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Quality Deduction of Fruits and Vegetables using Thermal Image Processing Technique

[1]Dr.A.Reni, [2]Prathyusha K S

[1]Associate Professor, Department of Food Processing and Preservation Technology,

[2]Reserach Student, Department of Food Processing and Preservation Technology

School of Engineering

Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, India.

ABSTRACT

With the globalization of world trade as well as the increasing demand of high-quality and safe agricultural products and food by consumers, many countries pay close attention to a more stringent food safety and quality standards. The use of this technology is to detect infrared radiation meaning the heat source and it generates the electrical signals from these laser signals. At present times traditional grading methods have been used broadly, but high cost and some inconsistencies guide post harvesting industry led to automation applications in classification operations. Inconsistencies associated with manual grading decrease when automated grading systems are used, resulting in decrease of the error rate and cost, while on the other-hand it speeds the increases. Tedious human inspection task for sorting vegetables, is reduced by designing an automated system consisting of developed conveyer platforms.This project suggests an efficient non-destructive Infrared Thermal Image Processing Technique for Quality Detection cum separation of vegetables mainlyto prevent the post-harvest losses.

Index Terms - Vegetable, Thermal Image processing, Quality Detector, IR Image sensor, non-destructive method

1. INTRODUCTION

Around 10% of Post – harvest losses is incurred in total food grains due to insects, rodents, micro-organisms, inappropriate storehouse etc. In India, about 14 million tonnes (MT) of food grains of worth Rs. 7000 crores warehouse losses have been lost annually. Among these losses, insects alone are responsible for losses of about Rs.1300 crores Banga *et al.*, 2020. Insects not only cause the losses in profitable terms by consumption alone but also due to spreading impurity also. About 600 species of insects was in stored grains and among these, about 100 species caused profitable losses in stored grains[1].

Insects and other pests are a major trouble to grain product and responsible for direct and indirect losses of grain on the farmstead and storehouse. According to Mihale *et al.*, insects are responsible for 10-60% of the pre and postharvest losses of grains in developing countries, together [1]..

Consumption of legumes by pests similar as insects during storehouse and microbial breakdown or impurity may make these fully uneatable and also it's a significant problem for the food assiduity. Losses as high as 50 are frequently encountered in some of the important legumes similar as bean, field pea, chickpea and lentil from some truculent storehouse insect[3]..

Food processors are gradually probing new and innovative technologies for food quality and safety profiling. TI or infrared (IR) thermography is a 2-dimensional, non-contact individual approach for measuring outside temperature of materials which can be usefully employed in non-destructive quality evaluation [4]. The eventuality of this method was first demonstrated. 50 years ago, however the first reported TI studies were limited due to the poor perceptivity of the TI systems available. Technological advances have led to the adding use of TI as a individual tool recording spatially resolved images of face temperatures. TI is extensively used in surveillance operations and was firstly designed for US military use in night vision. Still, with the advancement in computer logical tools with digitalized high- resolution imaging, it has plant operation in colorful other fields including drug, material science and fire safety [2]. It enables spotting of people or objects whose exterior temperature is distinguishable from that of background objects. In the medical knowledge, thermal imaging has been shown to be a useful system for analyzing patterns of temperature change, which can help detect areas of maximum heat product [4]. TI quantifies the changes in exterior temperature with high temporal and spatial resolution compared to single point measures as in the case of other contact approaches (Eg. thermocouples, thermometers). Non-destructive evaluation ways give information of product lots similar as discontinuities and separations; structure; ambit and metrology; physical and mechanical lots; composition and chemical analysis; stress and dynamic response; hand analysis and abnormal sources of heat [5]. TI systems are suitable for a wide range of operations due to their portability, real time imaging, non-invasive Andon-contact temperature dimension capability. They can also be applied to real food systems without revision (Nott and Hall, 2017). Temperature mapping where both spatial and temporal temperature distribution patterns are attained from an object have implicit operation for food product quality assurance, safety profiling and authenticity compliance. Adding demands for neutrality, thickness and effectiveness within the food assiduity, have needed the preface of computer

Thermal imaging is a methodology to convert the unnoticeable radiation pattern of an object into visible images for attribute extraction and analysis. Thermal imaging has implicit operations in important post-harvest operation similar as discovery of foreign accoutrements in food, quality evaluation of fruits and vegetables, quality testing of meat, temperature mapping in cooked food and grain, drying, and discovery of faults in packaging. The major advantage of infrared thermal imaging is thenon-invasive, non-contact, and non-destructive nature of the approach to determine the temperature distribution of any object or process of interest in a short period of [4]. Thermal imaging is a method to convert the unnoticeable radiation pattern of an object into visible images for feature extraction and analysis. Operation of thermal imaging for the discovery of all insect is grounded on the temperature difference due to heat produce due to respiration compared to grain temperature. Manickavasagan and White (2008) studied the temperature distribution pattern of over-ran wheat kernel and observed a strong correlation between the temperature distribution patterns of infested grain surface with the respiration rate of each insect experimental stage. These studies show the potential for on- line continuing finding of food grain infestation. Lately thermal imaging has plant operations in various food processing operations including the process of monitoring, product development and warehouse analysis.

Thermal imaging cameras can continuously register the thermo-grams and the estimation can be done on a conveyor belt[5].. The use of thermal imaging offers an alternative method in detecting insect infestation as the respiration of insect results in heat production higher than that of the grain. The mapping of the surface temperature of grain, insects can be detected. [6].

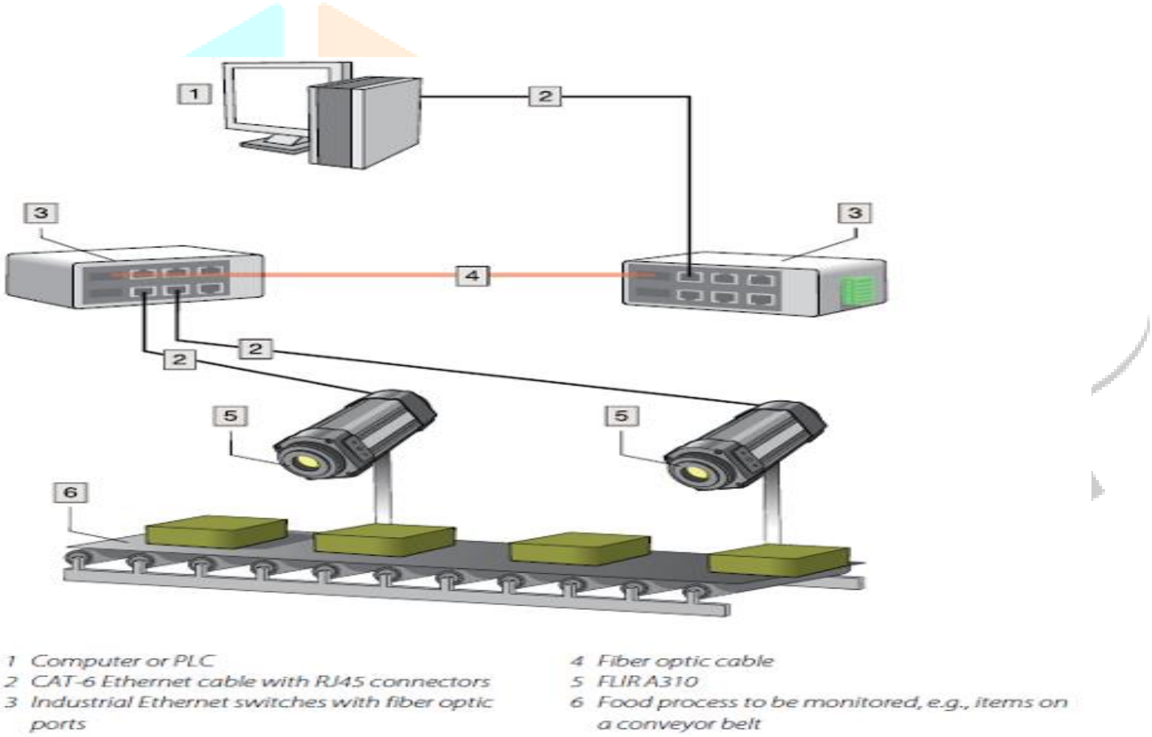

Fig. 1. Thermal Imaging in Quality Detection of Fruits and Vegetables

2. LITERATURE REVIEW

Food processors are progressively researching new and innovative technologies for food quality and safety profiling. TI or infrared (IR) thermography is a 2-dimensional, non-contact individual approach for measuring surface temperature of materials which can be usefully employed in non-destructive quality evaluation. Non-destructive evaluation methodologies furnish information of product properties similar as

- ✓ Discontinuities and Separations
- ✓ Structure
- ✓ Dimensions and Metrology
- ✓ Physical and Mechanical properties
- ✓ Composition and Chemical Analysis
- ✓ Stress and Dynamic response

2.1 Contamination in fruit

It's an exacting problem to determine contamination in fruit that are generally take place underneath the skin of fruit. finding defects additionally hugely affected by numerous factors like time, adulterant type, contamination extremity, fruit difference, and fruit pre-and postharvest states. The fruits which are grew naturally aren't yellow uniformly; rather, they're of green and yellow. Whenever mango and papaya are constantly orange/ yellow or tomatoes are red, likewise fruit vendors may have been used Calcium carbide; similarly, banana fruits can be identified when the stem is dark green where the remaining portion of banana fruits are yellow. To determine similar kind of problem in fruits Thermal imaging approach is used. The image is captured by Thermal Imaging Camera FLIR (ThermaCam E45). Thermal camera detects the blights in fruits. If fruit is matured by calcium carbide means it's contaminated by calcium carbide and when image of that banana fruit is taken by thermal camera further it represents the information of an image in terms of temperature. The different temperature profile of each sample is generated by thermal camera and category of an image is done by using artificial neural network.

2.2 Postharvest quality

Mechanically damaged fruits and vegetables result in significant profitable losses for food processors due to disabled appearance, increased microbial contaminant and accelerated growing (Varith et al., 2003). With the advancement in imaging technology on- line finding of subtle bruises on fruits & vegetables is possible. Non-destructive approaches for detecting bruise damage in fruits using imaging technologies including hyper-spectral imaging have been reported Cullen *et al.*,2007. Thermal imaging also shows implicit for objective quantification of bruise damage in fruits & vegetables. The first operation of thermal imaging as a potential way approach for bruise spotting in apples was reported by Danno et al.,1980. They monitored bruised apples under changes in temperature by means of natural convection, the author also employed TI to detect bruises on apples, observing 100 bruise discovery for Fuji and McIntosh apples at stored at 3 °C and air- warmed at 26 °C within 180s. Differences in the temperature between the bruised and sound tissue were attributed to thermal property differences. And concluded that the bruise discovery was altogether due to the variation in thermal diffusivity, not due to thermal emissivity differences since they observed no temperature differences between bruised and sound tissue under steady state conditions. Suggesting that α was high in bruised than in sound tissues. With the high α bruises can transfer heat from the apple'ssurface into the sound interior tissue briskly than can the circling sound tissue, resulting in lower skin temperature in bruised than in sound tissue.

2.3 Foreign body detection

The sight of foreign bodies in food is a major food safety issue. Graves, Smith & Batchelor (1998) summarised the approaches to food quality assurance with respect to foreign body finding. Meinlschmidt and Margner (2003, 2002) showed that the cooling actions of food and typical foreign bodies is different and could be exploited for distinguishing thermal images. They developed a thermal imaging system to determine foreign materials (rotten nuts, hard shells, and headstones) in hazelnuts. These studies showed that images with high contrast to separate foreign bodies could be made by using a flash light to heat the hazelnuts[7]. The author carried out experimentations on foreign body detection using active thermography. They described that the distinction between foreign bodies and food material by thermal imaging is possible due to differences in their thermal properties. Warmann and Märgner 2005 applied three different image processing approaches (thresholding, texture analysis, fuzzy intellection) for quality examination of hazel nuts using thermal imaging. The former two were found to be fit for the examination of large amounts of hazelnuts carried on a conveyer belt.

3.1 Image Acquisition

The images of the legumes are caught through the thermal camera (RGB picture). The Image obtaining is the initial phase in framework advancement to get the specimen or the image.

3.2 Image Pre-processing

Before analysis and recognition can be done, preprocessing has to be performed in order to enhance the image information content. The preprocessing consists of the following steps:

1) Dead pixel correction;

2) First enhancement filter application;

3) Second enhancement filter application;

4) Shading correction; and

5) Histogram stretching.

3.3 Image Segmentation

Image segmentation implies dividing of image into different zone having same components or closeness. The division is done using different methodologies k- means clustering,"otsu" strategy and changing over RGB picture into HIS model and so forth. Converting RGB to grayscale image. Segmentation and pre-processing undertaking are the beginning stage before the picture is applied for the following procedure. Principal of this procedure is to develop the binary image. The RGB grayscale is such a particular portion of such hued pictures. Where in one pixel point change in the range between 0-255, the same as the definition of the shadowing image of the grayish scale image.

3. THERMAL IMAGING SYSTEM

3.1 Feature Extraction

Colour and texture features can be used to identify infected and non-infected grains.

3.2 Colour co-occurrence Method

Let i and j are the coefficient of the co-occurrence matrix at the co-ordinates (i,j) and N is the dimension of the co-occurrence matrix..

3.3 Texture extraction

Energy (E) can be characterized as the measure of the degree of pixel match replication. It guarantees the thickness of an image. At the point when pixels are elementally the same as, the vitality estimation will be vast.

4. FUTURE DEVELOPMENTS

Thermal imaging presents many possible applications in food safety assurance and quality monitoring. As cheaper high- resolution IR sensors are developed, it's imaged that this technology will get more-wide in the food industry. Still, a number of limitations must be overcome before it's to be broadly adopted as an online magnitude tool for food quality. One of these is the need for cooling or warming of the product to help temperature contrast. The heating/ cooling process may alter the food product in an undesirable way, since utmost foods are sensitive to changes in the ambient temperature. Thus, the design of monitoring systems grounded on TI would need to be product specific, taking into consideration temperature forbearance of the foods to be monitored [8]. Obviously, similar heating or cooling systems would need to have a even spatial distribution over the field of view of the camera, other variations in the heat distribution would add unwanted variability to the thermo-gram.

5. CONCLUSION

Thermal imaging is an arising tool for food quality and safety assessment in the food industry. Study till date shows that chances exist for its implicit operation in food quality and safety control. Numerous of the operations of thermal imaging discussed are still at the experimental stages; additional investigation should be concentrated on facilitating the fabricated adoption of this method. Ultramodern TI is a quick, non-invasive, non-emitting approach and with upgrading technology is growing more reliable, user-friendly, accurate and cost effective. Given these attributes and the possible operations agitated, increased relinquishment of this technology by the food industry for improved effectiveness.

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