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Design and Implementation of Automated Prototype for Classification of Peach

Javier Eduardo Martínez Baquero
Professor, Faculty of Basic Sciences and Engineering, University of the Llanos, Villavicencio, Colombia.

Luis Alfredo Rodríguez Umaña
Professor, Faculty of Basic Sciences and Engineering. University of the Llanos, Villavicencio, Colombia.

Robinson Jiménez Moreno
Professor, Department of Mechatronics Engineering, Nueva Granada Military University, Bogotá, Colombia.

[1,2,3] *Orcid,0000-0003-4377-7867, 0000-0001-7346-5640, 0000-0002-4812-3734*

Abstract

This article shows the design and implementation of a prototype for peach classification machine by size and maturity state, which tries to reduce errors in the classification of the fruit in its collection stage, increase the amount of fruit in the correct state of maturity without go through premature maturation events and improve the quality of the working conditions of the personnel involved in the classification process. The prototype is developed to be used as a test in the company Frutos del Paraíso, dedicated to the production and commercialization of peaches, wanting to improve its classification model to increase productivity and reduce classification error, which leads to improvements in income.

Keywords. Digital Image Proccesing, Design, Classification machine, Automated system

INTRODUCTION

Globalization and development have led to a high demand for peach, so it is important to increase production quickly, improve product quality, implement good practices for managing the post-harvest of the fruit and reduce costs to compete in national and international markets and optimize the income of farmers and producers in the sector [1].

Actually, the micro-companies producing fruit collect, select and separate according to their size (weight and maximum, average or minimum diameter so that it reaches the consumer). In order to comply with the above, it is necessary to modernize the way of production and commercialization of the product.

Automation systems and technologies are implemented to operate machinery and control productions, avoiding the use of personnel in jobs that represent a risk to their health and well-being [2].

The new technologies are significantly transforming the user experience and modifying the production processes, with the aim of making a transition in the transformation of jobs creating new work roles in companies. The set of man-machine allows to obtain a greater performance in the business activity. The integration of machines in productive aspects allows human beings to devote more time to interpersonal relationships. Virtual assistants work hand in hand with people, assuming a series of functions that free humans from their tasks and allows them to provide better services [3].

About 60% of professions remunerated in the global economy have a minimum of 30% of activities that can be automated. Although these percentages vary according to the categories of activities, among the most automatable are agricultural activities, as well as transport and storage and mining activities [4].

The article is divided into 3 main sections, where the first section is called "Methodology", containing system stages, system design, Design and structural modeling of the prototype, Software design for digital image processing. The second section called "Results and discussions" refers to the comparison of the current system with the automated system and finally “conclusions”, where the findings are exposed after the development of the article.

METHODOLOGY

The first versions and models of Programmable Logic Controllers (PLC) were expensive, difficult to program, with relatively little memory and almost no peripherical elements. Already in the 80’s these improved, both in price and in benefits, but even the programming was difficult to perform, which meant that only a small group of specialists was trained to put it into service and maintenance [5].

An automated system is made up of elements or instruments, which are used to measure physical variables, exercise control actions and transmit signals. In all processes it is absolutely necessary to control and maintain certain quantities constant [6].

Real Spanish Academy defines Automatic as the discipline that deals with methods and procedures whose purpose is the substitution of the human operator by an artificial operator in the execution of a previously programmed physical or mental task [7].

The methodology used for the implementation of the peach classification system is divided into four phases which are developed sequentially following the order shown in figure 1:

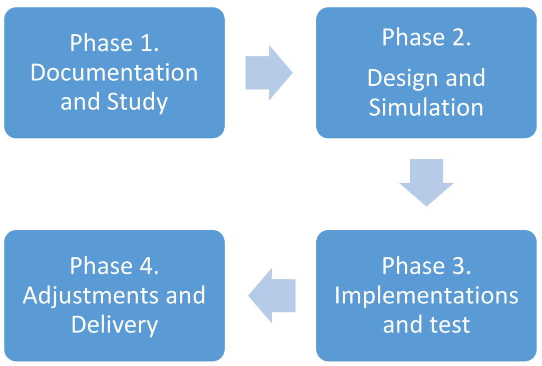

Figure 1. Methodology Diagram

Figure 2 shows each phase of the system and its block diagram.

Phase 1. Supply: Peaches are placed in a supply hopper and fall on the rollers of the conveyor belt.

Phase 2 Analysis: The rollers will transport the peaches to a closed section that will have an HD camera for the capture of the fruit in different angles, these captures are analyzed in a software that has been previously designed and performs the appropriate classification.

Phase 3 Selection: Finally the fruit goes through a section that has infrared barrier sensors that, when the fruit passes through, with prior classification, activate the device that opens the door to the dispatch trays.

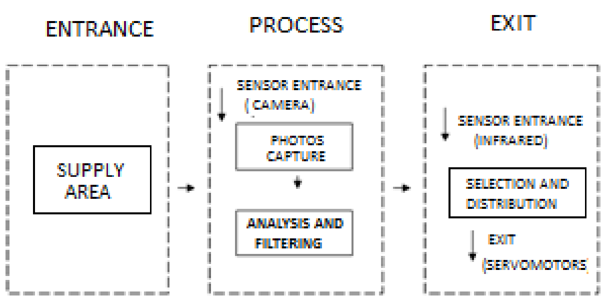

Figure 2. Block Diagram of the system

In final control elements it is important that the final control element works in a stable manner and has a good behavior [8].

The present work, a detailed study was carried out of the product to be treated, the harvesting and post-harvesting process, in addition to each of its types of classifications according to size for commercialization. The physiology and biochemistry of the maturation of the fruit of time, the changes in the color and the index of non-destructive maturity were studied.

An important aspect consisted in the study of the different classification machines of the fruits that are on the market, analyzing their characteristics, the guides of the peach classification machine.

Figure 3. Commercial classification machines

Currently, the company Fruto el Paraíso performs the calibration of their fruit manually, and have a standard for peach calibration at the time of being classified for marketing and distribution nationwide.

Table 1 shows the calibration data and fruit standards.

Table 1. Quality parameters by category for peach calibration

CATEGORY	DIAMETER (mm)	FRESH WEIGHT (g)
Extra (E)	>70	186+-13
First (P)	60-70	145+-17
Second (S)	50-60	99+-12
Industrial (I)	<50	69+-12

SYSTEM DESING

Design process of the automated prototype is described below.

Loading hopper

One of the first elements present in the automated prototype is the loading hopper, in which the fruits will be located to begin the selection process. As can be seen in figure 4, a simple design in stainless steel is presented.

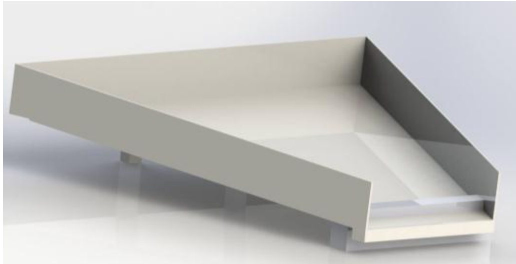

Figure 4. Loading hopper

Motor speed control

Motor speed control was carried out by implementing an RC circuit and Silicon Controlled Rectifier (SCR).

The RC circuit produces a shift of the phase between the voltage of the input and the voltage in the capacitor. The power supplied to the load is controlled by varying a potentiometer. The resistive value can vary and thus produce an adjustable phase shift, which will cause the power delivery to the load to also be variable. The diode in the thyristor gate is used to block the gate voltage during the negative cycle (180° to 360°). Once the circuit is experienced in the prototype, adjusted to the values of the components, the printed circuit is processed. Next, the circuit is shown in figure 5.

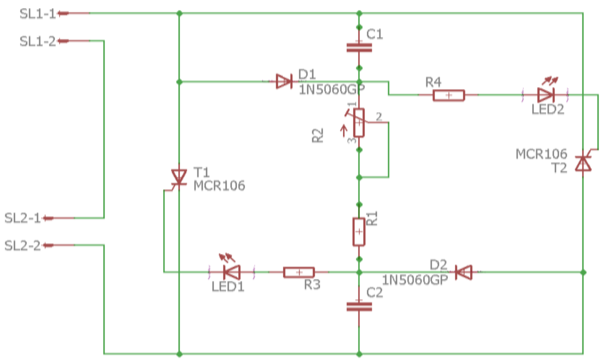

Figure 5. Motor speed control Circuit

Pulley system

Implementation of the pulley system used in the classification machine that generates impulse to the rollers, a simple transmission system was used, as shown in equation (1)

$$d1.n1 = d2.n2 \quad (1)$$

From equation (1), d1 refers to diameter of the drive pulley; d2 diameter of the driven pulley; n1 speed of rotation of the drive shaft and n2 speed of rotation of the driven shaft.

The transmission ratio (i) is equal to the output speed over the input speed. When the transmission ratio is less than 1, it is a reducing system. See equation (2).

$$i = \frac{n2}{d1} = \frac{d1}{d2} \quad (2)$$

Diameter of the drive pulley used in the simple transmission system is smaller than the diameter of the driven pulley, whereby the speed of rotation of the driven shaft is smaller than the driving shaft being a reducing system. Figure 6 shows the assembly of the rollers and figure 7 Pulley Desing.

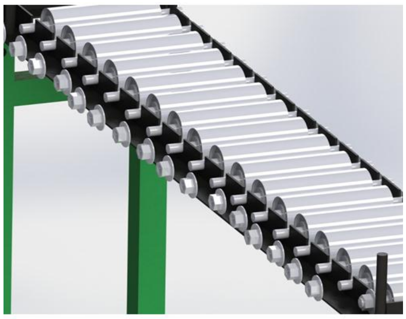

Figure 6. Roller assembly

Figure 7. Pulley Design

Brightness control

LED lights were implemented, a digital sensor BH1750 was installed which measures the light levels. On the other hand, the algorithm for the control of the luminous intensity that existed in the box was made and it affected the appropriate taking of the photos that were going to be processed in the software. Figure 8 shows the section of the box with the installation of the HD camera for capturing photos of the fruit and LED lights.

Figure 8. LED lights and HD camera

Figure 9 shows the circuit used to vary the light intensity of the LED strip used. Arduino One, a resistor, a transistor and a voltage source of 12V DC were used.

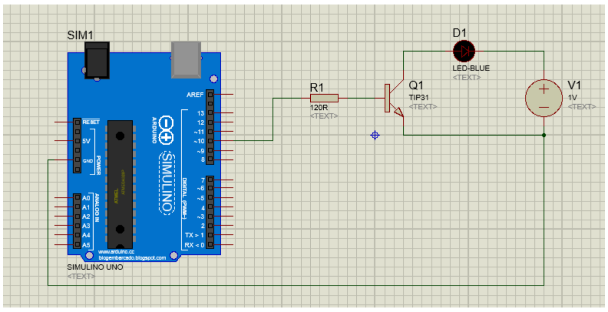

Figure 9. Brightness control circuit

The appropriate luminosity control test was carried out to capture photos to the peaches. Figure 10 shows the system without light control. It is evident that without brightness control the clarity in the photos is lost and it is not possible to carry out an adequate digital image processing.

Figure 10. System without brightness control

As seen in figure 11, the color tones of the fruit are better defined after applying the light control system, which leads to a better fruit selection result.

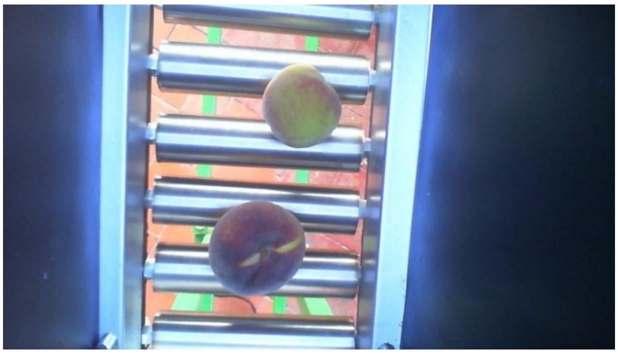

Figure 11. System with brightness control

Design and structural modeling of the prototype

The design of the machine was made in SolidWorks®, which includes the modeling of the rollers, supports, transmission shafts, analysis section box and distribution section with the dispatch trays.

Figure 12 shows the final design of the peach classification machine, observing each of the stages of the automated system.

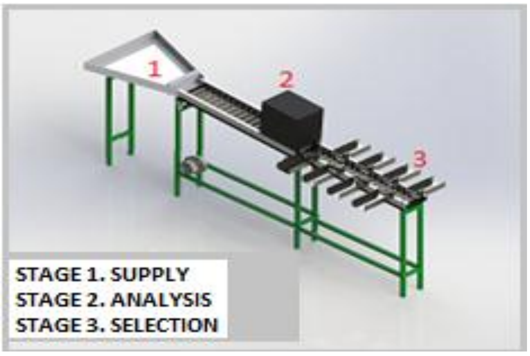

Figure 12. Final Design for classification machine

Software Design to Digital Image Proccesing

Use of sensors in technology, both in the industrial and domestic field, has become usual the measurement of mechanical, thermal, electrical and chemical magnitudes in sectors such as automated industries, robotics, experimental engineering, energy saving, environmental control, automobiles, appliances, computers, are tasks that would be unthinkable without the application of sensors [9].

To elaborate the software which does digital image processing, the Python programming language connected with the Raspberry Pi 2 card was used. On this card the camera is connected which takes the capture of the fruits while they pass through the rollers that they transport them.

The flow diagram of the software designed is described in figure 13.

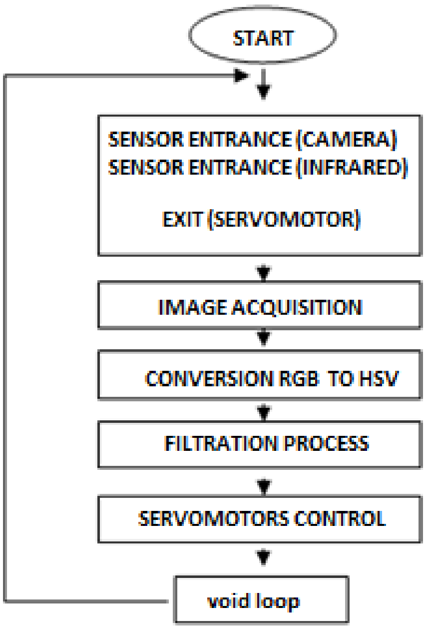

Figure 13. Software Block Diagram

Figure 14 shows the process in which the image is captured, the conversion RGB to HV and the filtering process performed by the designed software, with this the system determines the classification of the system, according to its size and state of maturity.

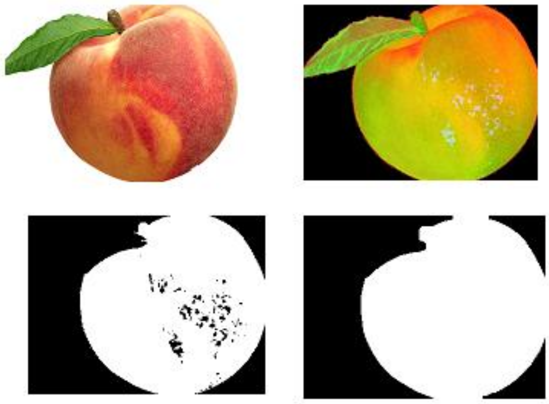

Figure 14. Image input - conversion RGB to HSV - filtering process

RESULTS AND DISCUSSIONS

As can be seen in tables 2 and 3, there is a considerable reduction in fruit losses at the time of selection.

Table 2 shows fruit losses due to poor selection due to the manual process currently performed.

Table 2. Losses of the fruit due to poor selection with the current system

CATEGORY	QUANTITY (Kg)	LOST (Kg)
Extra (E)	50	4.74
First (P)	50	7.2
Second (S)	200	32.31
Industrial (I)	250	21.55
TOTAL	550	65.8

As can be seen in table 3, there was a considerable decrease, more than half of the fruit in losses by classification with automated system in relation to manual system.

Through the manual selection process there is a total loss of 65.8Kg, compared to 30.13Kg of loss with the automated prototype.

Table 3. Losses of the fruit due automated system

CATEGORY	QUANTITY (Kg)	LOST (Kg)
Extra (E)	50	2.1
First (P)	50	4.33
Second (S)	200	15.6
Industrial (I)	250	8.12
TOTAL	550	30.13

Another important aspect in the prototype is the reduction of the fruit classification times. In a sample taken from 550Kg the manual classification of the fruit took approximately 5 hours. Using the automated system for the same sample, the classification was achieved in 1.38 hours as shown in figure 15.

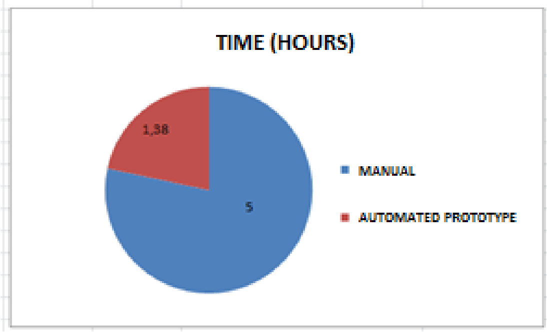

Figure 15. Time selection

CONCLUSIONS

Automated system were able to reduce the errors when making the selection of peaches, this thanks to the manual classification of the fruit was tedious and tiring for the person engaged for this activity and fatigue and other associated factors produced small errors at the time of classification.

Each system integrated into the peach classification machine allows the operator to accurately calibrate the size of the fruit avoiding the errors that are generated when the calibration is done manually.

The form of the used hopper adjusts to the needs of supply of the system, because it allows to use all the volume of the same to be filled with the fruit.

Digital Image Processing and implementation of digital filters has achieved that the algorithm used for the calibration of the fruit and the classification by state of maturity present a minimum error with respect to other methods conventionally used for this type of process.

Distribution phase offers the advantage of being able to select between different fruit categories according to the maturation and size characteristics which is a distinctive advantage of the process thanks to the fact that commercialization standards can be met.

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