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Automated Fruit Quality Detection Using Image Processing

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Abstract: ***In this paper, an automated fruit quality inspection and sorting system for apples has been proposed. The objective of this system is to replace the manual inspection system. This helps to speed up the process, improve the accuracy and efficiency of the system. In this work, the multiple images of apple are captured by using camera place above the conveyor belt. We have captured multiple images to make the proposed system more accurate which covers the maximum surface area of fruit. Then various image processing algorithms are used to extract the features of fruit such as texture, color, and size. Automated sorting and grading are done based on these features. The defected apple is diverted from conveyor using motor. The proposed embedded system works at higher speed and gives high accuracy in grading with low-cost solution. It will have a good prospect of application in fruit quality detection and grading areas. In the proposed algorithm, we have used k-means algorithm for segmentation and local Binary Pattern technique is used extract feature vectors of the test and training images. Then, the training and testing features are given to neural network algorithm to classify the test image into normal and abnormal class. We have considered the normal and abnormal (rotten apple images) for training purposes. Experimental results show that the proposed system accurately classifies the apple and gives better accuracy.***

Keywords: ***Automatic Sorting, Local Binary Pattern (LBP), Neural Network, Image Processing.***

1. INTRODUCTION

A fully automated method for combining tasks like feature extraction and sorting based on color, size, and weight is of- fered by an image processing-based fruit quality management system. After the fruit side view image is captured, several fruit features are extracted utilizing detecting algorithms for sorting using color and size.

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A. Motivation

One of the main economic sectors and a major contributorto India's economic growth is agriculture and horticulture. In India, the customary fruit examination is still carried out by human specialists. In the fields, a great deal of time is lost to inspecting the crops. This paper analyzes the fruit or vegetablequality based on color, shape, and size in an economical and secure manner. Fruits are sensitive materials; hence non- destructive methods should be used to evaluate them. Fruit sizeis the most significant physical attribute, but color is more similar to a visual attribute. Fruit classification is therefore essential for assessing agricultural output, fulfilling quality requirements, and expanding market share.Planning, packing, shipping, and marketing processes can all benefit from it.If grading and categorization are carried out manually, the procedure will be excessively slow and occasionally prone to errors. Fruits and vegetables are sorted by color, size, and othercharacteristics by the workers. The work will be completed more quickly and error-free if these quality measures are mapped into an automated system utilizing the appropriate programming language. The fruit business has found computerized machine vision and image processing techniques to be more and more helpful in recent years, particularly for applications in form sorting and quality inspection.

B. Problem Statement

In industries that manufacture products like fruit pulp, fruit juices or any other products involving fruits as raw materials sorting plays a vital role. In such industries the raw material, which is fruits, is used in exceptionally massive quantities, in such cases manually sorting the fruits is a very tedious taskand would require more human labor. This issue can be solved using an automated system that can sort the fruits efficiently without human intervention. In the proposed project we intendto develop such a system to sort fruits automatically based on their physical appearance by making use of various image processing algorithms, conveyor system and intelligent con- trollers. The prototype created can be extended to an industry level application by making some additions and implementingbetter hardware.

C. Objectives of Proposed System

The following are the main objectives of this project.

1. Effective method for classifying fruits.
2. Fewer intentional pauses.
3. A fully automated system that uses less power.

2. RELATED WORKS

A technique for detecting and assessing fruit size usingimage processing has been suggested in [1]. Using imageprocessing algorithms on the QT/Embedded platform, the system generates the fruits size detection program withan ARM9 processor as its primary processor. However, the outdated microcontroller is what gives the speed and efficiency.

A proposed system for detecting and grading fruits using image processing in [2]. Quality inspection is done using Artificial Neural Network and Fuzzy Logic Control. However, accuracy is low.

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The Grading of fruits based on quality using Image Processing has been proposed in [3]. Quality inspection is done using k-means clustering by extracting features and comparing with data set of feature vectors of images in dataset. However, the speed of the system in this method is quite slow.

The Analysis of Fruits by Image Processing Algorithms has been proposed in [4]. In these various methods of threshold- ding the images and algorithms used for it discussed andimage acquisition is done with help of vision box Dsp processor.

The Fruit Quality Identification System in Image Processing Using MATLAB has been proposed in [5]. In this quality detection of fruits is done with help of image processing techniques like k-means, fuzzy logic. Advantage of k-meansis stated over c-means.

The Fruit Detection Using Morphological Image Processing Technique has been proposed in [6]. In this quality inspection of fruits is done with the image morphological techniques. For color features, the method of color space conversion is employed. Canny edge detection and dilation techniques are used to texture features.

It has been suggested to use image processing in an ARM- based fruit grading and management system in [7]. In this sorting of fruit is done with the help of edge and color detection and grading is done with help of load cell and using ARM processor.

The Artificial Neural Network proposed image processing for smart Farming have been proposed in [8] Artificial neuralnetworks are utilized to construct algorithms for fruit grading and illness detection. These systems reliably identify and categorize tested diseases and yield better results for color andmorphology—90 results compared to texture. Additionally,he created a weight-based mango grading system using a mathematical formula that classified mango weight into five categories.

A simple color identification algorithm using a Neural Network have been in [9].approach and implemented in the system to assess a banana's level of ripeness. After the banana image is acquired, its RGB color components are extracted and resized. A straightforward heuristic technique is utilized to resize the color components of the resized images. In addition, a histogram for the rescaled image is createdand utilized as a feature vector to determine the banana'slevel of ripeness. They reported 96 accuracy when classifying ripeness using a neural network classifier and the error back propagation technique.

A new fruits recognition techniques with combines four features analysis method have been proposed in [10].Using a texture-based approach based on shape, size, and color can improve recognition accuracy. Thirty-six fruit photos weregathered in order to create a fruit recognition system. Twelve fruit photos are utilized for testing, and twenty fruit images are used for training. They computed the RGB component mean value for feature extraction. Additionally, compute the values of area, perimeter, roundness, and entropy and shape using threshold segmentation. The KNN algorithm produced an accurate recognition result of up to 95.

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3. METHODOLOGY

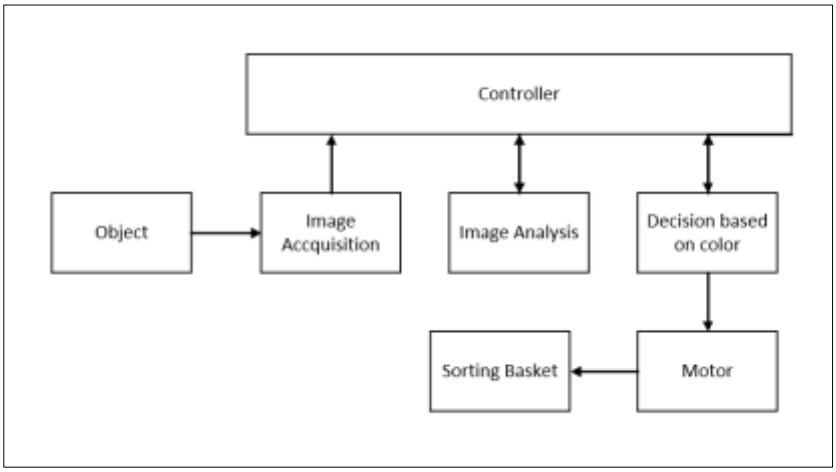

Fig. 1. Block Diagram of System

A. Description

The shortcomings of manual methods are intended to be addressed by this automated solution. The conveyor system, digital camera, IR sensor, raspberry-pi micro-controller, or PCare all included in this designed hardware model.IR sensor is placed at a fixed distance from conveyor belt for detecting apple presence. When apple comes in front of IR sensor,motor stops for a fixed time (2- 3sec).Simultaneously digital camera captures picture of apple. Sorting assembly is placedto sort defective and healthy apple .This sorting depends onthe type of image processing algorithm used and parameters processed to classify the object based on numerous factors likeshape,size,colour,texture etc. Efficient algorithms are used to get better output.

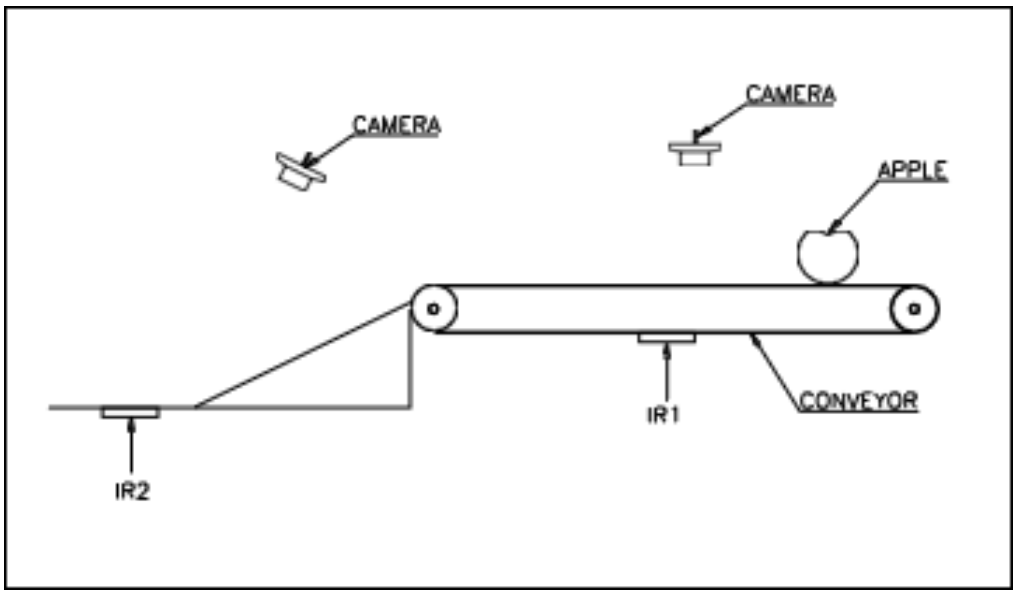

Fig. 2. Construction of System

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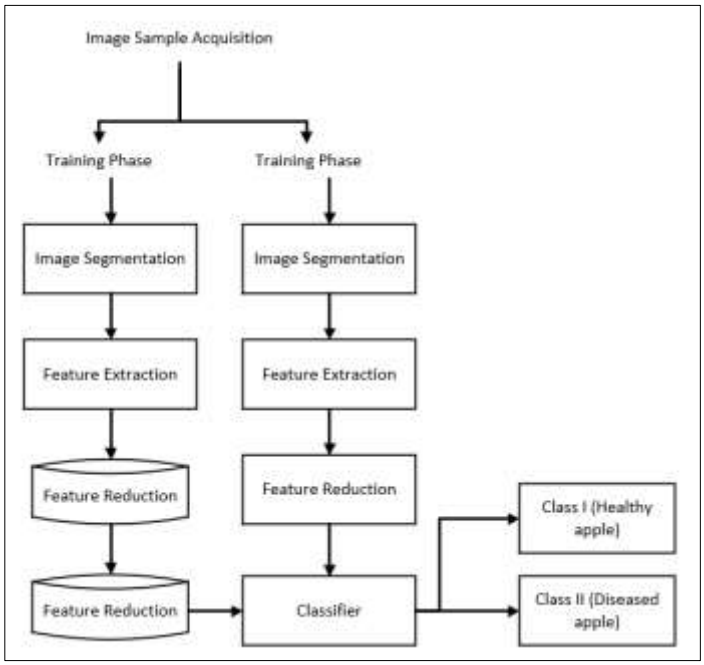

Fig. 3. Construction of System

A. Process Flow

Image Segmentation

The technique of dividing a digital image into several segments or sets of pixels (sometimes called super-pixels), is called image segmentation. Segmentation is to transform an image's representation into something more understandable and straightforward to examine. A collection of segments that together encompass the full image or a collection of contours that are retrieved from the image are the outcomesof image segmentation (see edge detection). When it comesto a certain attribute or computed property, like color, texture, or intensity, every pixel in a region is comparable.
There is a large difference between adjacent locations for the same attribute (s).

Feature Extraction

Feature extraction is a technique in image processing thatbegins with an initial set of measured data and creates derived values (features) that are meant to be non-redundant and informative. These features can then be used to help with latersteps in learning and generalization, and in certain situations, they can also improve human interpretations. Through theprocess of feature extraction, dimensionality is decreased while maintaining accurate and comprehensive description of the original data set. This starts with an initial collection ofraw variables and works its way down to more manageable groups (features) for processing.

Classifier

Pattern recognition requires the classification of images, and both efficiency and accuracy depend on the classification. Pre- processing, segmentation, and feature extraction are necessarysteps in a successful classification process. While each stage affects recognition rate,

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categorization plays a crucial role in pattern recognition. Several significant classifiers, including decision trees, KNN, artificial neural networks (ANNs), and support vector machines (SVMs).

4. RESULT AND DISCUSSION

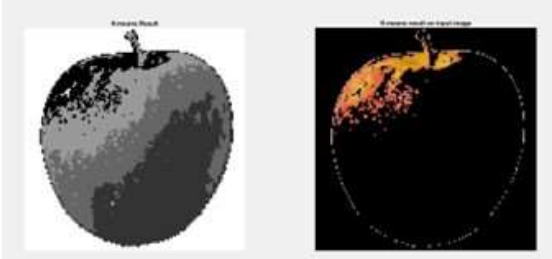

Fig. 4. K-Means Result on Healthy Apple Image

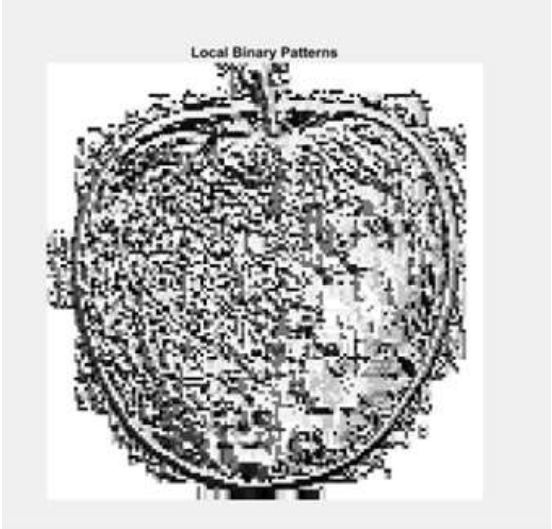

Fig. 5. Output After local Binary Pattern operation on Healthy apple image

Fig. 6. Message box displaying result

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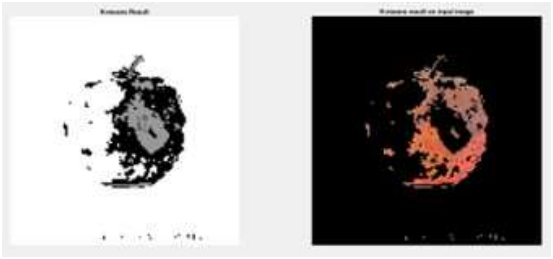

Fig. 7. K-means result on Diseased apple image.

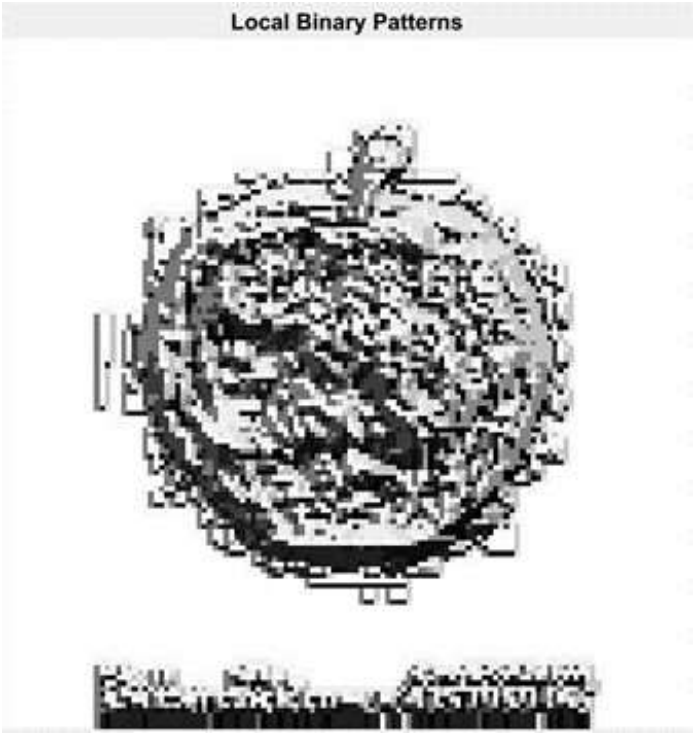

Fig. 8. Output After local Binary Pattern operation on Diseased apple image

Fig. 9. Message box displaying result

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In this proposed system classification of healthy and dis- eased apples is done with help of statistical value(centroid) obtained from feature vector. In the feature vectors physical attributes such as dark spots on surface of apple and anyindentations have been checked. These feature vectors arecompared with feature vectors from training dataset and then classification of healthy and diseased apples is done by thresh-olding technique

5. CONCLUSION

In this paper an automatic vision-based system is discussed for sorting apples based on their color and size. We were able to achieve good accuracy for detecting type of apple. Apples were classified using sorting assembly attached at the end of conveyor belt.

Table. 10. Result of sorting apples

Classification	Training Images	Testing Images	Accuracy (in %)
Healthy apple	20	5	75
Diseased apple	20	5	90

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