# Food Safety Inspection and Control Using Hyperspectral Imaging: A Review

**Samir Sawant[1], Yash Patole[1],Chinmay Sawant[1] and Asst. Prof. Diyva Kumawat[2]**

[1-3]University of Mumbai, Atharva College Of Engineering, Mumbai
[2]Assistant Professor, University of Mumbai, Atharva College Of Engineering, Mumbai

**Publication Info**

***Article history:***
*Received : 26 February 2020*
*Accepted : 19 May 2020*

***Keywords:***
*Hyperspectral imaging technique, Image reconstruction, Spectrum, Defects, Wavelengths.*

***Corresponding author:***
*Prof.Diyva Kumawat*
***e-mail:*** *divyakumawat@atharvacoe.ac.in*

**Abstract**

*Food health is a huge public concern, and if not taken seriously, it can lead to major outbreaks of food-related diseases that can turn out to be a very severe cause of social disruption. In food and agricultural applications, there is a major necessity to have a fast and mobile technique to increase the safety of foodstuffs production. In these situations, hyperspectral imaging has proven to be an efficient major in such a situation that is both quick and reliable and can assist in inspection and monitoring of food health. Including the identification of meat and meat bone-in foodstuffs as well as organic residues in food processing equipment are also documented because of their close association with food safety regulation, learned from different studies. Hyperspectral imaging gathers and integrates information from across the electromagnetic spectrum, close to other spectral photography. Hyperspectral image's main objective is to obtain spectrum information for each pixel in the picture taken from some random scene. An image is captured using a hyperspectral camera. This camera is built by various modules such as spectrometer, a microprocessor for image processing, and various lenses to attain all details of an image. This helps in detecting, identifying various objects, processes, and materials. This camera can be used in different fields to detect materials, components, gases, chemicals, elements, etc. in space stations and space missions, chemical reactions, laboratories, food detection systems, etc. With the above hypothesis, it can be seen that various hyperspectral imaging techniques, including hyperspectral near-infrared imaging, hyperspectral fluorescence imaging, etc., or their combinations can be used as some useful tools for food inspection and health monitoring. In this article, we will present a hyperspectral imaging technique that will help distinguish by contrasting their wavelengths between a fresh food product and a rotted food product.*

## 1. INTRODUCTION

Food protection refers to careful handling, preparation, and storage of food to protect people from foodborne diseases such as bacteria, fungi, bacteria and viruses, cramps of the stomach, diarrhea, fever, muscle cramps and more can be caused by foodborne disease. We will use available technology to detect any interruptions in the food produced, which is a rational thought. Hyperspectral imaging has been used widely in health and food health evaluations. The hyperspectral imaging method acquires spatial and spectral knowledge by integrating conventional imaging and visual techniques of food and agriculture. Hyperspectral images are usually triangular (3-D), with broad spectral dimensions and spatial dimensions. A hypothesis has been made that hyperspectral imaging can be regarded as one of the most successful ways of achieving automated testing, contributing to the removal of complete food safety issues. The naturally occurring hyperspectral imaging approach is ideal for evaluating moving materials because grocery products are typically in line with the development and production line. Hyperspectral imaging techniques have received significant interest from both academic and industrial sectors, and have been extensively researched and developed over the last 15 years for use in food and agricultural applications[1,4]. Hyperspectral imaging-scanning methods continue to extend the reach of their applications, adding new measurement principles and new instruments. Globally, food safety is a major concern, and many works continue to provide a technique or system for minimizing hazardous food products and their development. In the food and agricultural fields, there is an urgent necessity to create a mobile method to accomplish this need. A camera module will be used to reduce such harmful production and manufacturing of such food products. This camera module will be built in such a way that it will straight away give an output that will tell us which part is harmful or rotten and is not adequate to consume.

## 2. LITERATURE REVIEW

Seoung Wug Oh has presented an innovative way for recreating hyperspectral images with multiple everyday use digital cameras rather than a hyperspectral camera which would be extremely expensive. In order to reconstruct a sharp hyperspectral image , captured an image of the same subject using 6 different cameras at the same time using a common source of light. These images are then compared for their variation in spectral sensitivities. Best of those 3 images are further processed to reduce noise, also compared the reconstructed image to ground truth image which was captured by a hyperspectral camera. After comparing, the error is calculated and corrected and we get an approximate copy of a hyperspectral image. This method causes trouble when it is performed under fluorescent light. [1].

Alberto Signoroni et. al shows applications of hyperspectral imaging in different fields of science like Image Spectroscopy, Agriculture, Digital Microscopy, Tissue Imaging. Using HSI in 3D reconstruction and hyperspectral acquisitions have proved to provide more reliable and accurate results compared to the traditional methods. HSI also processes data from an invisible spectrum . In the field of food and agriculture , HSI has proved to be useful in inspecting food quality, adulteration, disease identification,freshness, etc[2].

Stefano Selci helps in the understanding of the expanded use of hyperspectral imaging in detail stated that HSI gathers information of each and every pixel where every pixel is associated with its own properties. It states extensive use of HSI in chemo-physical identification of materials , basically to identify unknown natural or synthetic chemicals and gases. Useability of HSI can be extended to invisible spectrums like infra-red and ultraviolet , therefore gases which absorbs these light like iodine vapor, nitrogen dioxide , chlorine can be identified easily, it also explains the use of Raman spectrometer to enhance the performance by using multichannel detectors which optimizing binary compression during post-processing of the image. [3].

Xiaona Li et. al provides a piece of extensive information on the recent development of hyperspectral imaging applications in food and food products, quality inspections, etc. Hyperspectral imaging andspectroscopic technology are rapidly gaining tools for food quality and safety assessment. In this paper imaging applications are discussed in relation to various fields such as, in food quality inspection, security issues, chemical gas reactions, detection of rare materials. Furthermore, this platform can be widened by introducing different spectral profiles.[4].

### 2.1. System Model

Various java programming IDLEs such as NetBeans and eclipse have been used for programming purposes. We have also analyzed various wavelength datasets of different food products available along with the food images captured from the camera module. . The functioning of this camera module will depend on the microprocessor and lens attached to it. While all wavelength detection and other programming modules would be supported by a software driver based on Raspberry Pi.

The block layout above consists of one-of-a-kind picture processing modes alongside with an exterior digital camera module. This digicam module is designed as an choice for acquiring photographs of food. There is a last block already created with the aid of the blocks for finding out the overall performance of the imaging phase. Multi-channel picture is saved in the digital camera module, and transferred to the subsequent section, i.e. multi-image processing unit.

After this processing stage the processed photograph will be retained for photo reconstruction, which will be substituted for the subsequent stage in thepredominant memory. The reconstructed photo has unique wavelengths of an appropriate component and the extracted photograph is then organized for software-based processing, which then offers the last end result to the corresponding device.

In our proposed method, we have captured some sample food images (fresh and rotten) and converted them into RGB format. We have worked on two food products apples and guavas in this process. After the conversion step, the converted images were analyzed and the hue of these converted images was calculated for obtaining the wavelengths of the food samples. For acquiring wavelengths of any image we require the hue value of that image sample. Accordingly, various hue values were calculated and multiple wavelengths were obtained from different food samples. After that, we compared these multiple wavelengths obtained to find out the average wavelength of the food sample. Two varieties of wavelengths were obtained for fresh and rotten food samples. After acquiring the average wavelengths of fresh and rotten food samples, we compared these wavelengths to find out the difference in the fresh and rotten or damaged food products. Accordingly, in the case of apples, we found out that all the fresh apples

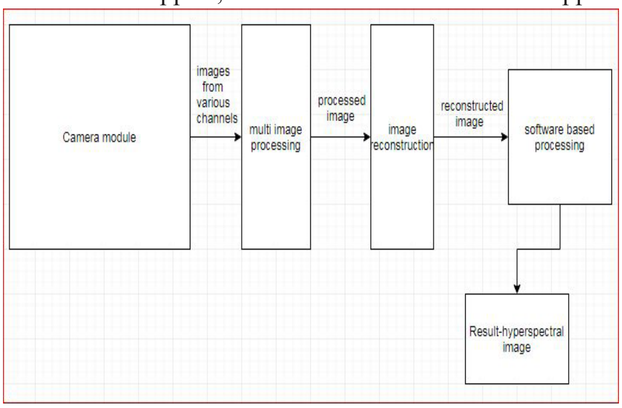


**Figure 1:** Block diagram of the pictureprocessing modules

had a different range of wavelengths compared to the wavelengths of rotten apples. In the case of guavas, we found out that all the fresh guavas had a similar range of wavelengths whereas, the wavelengths of rotten guavas were different.Similarly, using this approach, we will also be able to identify defects in different food items.

## 3. CONCLUSION

This paper summarizes the use and advantages of hyperspectral imaging used in food safety and control. Hyperspectral imaging is a popular technique that can extract both spatial and spectral information from an image sample. There are many benefits of hyperspectral imaging in the area of food safety and control. The primary benefit of this technology is that it obtains an entire spectrum at each point of the sample image, which then allows others to access the data without prior knowledge of the sample. Secondly, this approach provides a full overview of the development of new methods and techniques for scanning and analyzing product samples in other fields of technology. The lens used in the camera module provided us with distinct images of food items for processing. Furthermore, this technology can also be used for plant disease detection and plant protection processes.

## 4. REFERENCES


[1] Alberto Signoroni , Mattia Savardi , Annalisa Baronio and Sergio Benini " Deep learning meets hyperspectral image analysis", Information Engineering Department, University of Brescia, I25123 Brescia, Italy

[2] HIS Wikipedia: https://en.wikipedia.org/wiki/HyperspectralImaging.

[3] Hyperspectral imaging:https://link.springer.com.

[4] Seoung Wug Oh "Do it yourself hyperspectral imaging with everyday digital cameras", DOI 10.1109/CVPR.2016.270.

[5] Stefano Selci "The future of hyperspectral imaging",Institute for Photonics and Nanotechnologies, ARTOV C.N.R., Via del Fosso del Cavaliere 100, 00133 Roma,Italy.

[6] Xiaona Li, Ruolan Li, Mengyu Wang, Yaru Liu, Baohua Zhang and Jun Zhou, "Hyperspectral imaging and their applications in the non destructive quality assessment of fruits and vegetables", DOI: 10.5772/intechopen.72250.


 