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Automated Sorting System for Tahiti Lemons Using Raspberry Pi

Carlos Janampa Paitan
Jose Elias Flores Llallico
Brayan Freddy Orellana Garcia
Herbert Antonio Vilchez Baca

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Autores:
1. Carlos Janampa Paitan – EAP. Ingeniería Industrial
2. Jose Elias Flores Llallico – EAP. Ingeniería Industrial
3. Brayan Freddy Orellana Garcia – EAP. Ingeniería Industrial
4.Herbert Antonio Vilchez Vaca – EAP, Ingeniería Industrial

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Automated sorting system for Tahiti lemons using Raspberry PI

Carlos Janampa-Paitan
Department of Industrial Engineering
Universidad Continental
Huancayo, Peru
46844016@continental.edu.pe

Jose Elias Flores-Llallico
Department of Industrial Engineering
Universidad Continental
Huancayo, Peru
70063535@continental.edu.pe

Brayan Freddy Orellana-Garcia
Department of Industrial Engineering
Universidad Continental
Huancayo, Peru
75734688@continental.edu.pe

Herbert Antonio Vilchez Baca
Department of Industrial Engineering
Universidad Continental
Huancayo, Peru
hvilchez@continental.edu.pe

***Abstract*— According to FreshFruit in the period 2023 the production of Tahitian lemons was 13 515 tons for USD 14 million being one of the most important citrus fruits in the Peruvian economy. This work develops an automated system for the classification of Tahiti lemons by size and maturity grade from green to yellow. For the simulation of the classification of Tahiti lemons by size from 3 to 6 cm, the bottleneck was determined by direct observation and then the mechanical system was programmed for the classification by size and degree of maturity through the detection of color by HSV to classify Tahiti lemons greater than 10% damage or by maturity, and then obtain the simulation in Factory IO and TIA PORTAL with connection to PLC S7-1200 1214 DC/DC/DC and a HMI TP700. Finally, the grading proposal was implemented in which 100% of the Tahiti lemons were recognized and packed for export through the interactive HMI screen, being able to classify and count them automatically, which has a graphical environment for the operator to manipulate them.**

Keywords—Automated Selection, Colour Filter, Image Segmentation , Bottleneck, TIA PORTAL.

INTRODUCTION

According to FreshFruit, in the period 2023, Tahitian lemon production totaled 13,515 tons for USD 14 million, making it one of the most important citrus fruits in the Peruvian economy [1]. Peru has a 55% export share of citrus to the United States, producing this product in the northern coast, Ica, Amazonia, Lambayeque, Piura [2]. The main agricultural companies of Tahitian lemons agree on minimum conditions to meet the quality standards for export with respect to color, size, juice content, firmness, having in the productive sectors 333 plants/ha and producing 60t/ha which seeks to have calibers of 48 to 58 mm [3], [4]. Inspections in Peruvian industries are carried out visually, which are recurrent to examine the surface of the citrus fruit; however, such sensory inspection of colors depends on the perception of the individual, so the acceptance criteria are not uniform, such visual inspections take several hours of work, which generates fatigue and tiredness to workers and therefore lower quality standards, so export companies seek systems capable of detecting imperfections to classify Tahiti lemons according to the standards of consumers [5-6-7].

In the fruit and vegetable industries there are sectors where the classification is done manually, which is costly because of the labor and the time taken in each process is high, which has been noted inconsistencies and low efficiency with respect to the quality standards required in the market [8]. The external quality inspections such as color, texture, shape, which such criteria vary for each work personnel since they are visually having different criteria of acceptance which are not uniform, in addition to them by the amount of hours exposed fatigue and visual fatigue is generated so that the quality aspects of the product are reduced [9-10].

Manual fruit sorting is costly and time consuming to process due to the demand for quality fruit, which has been shown that visual inspection to separate damaged fruit from good fruit is often not uniform due to varying color criteria and individual judgment, so different industries are looking to replace manual labor with nondestructive systems that can sort in an automated manner with the requested quality requirements [11-12].

Automated grading plays an important role in the economics of a company since replacing labor with an intelligent system that can recognize internal and external characteristics is more cost effective because there is no need for labor interaction and there is a uniform acceptance grading on the product by the required quality standards such as color, shape, texture, geometry [13-14].

In fruit industries the technological advance has generated the use of deep learning of convolutional neural networks to obtain a classification model of 360 types of fruits containing 131 varieties considering as requirements, good, raw and damaged, which has been trained for 50 epochs having an accuracy of 95 % [15]. Automated systems to predict the maturity level of strawberry by CNN were used to obtain