Quality Detection System for Bananas

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***Abstract*—The issue of food being artificially processed to serve the market's need is not new. Especially, in a developing country like India, with the low ratio of number of good to bad bananas being sold and constant market competition to make profit, vendors resort to selling artificially ripened bananas. This calls for a system that differentiates between a modified and un-modified banana. Distinguishing a good and bad fruit with mere eyesight is a tough task, even for experts. Our system detects the quality of the fruit through hyper-spectral imaging. The IoT technology serves as a bridge between the information created and analysed. Analysis is done using Machine learning.**

Keywords— Internet of Things (IoT), Banana Quality, Machine Learning, Hyper-Spectral Imaging

I. INTRODUCTION

Calcium carbide- (CaC2) is used to easily generate low levels of ethylene gas which can hasten the (outside at least) ripening of fruits like bananas, mangoes etc. Consumption of carbide-ripened fruits is extremely hazardous to health, primely affecting the nervous system. Acetylene, generated from carbide reduces oxygen supply to the brain. In acute stage, it causes headache, vertigo, dizziness, delirium, seizure and even coma. In the long term, it may produce mood disturbance and loss of memory. Immediately after consumption, there may be abdominal pain, vomiting and diarrhoea. Other toxic effects include skin burn, allergy and jaundice. For this reason, it is very essential to restrict our consumption to good quality fruits. Over the years, economy has steadily grown and resulted in increased prices of all day to day commodities including fruits and vegetables. Given the health concerns surrounding artificially modifies fruits and the increased costs, it exemplifies the need for a quality detection system. The detection of quality is a tedious task since it involves chemical tests. Installation of a single unit of our system in each selling point (supermarkets and export units) can be used for evaluation. Furthermore, results from each evaluation are stored on the cloud, resulting in increased accuracy. This provides a simple and cheap method to determine the fruit's quality.

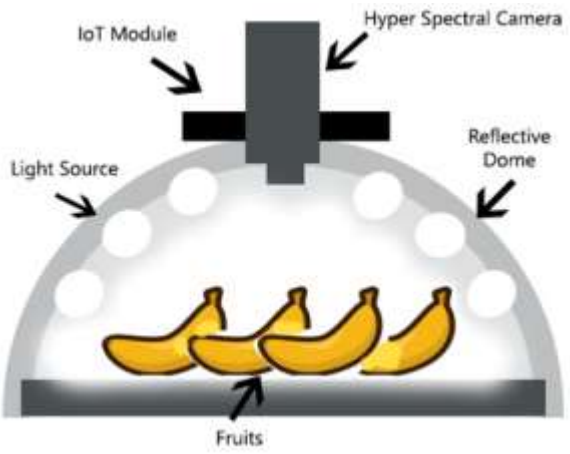

Fig. 1. Product Design

II. PRODUCT DESIGN

The fruit (in our case Banana) is placed inside a reflective dome. The lights inside the reflective dome provide the required brightness to capture a clear image of the banana through the hyper spectral camera. The reflective dome concentrates the light on the fruits. The hyper spectral camera transfers the image through the IoT module to the cloud storage. A machine learning algorithm is deployed over the images as described in the flow diagram (through the web interface). The image and the results are stored on the cloud.

(1) Images of the fruit are captured using a hyperspectral camera and a normal camera in the IoT module. The hyper spectral image is used for analyzing the interior layer and the normal image is used for the exterior layer.
(2) The images are individually analyzed. They are first

subjected to a clustering algorithm that find patterns within the image to identify sections that can be compared to the existing data.

(3) The internal and external images ae superimposed to consider both layers simultaneously and fed to a clustering algorithm.

(4) Three level evaluation is carried out. First, the external is mapped to all the similar external layers in the database. Second, the internal layer and superimposed images are mapped. With a priority ratio of 1:5:4, the external layer, internal layer and super positioned images are chosen respectively for further analysis.

(5) Feature selection algorithm is used to obtain the best set of features for the lowest error rate.

(6) A final classification algorithm is run to identify if the obtained image is artificially modified.

Initially, a chemical test performed with a sensor solution that contains bio-functionalized gold particles accurately determines and classifies good bananas from modified. When the solution is mixed with water and the fruits are washed in the solution, the color changes if the fruit is modified. (Source: Food and Technology Department Puducherry)

III. WORKING

We propose a system wherein o the overcome the morbid health effects of a modified fruits and to provide an economically feasible solution. Using hyperspectral image captured of the fruit, the system can view the interior of a banana (determines composition pattern and density). The exterior view provides the color, texture, and spot density. Using the Machine Learning approach to Pattern Recognition, we test the quality of the fruit by matching it to the patterns to good and bad fruits.

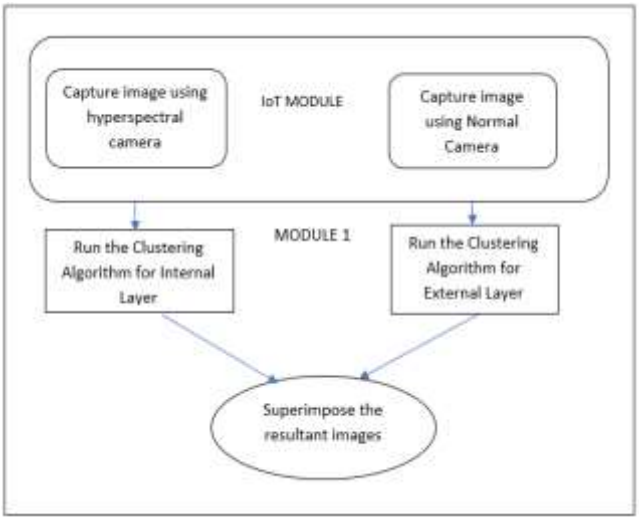

Fig. 2. Module 1

A. *Module 1*

Two images are captured using the hyper-spectral camera and a normal camera. To find patters in the inner layer and external layer (to gather visible features like Colour Density, Texture, Uniformity of Colour, Existence of spots) that suggests good quality, a clustering algorithm (k*-means clustering) is run on either capture. The results are superimposed so as to treat the pictures as one and run further clustering.

B. *Module 2*

After the results have been super imposed, the clustering algorithm is run for the third time. This time, it correlates and identifies relations between the internal and external layer while considering the quality based on supervised learning. The internal layer is then mapped to its 'true' external layer (based on quality) after which a feature selection algorithm is run (PCA). This data gets stored on the cloud.

C. *Module 3*

The web interface allows ease of access and also is where the analysis takes place. It accesses the preloaded datasets through the Cloud storage. A classification algorithm (k*-means algorithm) is used to classify the quality factor of the fruit. It is proven to be computationally faster and is easier to implement.

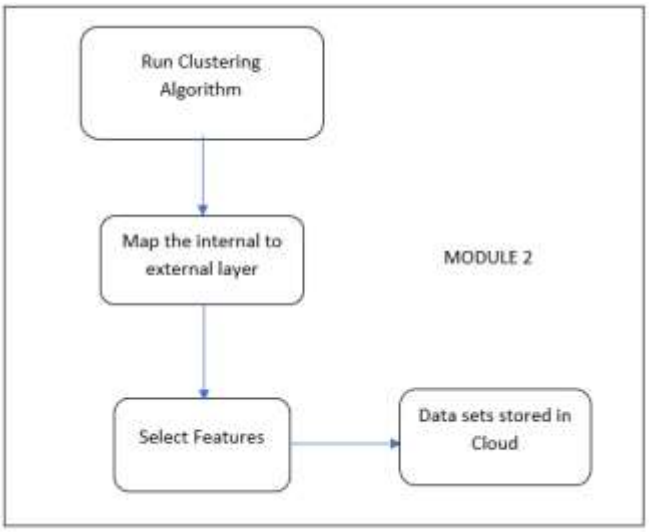

Fig. 3. Module 2

Fig. 4. Module 3

IV. TECHNOLOGY USED

A. *Hyper spectroscopy*

Hyper spectroscopy gives deep insight into the fruit or vegetable. It works on the principle of scattering of light into different wavelengths when it hits different surfaces. It collects and processes information from across the electromagnetic spectrum. The goal of hyper spectral imaging is to obtain the spectrum for each
pixel in the image of a scene, with the purpose of finding objects, identifying materials, or detecting processes.

B. *Image Processing*

Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. It is a type of signal processing in which input is an image and output may be image or characteristics/features associated with that image.

C. *Pattern Recognition*

It involves finding the similarities or patterns among small, decomposed problems that can help us solve more complex problems more efficiently**.** In our case, we use pattern recognition to identify clusters that match the clusters of a genuine fruit. We use Machine Learning for Pattern Recognition.

D. Internet of Things

The internet of things (IoT) is a computing concept that describes the idea of everyday physical objects being connected to the internet and being able to identify themselves to other devices. It has a significant application to all futuristic projects.

V. CONCLUSION

With economic growth, fruit prices have risen through the years. The detection of quality is a tedious task and involves the use of chemicals. In order to provide a cost-effective solution, a single unit of our system can be remotely installed and data that is need to classify the fruit can be accessed through cloud. This provides a simple and cheap method to determine a fruit's quality as it can be accessed through the web interface on one's phone. It helps consumers to distinguish between natural and artificial fruits to lead a healthy life with minimal effort.

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