March - April 2020
ISSN: 0193-4120 Page No. 2227 - 2232

Implementation of Auto – Conveyor Characterization System for Industrial Automation

Purushottam Chilveri
Department of Electronics and Telecommunication Smt. KashibaiNavale College of Engineering, Vadgaon Bk. SPPU Pune, India
Email: pgchilveri@gmail.com

Madan Mali
Department of Electronics and Telecommunication Sinhgad College of Engineering, Vadgaon Bk. SPPU Pune, India
Email: madanbmali@gmail.com

Shreya Mali
Department of Electronics and Telecommunication Smt. KashibaiNavale College of Engineering, Vadgaon Bk. SPPU Pune, India
Email: malishreya6@gmail.com

Article Info
Volume 83
Page Number: 2227 - 2232
Publication Issue:
March - April 2020

Article History
Article Received: *24 July 2019*
Revised: *12 September 2019*
Accepted: *15 February 2020*
Publication: *18 March 2020*

Abstract
In mass fruit production and packaging, there is importance of sorting and segregating the fruits based on various specifications. Such fast sorting system helps farmer or industry personnel with minimum human involvement. In this paper, the auto sorting system for fruits is proposed. It identifies the ripen fruits moving on conveyor belt and accumulates in separate package box. Similarly, the system identifies and sorts fruits of required size in boxes. It also maintains the record of bulk of fruits in each pack. The system is being implemented using image processing techniques on Matlab software to check size and ripeness of the fruit and utilized for sorting mechanism.

Keywords – *fruit sorting, size, ripeness, image processing.*

I. Introduction

India is spread in villages and farming is the prominent source of income to masses. More than three hundred thousand villages are involved in Gross Domestic Products (GDP) in the nation. Classical way of farming is being replaced by the advanced technology so as to get better productivity and effectiveness on many fronts. Post harvesting tasks are important in many ways. In case of food grains, the cleaning, removal of chaff and clean bagging is vital; similarly in case of fruits the segregation based on colour, size does matter for packaging. When the production of fruits is on mass scale, manual classification / segregation becomes difficult; it reduces accuracy and speed too. The system proposed makes this segregation process speedily and effectively. Indian farmers as well as many business industries are now days involved in import and export of farm items. Export of fruits has become one of the prominent businesses. The best example is mangos – export. Classification of mangos based on how much is it ripens, what are their sizes etc. are some of the important parameters before packaging for export. These parameters are being measured and controlled manually also but it consumes lot of time, and reduces time to market. It leads to high amount of human error too. Automation is the best solution to it. The similar kinds of tasks are being tried at many places and being given thoughts by many researchers also. Still the scope for improvement and more number of features is there. The relevance of the proposed system is therefore more as far as farming and packaging automation is concerned. The prominent parameters for segregation of fruits are the amount of ripeness, size and the number of fruits being packed in a packet or basket. These parameters are being monitored in real time. The fruits are being

TEST Engineering & Management

March - April 2020
ISSN: 0193-4120 Page No. 2227 - 2232

moved on a conveyor belt for the purposed of segregation sequentially. Camera takes the photo of fruit and the captured image is processed by processor. The ripeness amount is being measured based on colour. Similarly, the size is also measured. The decision based on these parameters is taken for segregation. Further, the number of fruits being packed in a packet is also monitored. The weight of packet or basket is also the criterion to segment the packets. Thus the process of segregation has become faster and more accurate without involvement of human interference.

II. Earlier Work

This is the scenario for which many projects have been tried and developed. Although not same but many related work have been done by many researchers. Some of papers have been referred and explored here. GuoFeng, have implemented image processing algorithm that first extracts the fruit area from image background and then calculates its colour ratio [1]. The prominent demerit is large amount of fruits will take long time to be sorted. S. Maheshwaran, have implemented a system in which, the artificially ripened fruits that can be distinguished from naturally ripened fruits using a histogram threshold value [2]. The android app according to the requirement was also developed. It has an efficiency of 91%. The major limitation is requirement of smartphone to install the application for the working of the system. Marco Aurelio, implemented the image processing algorithm for finding out the colour composition [3]. However, the main limitation is that it is designed and works for citrus fruits only. A. Sagahyroon et al have proposed Direct - Sequence code division multiple access. It uses M users operating over a Rayleigh fading multipath system of L paths [4]. It has flexibility in reprograming. Khurram et al have implemented Canny Edge Detection algorithm [5]. It has low error rate and preserves useful information; but the demerit is that it is used for only two different classes of fruits. Wen-Hung Chang implemented a vision based system. This system measures fuzziness. The degree of match for sorting of fruits is used [6]. Then optimum threshold value is obtained. Three fuzzy sets are defined. Matching of fuzzy sets is done. Maximum matching degree represents colour of fruit. The proposed Fuzzy method is superior to traditional statistical methods and has an accuracy of 93.3% which is better. However, the constraint is speed limit of 3 sec/cycle. Hadha Afrisal et al have shown Mechanical sorting and grading mechanism with computer vision algorithm [7]. Portable fruits sorting and grading determine the quality of fruit on the basis of maturity. The limitation is that it is useful only for small agro-industries. Chandra Sekhar Nandi et al have explored preprocessing of image, extraction of features, feature selection and classification [8]. It has replaced manual sorting system at accuracy of 96%. It is only applicable for checking the maturity of the fruits. Sanchiz et al have implemented image analysis processes, image acquisition and fruit location, colour processing and size estimation [9]. Its merit is the capability of classification according to maturity degree, weight, size, density, skin effect etc. with major drawback of speed. Javier Calpe et al have proposed image analysis procedure for fruits on the lane, data is processed for eight pieces in the image and final measurement is done [10]. It exhibited excellent cost versus performance ratio, high scalability. It also exhibited robustness and open architecture. The limitation is that the system is made according to the Spanish fruits so it is applicable to the Spanish market fruits only. Susovan Jana, SaikatBasak proposed a robot assisted machine. This machine consists of computer vision and machine learning. This proposed model is useful in ensuring faster production chain [11]. This automated machine efficiently classifies different types of fruits. The proposed model is having 83.33% accuracy, it also maintain balance between accuracy and execution time. Vidya P Korakoppa have implemented model which reduces the content of noise in an image because noises cause degradation in the quality of image [12]. This method of reducing noise in the images increases the efficiency by reducing the number of comparisons from 21 to 13. This system has high cost efficiency and high power efficiency because it consumes half the power compared to the other Spartan families. Paining Chen, MingyuGao, Jiye Huang proposed a high speed colour sorting algorithm based on FPGA [13]. It's each action has an independent colour sorting mechanism,

March - April 2020
ISSN: 0193-4120 Page No. 2227 - 2232

which improves the speed and accuracy. S. Md. Iqbal proposed a model which employs mechanical weigh scale for grading of fruits based on weight [14]. This system has high performance throughput and reliability.

The literature survey has thrown light on the earlier work done in this domain and published in the standard journals and conferences. The similar kind of try also has been made by student community at academic level. However, there is scope for lot of improvements in the parameters such as flexibility, speed and segregation based on dimensions. This scope is given focus in the system proposed in this paper.

III. METHODOLOGY

The proposed system consists:

1. Processing of captured image using Matlab and identifying the fruits which are ripe and of correct size.
2. The segregation of required fruits using a mechanism and conveyor belt (as shown in Fig.1).

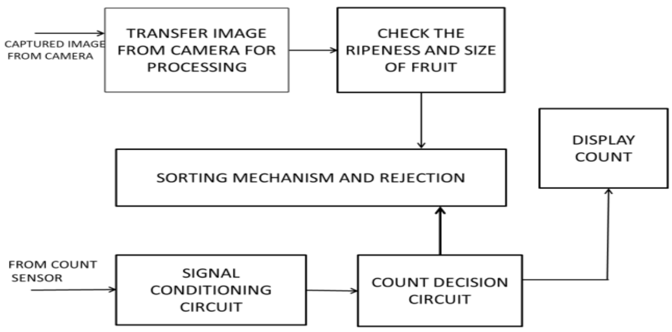

Fig. 1: Block Diagram

The work description in detail is given below - Assemble the fruits on moving conveyor belt. Camera will capture the image of fruit. It will send to image processing software where ripeness, i.e. colour of fruit and size will be checked. Accordingly, it will send message to the processing board. If fruit is ripe and does get match with the desired specifications, then it will be passed forward on conveyor belt, otherwise it is pushed into a box.Count sensor will check continuously the count. Once the required count is reached, then signal is given and the box is ready to be packed. The count sensor senses the fruits and logic circuit maintains the count of the fruits. Signal conditioning circuit converts the incoming signal from sensors to signal compatible to the logic circuit. Count decision logic triggers the display/alarm to mention the fullness of the bag/packet of fruits. Sorting mechanism consists of conveyor belt along with drive and the rejection/acceptance mechanism/actuators.

The image processing includes:

A. Detection of ripeness (i.e. detection of colour)

B. Detection of size of fruit.

These two processes are combined to form a code in Matlab and hence find the ripeness and size of fruit.

A. Detection of ripeness:

Initially the image is read from specified location. Then the image is resized.Intensity values of colours such as red, green and blue in the image are calculated. Then, mean of these intensity values is calculated.Red intensity in the image is calculated. In this proposed system, apples are sorted. Hence, red intensity in the image is calculated. Threshold value for red intensity is set. If the overall red intensity value of image is greater than value of threshold, then the fruit is declared as a ripe fruit, otherwise it is graded as unripe as shown in Table I.This categorization can be expressed mathematically as –

$$F = (R) \cup (Un) \quad (1)$$

where, F = set of total number of fruits taken together,

R = set of total number of ripe fruits,

Un = set of total number of unripe fruits

F is the union of R and Un sets.

TABLE I
DETECTION OF RIPENESS

Status of fruit	Amount of red intensity
Unripe (Un)	<T (less than threshold value)
Ripe (R)	>T (greater than threshold value)

March - April 2020
ISSN: 0193-4120 Page No. 2227 - 2232

B. Detection of size of fruit:

Initially, the image is read from the specified location. Then, the image is resized. Colour image is converted to gray scale image.The ‘edge’ command in Matlab is used to obtain edge of the image. It is obtained using ‘canny’ filter (as shown in Fig. 4).Then, size of the image is obtained and is stored in variables m, n. Variables i and j vary from 1 to the size of image. In Matlab, binary images are represented using two values, 0 and 1. 0 represents black pixel. 1 represents white pixel.

In an ‘if’ loop, white pixels are checked. If a pixel is white then its location is stored in variables i1 and j1.The distance between one white pixel and other white pixel is calculated. If a pixel is white, then its location is taken, and that location is subtracted with the other white pixel location (as shown in Fig.5). Correspondingly, every white pixel is subtracted from that distance and it is stored in a variable ‘disi’.Distance between white pixels are calculated and stored in variable ‘disi’. Then, the maximum value of this variable is found. A threshold value is set. If the maximum distance between two white pixels is greater than the threshold value, then the fruit is declared as large fruit. Similarly, if the maximum distance between two white pixels is comparatively less than the value of threshold, then the fruit is declared as small fruit (as shown in Fig.6). Table II shows the detection of size of fruit.This categorization can be expressed mathematically as –

$$F = (S) \cup (L) \qquad (2)$$

where, F = set of total number of fruits taken together,
S = set of total number of small fruits,
L = set of total number of large fruits.
F is the union of S and L sets.

TABLE II
DETECTION OF SIZE

Size of fruit	Maximum distance between two white pixels
Small (S)	$<$T’ (less than threshold value)
Large (L)	$>$T’ (greater than threshold value)

A GUI is created which is based on the above code for size detection and ripeness measurement as shown in Fig 7. Browse feature is available which allows inputting the image. Then further operations such as RGB to gray are performed. Based on the colour and size, the sorting is done with four categories i.e. small unripen, big ripen, small unripen and big unripen.This categorization can be mathematically expressed as –

$$F = (SUn) \cup (SR) \cup (LUn) \cup (LR) \qquad (3)$$

where, F = set of total number of fruits taken together,
SUn = number of small and unripe fruits
SR = number of small and ripe fruits
LUn = number of large and unripe fruits
LR = number of large and ripe fruits
F is the union of SUn, SR, LUn and LR sets.

It can also be expressed in the form of matrices such as:

$$\begin{bmatrix} S \\ L \end{bmatrix} \cdot \begin{bmatrix} R & Un \end{bmatrix} = \begin{bmatrix} SR & SUn \\ LR & LUn \end{bmatrix} \qquad (4)$$

Above equation (4) shows the multiplication of a 2x1 matrix and 1x2 matrix to obtain a 2x2 matrix. The 2x1 matrix depicts small and large sized fruits, whereas the 1x2 matrix depicts ripe and unripe fruits. The product of these matrices is the entire set of fruits categorized as:

1. Small fruit and unripe fruit
2. Small fruit and ripe fruit
3. Large fruit and unripe fruit
4. Large fruit and ripe fruit

The arrangement of conveyor belt is shown in Fig. 2. The final output of GUI is given to mechanism board.

March - April 2020
ISSN: 0193-4120 Page No. 2227 - 2232

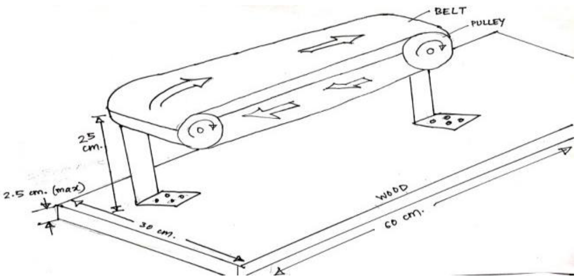

Fig.2. Conveyor Belt arrangement

Dimensions:

- Length of wooden plank = 60 cm
- Breadth of wooden plank = 30 cm
- Width of wooden plank = 2.5 cm
- Height of metal plate (connecting pulley and wood) = 25 cm

Motor used: 12 V, Type - 15 rpm

IV. Specifications And Features

- Number of cameras = 2 Max
- Image processing by MATLAB software
- Conveyor belt = DC/AC Drive
- Number of Boxes for sorting = 2 Max
- Indication for fruit count = Display/Alarm
- Sensor for fruit = LED/Photo diode
- Number of fruits in one box = 12

V. Hardware And Software

The hardware used is as follows:

- IR sensor
- Camera – IP webcam

Fig.3. IP Webcam

IP webcam is an app that converts android device into an internet camera having multiple view options. These multiple view options can be seen on any platform using an internet browser or a VLC player. This tool allows conversion of android device into a video surveillance tool (as shown in Fig.3).In the implementation of the system, IP webcam is used as wireless camera for capturing images. The other hardware and software details are listed below -

- LCD display unit
- DC motor unit
- Conveyor belt
- Sorting mechanism
- Matlab

VI. Results And Analysis

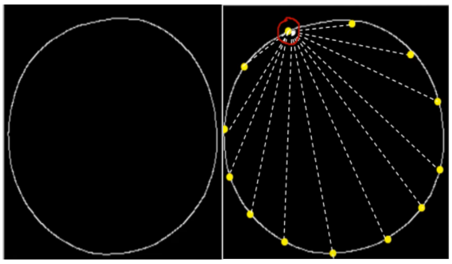

Fig.4. Edge of image Fig. 5. Position of white pixels and distance between them.

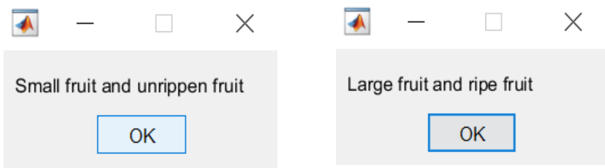

Fig. 6. Outputs observed when the code is run

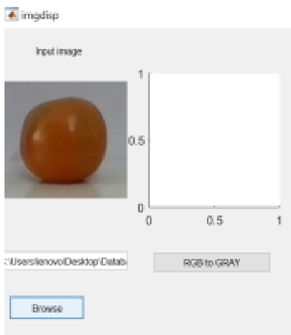

Fig. 7.A view of Graphical User Interface (showing only browsing an image and converting RGB to gray scale)

March - April 2020
ISSN: 0193-4120 Page No. 2227 - 2232

This section consists of summary of various stages of work starting from implementation of code in Matlab. This section also consists of the results obtained.The results of image processing in Matlab include detection of ripeness and size of the fruit in the image. The code in Matlab is run to obtain the results as shown in Fig.6. A GUI is developed according to the code. A GUI allows browsing an image and converting it into gray scale image (as shown in Fig.7) and further processes. The output of GUI is given to the sorting mechanism to sort the fruits into four types such as:

1. Small fruit and unripe fruit
2. Small fruit and ripe fruit
3. Large fruit and unripe fruit
4. Large fruit and ripe fruit

The sorting mechanism sorts the fruits and adds them into four boxes showing the different types.

VII. Conclusion

The conveyor belt automatic fruit categorization segregation system is being implemented with the help of image processing technique, the segregation of fruits and packaging of boxes with required number of fruits is also part of the system. The system is programmable hence it is possible to modify for better speed and accuracy. The addition of more number of features is also possible with scalability. The system consists of processing board as well as image processing hence the flexibility is more on both sides. The prime utility is in such applications where very less human intervention is expected. More accuracy, high speed and modularity made this system relevant, state of the art and keeping pace with farming and packing.

VIII. Acknowledgement

The designing and implementation work is carried out in the department of Electronics and Telecommunication – SKN College of Engineering, Pune. Authors are very much thankful to Guide, Head of the Department and faculties for the support.

IX. References

1. GuoFeng, Cao Qixinn (2004) Study on color image processing based intelligent fruit sorting system: Published in: Fifth World Congress on Intelligent Control and Automation (IEEE Cat. No.04EX788).
2. S. Maheshwaran, S. Sathish and P. Priyadarshini. (2017) Identification of artificially ripened fruits using smart phones: Published in: 2017 International Conference on Intelligent Computing and Control (I2C2).
3. Marco Aurelio Nuño-Maganda, Yahir Hernández-Mier (2014) FPGA-based real-time citrus classification system: Published in: 2014 IEEE 5th Latin American Symposium on Circuits and Systems.
4. A. Sagahyroon, M. El Tarhuni, S. Ibrahim (2008) AN FPGA implementation of the searcher algorithm: Published in: 4th IEEE International Symposium on Electronic design, Test & Applications.
5. MdKhurramMonirRabby, BrintaChowdhury, and Jung H. Kim (2018) A modified Canny Edge Detection Algorithm for Fruit Detection & Classification: Published in: 10th International Conference on Electrical and Computer Engineering.
6. Wen-Hung Chang, Suming Chen, Sinn-Cheng Lin, Pai-Yi Huang and Yung-Yaw Chen (1994) Vision Based Fruit Sorting System Using Measures Of Fuzziness And Degree Of Matching.
7. HadhaAfrisal, Muhammad Faris, Guntur UtomoP, LafionaGrezelda, Indah Soesanti, MochammadAndri F. (2013) Portable Smart Sorting and Grading Machine for Fruits Using Computer Vision: Published in: 2013 International Conference on Computer, Control, Informatics and Its Applications
8. Chandra Sekhar Nandi, BipanTudu and ChiranjibKoley (2014) A Machine Vision – Based Maturity Prediction System for Sorting OF Harvested Mangoes: Published in: IEEE Transactions On Instrumentation And Measurement, Vol. 63, No.7, July 2014.
9. Pla, F., Sanchiz, J. M., Sanchez, J.S. (2001) An Integral Automation Of Industrial Fruit And Vegetable Sorting by Machine Vision.
10. Javier Calpe, FilibertoPla, JordiMonfort, Pedro diaz, JauncarlosBoada (1996) Robust Low – Cost Vision System For Fruit Grading.
11. Susovan Jana, SaikatBasak, Ranjan Parekh(2017)Accuracy 83.3%.
12. Vidya P Korakoppa, Mohana, H.V. Ravish Aradhya(2017)Reduces noise in the image by different algorithms.
13. Paining Chen, MingyuGao,Jiye Huang*, YuxiangYang,YuZeng(2018)It has high speed colour sorting.
14. S.Md.Iqbal, B.Sundaresan, a.Gopal(2017)The system has high throughput and reliability.