A Research on Fruit Maturity Detection Techniques

M. Surya Kiran, G. Niranjana

Abstract— ***Fruits are the major source of food to humans. Damage in fruits can be of different types. Damage due to insects or damage during transportation are the most common types of damages caused. Fruits are also unfit for human consumption when they mature beyond permissible limit which can be termed as rotten. Fruit maturity detection is divided into different stages depending on type of fruit detection used. Various sensors and image processing methods are used for this purpose. The major stages involved in this process are pre-processing, detection using sensors and image processing. Spectroscopy has been a huge development in image processing. In later stages the results are classified or clustered according to the requirement. This paper presents a survey of the existing fruit maturity detection techniques.***

Keywords— ***Image processing, sensors, RGB.***

1. INTRODUCTION

Harvested fruits are normally consumed after 4 to 5 days of time period. Some fruits have to be consumed within very less time period where as some variety of fruits can be consumed after 10 days after harvesting. Damage present in the fruits may also vary based on fruits. Some kind of damage is visible to naked eye where as pest or insect damage may not be visible to naked eye. Manual picking of fruits and classifying them according to maturity and damage done may be time consuming and may not prepare for sending fruits to consumer within stipulated time. Taking these factors into consideration pre processing techniques can be applied to determine maturity and detecting damage done. Damage done by insects has visible blemishes on the skin of fruits. Sensor based method combined with image processing can be applied and to detect both maturity and damage at same time saving time

Fruit maturity detection has many methods. Image processing and sensor based methods are most popular now. In image processing the high resolution images of fruits are taken and are preprocessed. Sensor based methods detect the gas emitted by fruits and based upon the parts per million of gas level detect the maturity of fruits.

In both methods the first stage is different but classification or clustering can be similar. Image processing may consist of several stages as 1) Fruit image recognition 2)Fruit grading by colour detection 3)Classification of fruits. In the first stage images of fruits are taken using high grade infrared sensors or cameras with sufficient lightning and exposure. Images taken can be from night time or day time.

In the next stage fruit grading based on hue detection is carried out. In this stage the hue comparison of images taken are compared with standard colour of perfect fruit. The images of different stages of maturity are taken during the first stage. Based on the extracted data from the images the fruits are classified as ripe or matured.

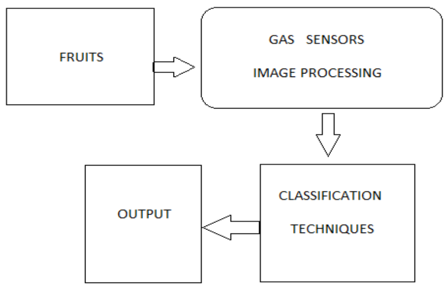

Fig 1.Model diagram 1

2. PREPROCESSING

This is the most crucial part of fruit maturity detection. When using image processing method the detection of fruit maturity depends upon the pixelated images. Sensor based detection has to be done such that the gas emitted does not mix with gases emitted from atmosphere. There are different techniques of image processing and sensor based techniques.

Choi et al .[1] has implemented image processing method using ccd camera for processing the colour of fruit images. Colour of fruit colour image is used for pre processing, segmentation for defects detection. Near Infrared spectroscopy has been used for measuring internal qualities of fruit. Waves are incident on the fruits through a filter present between the fruits and spectrometer. Chemical properties present in fruits affect the waves absorbed and reflected in this method. Matured fruits have very high absorption rates compared to ripe fruits. Size, shape and volume of fruits also has been taken by the author. Two methods have been used. Accuracy of 97.4% has been achieved through this method.

Lee et al .[16] has used pre selected colours of interest that are specific to given application to calculate a unique set of weights for colour conversion. The three dimension RGB colour spaces is converted into a small set of colour points unique to application. In this method user can change colour grading thresholds in a manner consistent with human colour perception and the changes in preferred colour ranges can be completed without reference to precise reference colour. User can define the colour index by which

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M. Surya Kiran, SRM Institute of Science and Technology. Chennai, T.N, India.

Dr.G. Niranjana, SRM Institute of Science and Technology. Chennai, T.N, India.

the fruits can be classified. Some fruits based on weather can change colour of skin. Lee [16] has used this to determine the fruit maturity.

Wajid et al. [17] has collected RGB colour images of oranges which were captured using a camera sensor at 1024 pixel resolution on a black background has used a boder/interior pixel classification(BIC) to separate image components. Water shed method has been used to segment the images to give more pixilation for better results. Classification methods such as naïve bayes, neural network and decision tree have been compared. Decision tree classification has achieved an accuracy of 93.13%.

Deshmukh et al [21]. Presented detection of ripening stages using a wireless electronic nose. XBee which made up an array of gas sensors were used. Mangoes were used as a test case for maturity detection. Separate chambers were created for placing the arrays and fruits. An air tight chamber was created to place the fruits such that the gases released do not mix with atmospheric gases. Figaro gas sensors were used to detect the gases. Gas parameters like alcohol, hydrogen, methane and LP gas were detected. This method can be carried by user and does not take much space. Principal component analysis has been used to classify the variables. Principal component analysis uses an orthogonal transformation for converting a set of observations of correlated values known as principal components. LabVIEW software has been used as interface between the hardware and the development. LabVIEW provides the graphic user interface for the viewer. Radar patterns have been observed by the author where for different ripening stages different colours have been observed. The method used is time consuming compared to other methods.

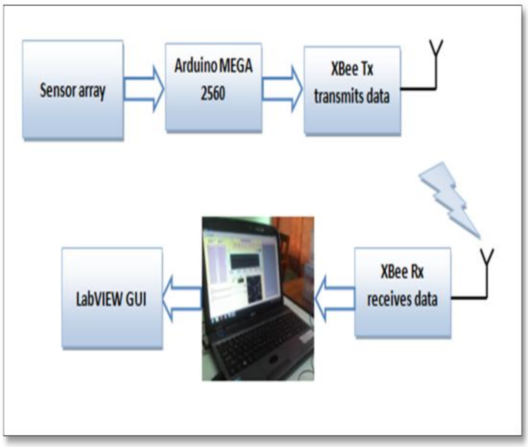

Fig 2.Deshmukh et al [22]

Leekul et al .[18] has used sensor system in which rician k –factors were utilized to determine the fruit maturity. Durian fruits which were used had high reflection of waves based on k-factor but lower scattered wave k-factor component, when compared with immature durian. Accuracy as high as 92.7% has been achieved through k –factor thresholds. Sensor frequency of 915 MHz was used to scatter the waves. Durian fruits have been classified into immature and export grade. Durians had been classified into three varieties according to shell present on the fruit, prickly shell, smooth shell and spherical shell. Prickly shell did not interfere with scattered waves but size and shape of durian has been taken into consideration. Spherical durians used have given readings with much accuracy compared to prickly. This comes as a disadvantage because durians without shell are prone to more damage.

Matteoli et al [12]. Has achieved grading of fruits maturity by estimation of firmness based on the flesh of fruit by means of multivariate retrieved techniques acquired with spectrometer and has processed them with a maturity fuzzy classifier. Fiber optic spectrometer has been used for measuring reflectance from the fruits. Fuzzy logic classifier has been used to classify at last stage.

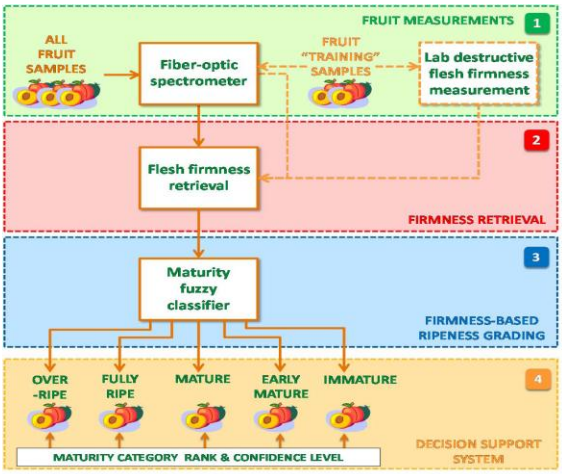

Fig 3. Matteoli et al [12]

Ullah et al[20].has used fluorescence spectroscopy to detect the maturity in fruits. Intensity of chlorophyll fluorescence decreases with ripening on basis of partially and fully ripe mangoes. Chart has been created to differentiate maturity using the levels of chlorophyll fluorescence.

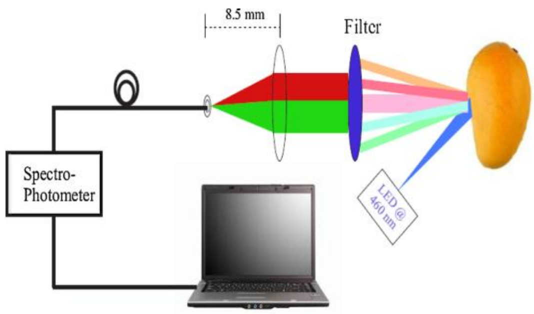

Fig 4. Ullah et al[20]

Filter has been used to transmit the light waves onto the fruit. The intensity of fluorescence emitted has been captured to determine the maturity. It has been proved that chlorophyll fluorescence decreases in ripe fruits. Carotene component present in fruits plays a major role in determining the fluorescence absorbed by the fruits. Pulp spec-tra shown that the chlorophyll peaks disappeared in fully ripe mango where as in unripe mangoes the levels were high.

TABLE 1.FRUIT PREPROCESSING STAGE

SNO	STUDY BY	METHOD USED
1	Choi et al. [1]	Colour image processing
2	Deshmukh et al. [21]	Wireless electronic noise (WEN) using XBee
3	Sa et al. [4]	Colour(RGB) and Near infrared(NIR) technique
4	Hasanuddin et al. [9]	Ehylene gas detection
5	Hasegawa et al. [22]	(Sic – FET) gas sensors for detecting ethylene gas
6	Mustaffa et al. [7]	Open Cv histogram
7	Noomhorm et al. [3]	Near Infrared (NIR) Spectroscopy
8	Zawbaa et al. [13]	Scale invariant feature Transform(SIFT)
9	Lee et al. [16]	Direct colour mapping
10	Leekul et al. [18]	Rician K – factors

3. CLASSIFICATION

Once the hue detection or the images have been separated the next stage is to classify them into ripe, unripe or matured stages. Sensor based method in study have used gas discharge index scale to classify the maturity of fruits. Commonly used techniques are clustering and classification. Features used for classification are geometrical features, histogram features and gradient features. Geometrical features have smoothness, lesions and holes have been included.

Ethylene gas released by the fruits is calculated in parts per million. Threshold limit for ripe, unripe and matured fruits has been already been calculated and taken in a chart. Logistic regression has been considered as best suited for binary classification. Ripe fruits can be classified into success where as matured fruits can be classified into failure. Decision tree classification can be used to classify the images according to damge done by pests.

TABLE 1.FRUIT CLASSIFICATION STAGE

SNO	STUDY BY	METHOD USED	ACCURACY
1	Choi et al. [1]	Artificial neural networks	97.4%
2	Zawbaa et al. [13]	Random forest Classifier	96.17%
3	Matteoli et al. [12]	Firmness based Fuzzy classifier	80%
4	Nandi et al. [8]	Support vector Machine	96%
5	Kumari et al. [15]	Support vector Machine(statical co-occurance)	95.3%
6	Wajid et al. [17]	Decision tree Classifier	93.13%
7	Leekul et al. [18]	K – factor threshold	92.7%

4. PROPOSED METHOD & RESULTS

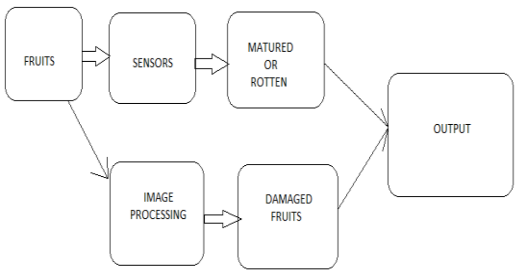

Fig.5Model diagram 2

Maturity of fruits has only been detected using the above methods described so far. In proposed model fruit maturity is detected using gas sensors and image processing which are done in parallel. In the later stage the fruits are classified into matured and damaged, rotten and ripe and non – damaged fruits which are ready for consumption.

5. CONCLUSION

From the above discussion about fruit maturity detection, it is decided that sensor based detection through smell or gas released is can be more accurate. Employing gas detection method can be more advantageous as the method can be implemented at any time of the day. Different gas sensors are available in the market and the high quality sensor for accurate detection should be used as there the gases present in atmosphere can affect the ethylene gas content.

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