system was developed. Mechanical and electronic design of system was developed with considering the system constraints.

2.1 Mechanical design

Mechanical part of system was designed at SolidWorks environment. Mechanical part consists of motors, valves, five independent tumbler. 15 olives were placed at each tumbler. 75 olives could be placed in the system at same time. Designed mechanical system was and it’s produced form was given in Fig. 1.
2.2 Electronic design

Electronic controller card of system was designed at Altium environment. Electronic part consists of a microcontroller and darlington transistors. Supply pins of each valve connected same line and ground pin of each valve connected to transistor outputs. When data arrived to controller via serial port, controller opens or closes related valve according to the command. Schematic design and its printed form of designed circuit were given in Fig. 2.

3. Image Processing Algorithm

3.1 Camera

In this study U-eye UI-3240-CP C camera was used for image acquisition. A 4.2 mm Azure lens was integrated to camera for improving its field of view. Properties of used camera were given in Table 1.

<table>
<thead>
<tr>
<th>Camera Properties</th>
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<tr>
<td>Optical class</td>
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<td>Interface</td>
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<td>Resolution</td>
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</table>

3.2 Image pre-processing

Median filter was applied to gathered image as a pre-processing operation for smoothing the image and removing the noise on image. After the filtering operation, format of the image was changed from RGB to HSV. HSV
color space is used frequently in color detection algorithm because of its cylindrical form. RGB and HSV color spaces were given in Fig. 3.

![HSV and RGB color spaces](image)

Fig. 3 HSV and RGB color spaces

After this color space conversion a pre-determined threshold was applied to the image. Sample image before and after pre-processing was given in Fig. 4.

![Frames before and after pre-processing](image)

Fig. 4 Frames before and after pre-processing

3.3 Feature extraction

After the pre-processing operation a threshold applied to image. This threshold was determined used the Hue histogram of image. A sample image and its Hue histogram was given in Fig. 5

![A sample image and its HUE histogram](image)

Fig. 5 A sample image and its HUE histogram

Connected component labeling algorithm was applied to the image and each green olive in a tumbler was detected. After that mean value of HUE channel at detected olive was selected as a feature. Basic Euclidean distance
between detected olive image and sample olive image was calculated. If Euclidean distance of detected olive is greater than a pre-determined threshold, related olive can be assumed as green.

3.4 Detecting the position of colored olives

Olives were placed equally spaced on each tumbler. Position of olive which has minimum row index in the tumbler was assumed as starting position. Positions of the other olives were detected depending on the row index. Valves mounted on mechanical system at related position were opened by electronic card according to received data. Sample image and detected olive positions were given in Fig. 6.

4. Conclusions

In this study an image processing based olive machine was developed. Green olives were separated from other colored olives. Basic Euclidian distance was used for detecting of green olives in image processing algorithm. It was observed the developed image processing algorithm is not robust against disturbances such as un-stable light conditions and shadows. In future, it is planned that algorithm will be made more robust with revisions. Background subtraction will be added to image processing algorithm to detect olives. In addition to background subtraction, at feature extraction other parameters max and min values of Hue channels will be added in the feature space and Mahalonobis distance will be used instead of Euclidian distance to increase robustness of algorithm.

In addition to software revisions, mechanical design of system will be revised. It is planned that developed system will become an industrial machine with mechanical and software revisions.

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References