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A Review on Non-Destructive Techniques for Evaluating Quality of Fruits

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***Abstract*— Even though the fruit ripening is a natural process, it can also be processed by means of different artificial fruit ripening agents. In the recent years, due to the effect of artificial ripening of fruits the various health related issues has increased. Thus the consequence of artificial ripening has become questionable. There are both direct and indirect health hazards allied with artificial fruit ripening agents, which requires both qualitative and quantitative analysis of chemicals and their impact on fruit quality. So it is important to evaluate the quality of artificially-ripened fruits, and to analyze the changes in food value. The presence of artificial ripening agent is usually encountered on the fruit skin. But it is also very important to enumerate the existence of detrimental chemicals within fruit-flesh and to analysis the impact of these chemicals on the food value of artificially ripened fruits. This paper is a review in image processing in order to design a fruit grading system based on Machine vision, Near infrared spectroscopy and Hyperspectral imaging.**

Keywords*— *Hyperspectral imaging; image processing; fruit quality; artificial fruit ripening.

I. INTRODUCTION

As the world is getting colonized, health is getting poor and everyone wants to have fruits. Fruit ripening is the natural process in which the fruits attained their desirable color, flavor, quality, edible
nature, palatable, nutritious and other textual properties [1]. Usually fruits produce plant hormone
called ethylene, which helps in the ripening process. But the majority of fruits nowadays where artificially get ripened using various detrimental chemicals, which could become very dangerous to the consumers. So it is very essential to analyze and control the quality of fruits. The term quality refers to the degree of excellence of a product or its effectiveness for a use. Quality of fruits encompasses sensory attributes, nutritive values, chemical constituents, and defects. The sensory evaluations are usually preferred by the use of various instruments [2].

Unripe fruits often be full of a variety of different organic acids namely citric acid, malic acid, ascorbic acid, formic acid, tartaric acid etc. After certain chemical changes these acids get transformed into sugars and the fruits turn saccharine. In fruit ripening process, chlorophyll is produced and simultaneously decomposed. Starch is induced by amylase and it usually produces sugar. Pectin converts into pectinase and decomposition of pectin unglues the fruit cells [5]. Also the fruit cells have been able to slip past one another makes the fruit further soft and smooth.

As the health hazards increases day by day due to the consumption of these artificially ripened fruits, it is essential to perform qualitative and quantitative analysis of the presence of detrimental ripening agents within the fruit-skin and flesh to identify with the relevant health hazard. The existence of artificial ripening agent is usually encountered on the fruit skin. But it is also very important to reckon the presence of detrimental chemicals within fruit-flesh and to learn the impact of these chemicals on the food value of artificially ripened fruits.

Today, India has emerged as the second largest producer of the fruits (46 million tone), contributing nearly 10% of the world production. Even though the country is the second largest producer of the fruits in the world, per capita consumption of fruits of our country for over one billion populations is very little. But recently many Indian agricultural produce and fruits where rejected by some international markets, since the amount of detrimental chemicals in it is very high. The quality assurance of fruits is very crucial as with the liberalized international trade system and globalization [3]. Conventionally, the quality of fruit is assessed only by the human visual inspection, other than chemical or biological quality experiments which requires high cost, tedious and time consuming. Thus necessitate the need of an accurate, real-time, fast and moreover non chemical quality evaluation method, in order to ensure the quality and assure safety to the fruit consumers [5].

The remainder of this paper is organized as follows. Section II presents related work. Section III briefly addresses the overview of artificial ripening agents. Section IV reports the Quality evaluation methods of fruits. Finally we conclude with Section V.

II. RELATEDWORK

Even though fruit ripening is a natural process, it can also be done using different artificial fruit ripening agents. In the recent years, due to the effect of artificial ripening the different health related issues has increased enormously. Thus the effect of artificial ripening has become questionable. There are direct and indirect health hazards associated with

artificial fruit ripening agents, which requires both qualitative and quantitative analysis of chemicals and their impact on fruit quality. So it is very significant to analyze the different detrimental chemicals present within artificially-ripened fruits, and to analyze the changes in food value. The presence of artificial ripening agent is usually encountered on the fruit skin. But it is also very important to measure the presence of detrimental chemicals within fruit-flesh and to analysis the impact of chemicals on the food value of artificially ripened fruits.

Recently many Indian agricultural produces and fruits are discarded by some international market. This, indeed, is a black remark for all the Indian farmers and cultivator. Though India is the largest producer of bananas, its yield is low compared to countries such as Indonesia, Guatemala. The mellowness of fruits, especially bananas, is tested using various methods. Image processing unit is the heart of this system and it hastily manipulates and accelerates the formation of images in a frame buffer deliberate for comparison. This unit converts the captured image into Cyan, Magenta, Yellow and Black (CMYK) format [6]. A reference image is compared with the actual image. The reference image is obtained by placing the naturally, completely ripened banana and taking the IR image of that banana. The reference image is a standard image. Any deviation of the actual image from the standard image is detected as artificially ripened banana.

Texture is a significant property of the surface of fruits that characterizes its nature, so in many situations it is the only information that can be used for image analysis. The term texture [1] can be defined as a spatial arrangement of intensity attributes which are correlated with areas of visual scene corresponding to surface regions. An image region is said to have constant texture, if the local properties of a region are constant. Thus texture analysis has recognized as a significant consideration in the field of image analysis and pattern recognition. The analysis of texture exhibits a few sort of periodicity of the basic pattern as in the case of Spongy Tissue in mango. Visual assessment of texture made by human is time consuming and the visual assessment made by human does not attain a high level of accuracy and preciseness. Automated visual assessment of the textural pattern improves the accuracy and preciseness during detection detrimental chemicals present in fruits.

In the literatures reviewed, the researchers worldwide have been effectively working in a variety of texture analysis algorithms for different applications like detection, recognition, classification, segmentation, clustering of different chemicals present in fruits. Many algorithms endure from low sensitive detection, difficult back ground adaption and high memory requisite. There were many problems and confines associated with the available techniques have been reported by many studies [3]. Each of the algorithms has some downside under all lighting conditions and no one has used a robust.

III. OVERVIEW OF ARTIFICIAL RIPENING AGENTS

Ethylene is the most important ripening agent produced naturally within the fruits which instigate the process of fruit ripening. There are multifarious uses of many ripening agents to release ethylene in order to swiftness the fruit ripening process.

The different chemicals like ethanol, methanol, ethylene, ethephon, or calcium carbide are used to ripen fruits and vegetables artificially. The use of calcium carbide is much widespread in many regions.

Ethylene: A very small concentration (I PPM) of ethylene in air is adequate to promote the fruit ripening process.

Calcium Carbide: Calcium carbide is widely used in different parts of the world. Once applied on the fruits, calcium carbide comes in contact with the moisture and release acetylene, which has fruit ripening characteristics similar to ethylene.

Calcium carbide contains traces of arsenic and phosphorous hydride, which are hazardous for human health.

Ethephon: Another ripening agent often considered better than Calcium carbide, because it requires less time for ripening. The fruits ripened with ethephon have more acceptable color than naturally ripened fruits and have longer shelf life than fruits ripened with Calcium carbide.

Ethephon is decomposed into ethylene bi-phosphate ion and chloride ion in aqueous solution.

IV. QUALITY EVALUATION METHODS OF FRUITS

The measurement of quality parameters involves various scientific principles such as chemical reactions of various constituents and their behavior during the reactions, principles such as reflection, refraction, absorption, transmittance and scattering.

The most recent non-destructive techniques [8] used for the evaluation of quality determination of fruits are NMR, X-ray, NIR spectroscopy, Electronic nose, Ultrasound, Machine vision and Hyperspectral imaging. Here we are focusing on the most three relevant quality evaluating techniques which have great potentials in non-destructive quality evaluation. And among these techniques widely used are Machine Vision, Near infrared spectroscopy and Hyperspectral imaging.

A. Machine vision

Machine vision in image processing is an imperative technique to evaluate the quality of fruits. Color analysis is a method in machine vision. The different colour of fruits represents various ripening stages of fruits and is an important indicator related to maturity, defect and other quality attributes. It is also one of the most useful parameters to be used in the machine vision. Various research works have been done in order for evaluating the quality of fruits based on colour using monochrome and colour cameras. The visual spectral range is 400-700 nm and was used for this study. Here we adopted partial least-squares regression (PLS), principal component regression (PCR) and multiple

linear regression (MLR) methods with respect to reflectance. From this the MLR models in the wavelength range of 440-480 nm was the best.

In order to evaluate the external characteristics of fruits, the machine vision non-destructive technique based on red-green-blue (RGB) color vision systems [10] have been successfully applied. Colour is an important quality factor that has been widely studied. The image grading [12] of fruits was achieved in six steps: image acquisition; ground colour classification; defect segmentation; calyx and stem recognition; defects characterization and fruit classification into different quality classes.

An ambiguity of computer vision is that [11] its results are influenced by the quality of the captured images. Often due to the unstructured nature of typical agricultural settings and biological variation of plants within them, object identification in these applications is considerably more difficult.

B. Near infrared spectroscopy

Near Infrared spectroscopy (NIRS) has been used by many researchers for quality evaluation of fresh fruits. The use of near infrared (NIR) spectroscopy was proved to be a useful tool for quality analysis of fruits. A bifurcated fiber type NIR spectrometer, with a detection range of 800~2500 nm by InGaAs detector, was used to evaluate the firmness of peaches [13]. This technique has gained a great attention in fruit quality investigation mainly due to its correctness for recording the spectra of solid and liquid samples at small cost without any pretreatment and in a non-destructive way [14].

C. Hyperspectral imaging

Another nondestructive method for quality evaluation of fruits is hyperspectral imaging technique which differs from the spectroscopy in the fact that the fruit quality attributes can be assessed from both spatial and spectral information. This makes the hyperspectral imaging technique much better than spectroscopy to extract minute details or information from the objective of better quality evaluation. Hyperspectral imaging [7] combines imaging and spectroscopic technology which is rapidly gaining ground as a non-destructive, real-time detection tool for fruit quality assessment. Hyperspectral imaging could be used for simultaneously obtaining large amounts of spatial and spectral information of fruits.

Hyperspectral imaging (HSI) is a non-destructive, rapid, and chemical free method, and is now emerging as a prevailing analytical tool which simultaneously offering spatial information and spectra signals from one object [15]. This paper illustrates the recent advances and applications of HIS in detecting, classifying, and visualizing quality of fruits and vegetables. The basic principle of HIS is that it comprises both imaging and spectroscopy which then generate high resolution images at a consecutive wavelength range. Imaging technology help to sample this image in a 2 D plane and spectroscopy studies the relationship of light and matter. Thus results to produce the physical or chemical message of the targeted area.HSI can be able to performed in reflectance, transmittance, and fluorescence and scattering mode. More importantly, morphological calibrations that are essential for non flat objects as well as feature wavebands extraction for model simplification are provided. Then here specifically categorized the physical and visual attributes such as size, shape, weight, color, and surface defects into safety features assessment, textural characteristics inspection, and biochemical components detection.

V CONCLUSION

In this paper we first done a detailed review on artificial fruit ripening and discussed the various artificial ripening agents. Then here disclose the main three recent non-destructive methods to evaluate the quality of fruits, such as machine vision, near infrared spectroscopy and hyperspectral imaging. Among these techniques the much better one is hyperspectral imaging. Due to the limitations of non-destructive techniques such as machine vision and spectroscopic techniques, hyperspectral imaging was developed. Hyperspectral imaging has several merits over RGB imaging and is a recent research area in chemical imaging for fruit quality assessment.

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