- **Smartphone-Based Image Analysis for Rapid Evaluation of Kiwifruit Quality during Cold Storage**
  (Link: https://www.mdpi.com/2304-8158/11/14/2113)

Summary

In this paper, authors represented and analyzed 300 'Xuxiang' kiwifruit in order to observe the lifespan including rotting process in cold storage (2° C). Since kiwi is a citrus fruit, therefore, previously various methods including Vis-NIR , Sinclair IQ Firmness Tester (SIQ) and RGB image processing were used to detect the pH level, lifespan of kiwifruit, quality index and flavor compounds for extending the cold storage life. Here, authors used some tools, for insurance, temperature compensated refractometer NMR analyzer for identifying the weight loss, firmness, total soluble sugars, soluble solid as well as the shelf life. The main focus of this paper is how we can use smart phone image analysis using RGB recognition software for enhancing the shelf life of 'Xuxiang' kiwifruit in cold storage (2° C). Then RGB recognition will provide results following some parameters and central R/B and B/G of kiwifruit refers to the storage time. Thus, smartphones will be able to detect the freshness of kiwifruit.

Methodology

This paper used RGB recognition image processing for analyzing storage time, total plate counts, and some other factors including 1,3-Cyclooctadiene, ethylene with some other chemical ingredients. RGB images recognition analyzes the central R/B and B/G for detecting overall storage time. First of all, after taking pictures of different stages of 'Xuxiang' kiwifruit, then they carried out some chemical experiments for determining other factors like water distribution using NMR analyzer, Total plate counts (TPC), Total soluble sugars (TSS) which is measured by spectrophotometer through anthrone sulfuric acid colorimetric method. After collecting all required info, they observed the appearance of kiwifruit for 1 month in cold storage.

Components Used

The following components are used here:

1. Shenzhen Zhijie Imaging Camera
2. Colorpic App
3. Huawei P40, China (Smartphone)
4. Sartorius BSA224S electronic balance
5. Fruit firmness tester
6. SUPOR JR05-300 (Home type blender)
7. HIRP V1700G (Spectrophotometer)
8. Niumag Benchtop NMR Analyzer PQ001
9. Carr-Purcell-Meiboom-Gill
10. Chromatography–mass spectrometry (HS-SPME-GC/MS)
11. Solid-phase microextraction head (50/30 μm DVB/CAR/PDMS)

Findings

Here, they found some findings after analyzing various factors. of 'Xuxiang' kiwifruit and the ratio of R value, G value and B value using RGB image recognition using the Colorpic app from a smartphone. This image processing through a smartphone can detect the shell life of kiwifruit stored in cold storage (2° C).

Novelty

The innovative technology of this research work is using RGB image recognition technology through smartphones for predicting shelf life and quality parameters rather than using other instruments.

Analysis

Several analyses were held during this experiment including volatile flavor compounds, TSS, TPC, image processing using RGB recognition using Huawei smartphone, physical quality attributes like fruit fresh color, appearance, firmness of kiwifruit etc.

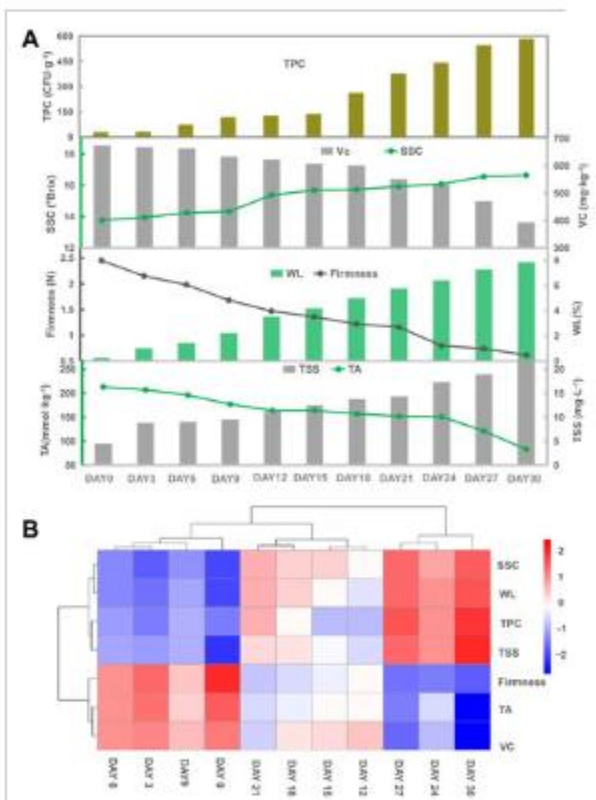

Figure 2. Firmness, weight loss (WL), titratable acidity (TA), total soluble sugars (TSS), total plate count (TPC), soluble solids content (SSC), vitamin C (VC) of 'Xuxiang' kiwifruit stored at 2 °C for 1 month (**A**). Heatmaps for quality indicators (**B**).

Research Gap
Here, every single quality analysis for better understanding of kiwifruit's lifespan including the storage time in cold places and more accuracy rate for predicting decay time of kiwifruit.

Problems Faced
While writing a summary of this research paper, the components used are not clearly defined in points. They wrote here within the material and methods segment.

Future Work

In future, instead of using RGB recognition methods in smartphones, the researchers can try to implement actual image processing through CNN and k-means clustering with Gaussian elimination for securing better identification of rotten kiwifruit.

- **An Infrared based sensor system for the detection of ethylene for the discrimination of fruit ripening**
  (Link: https://www.researchgate.net/publication/319015188_An_Infrared_based_sensor_system_for_the_detection_of_ethylene_for_the_discrimination_of_fruit_ripening)

Summary
Ethylene, a hormone for speeding up the ripening process of a fruit, can be measured through different methods, for instance, optical based sensors, e-nose sensors, electrochemical sensors etc. which are not only expensive but also accuracy level for detecting ethylene is very low. In this research paper, the authors highlighted a new approach of detecting ethylene with Infrared (IR) thermal emission based ethylene gas sensor. Since most of the fruits produce a wavelength. So applying a silicone temperature detector and infrared rays on a fruit with wavelength changing applications can detect ethylene more accurately from the absorption of IR across the fruit's wavelength and converting the output in electrical signal (mV). This can also detect original and artificial ethylene.

Methodology

First of all, for detecting the ethylene level of a fruit, a thermal wave emitter is fabricated using a micro electromechanical system. Then an estimated IR is produced and it is placed in front of a fruit. Also the silicon temperature detector detects the temperature of different areas of the tested fruit. Then a certain level of IR is being absorbed by the fruit and from here, the rest of the IR reflects which is then transformed into electrical sensors for analyzing through a software.

Equations

The ethylene concentration is measured by,

% Sensitivity = (Gas concentrat ion /Change in detector output voltage)$\times$ 100

Components Used

The list of components used here are as follows:

1. DC power supply (0-25V) (Agilent, E3631A)
2. 6½ digit multimeter
3. IR thermal radiation source
4. Silicone temperature detector
5. Gas test cell
6. Custom reflector

Findings

Previously used methods for identifying ethylene in fruit do not provide accurate results. Therefore, using Infrared (IR) thermal emission based ethylene gas sensor with silicone temperature detection is more accurate and reasonable and easier to implement.

Novelty

The novelty of this research is, they have introduced a new approach of detecting ethylene levels more accurately using Infrared (IR) thermal emission based ethylene gas sensors. This can also detect original ethylene produced by fruit and artificial ethylene.

Analysis

In the analyzing segment, they analyzed the absorption spectrum of ethylene, response and recovery time, calibration of the sensors, reproductively and estimating artificial ethylene.

Research Gap

The authors did not mention any hands on based technology like smartphones or other devices where we can use this method easily.

Problems Faced

While going through the entire process, I was having difficulties understanding.

Future Work

In future, they can implement their strategy in smartphones or other devices so that it becomes handy and cost effective at the same time. Moreover, this approach can be used in cold storage too.

- **Implementation of Deep Learning Methods to Identify Rotten Fruits**
  (Link: https://ieeexplore.ieee.org/abstract/document/9453004)

Summary

In the agricultural segment, identifying fresh and rotten fruit is essential since rotten fruits not only cause health deterioration but also fresh fruits can be affected by the rotten ones. Therefore, in this paper, the authors proposed a model to prevent the propagation of rottenness including an integrated system proposal for increasing productivity and reducing human efforts, manufacturing cost and time. Here , they have tested on three types of fruits: apples, bananas and oranges. Later on, using the Convolutional Neural Network and some other image processing methods, then training the machine on a Kaggle dataset for achieving the highest accuracy rate as 99.46%. Another research area of this paper is on CNN model for detecting fresh and rotten fruits.

Methodology

In this research, they have used some methods of image processing with machine learning techniques. First of all, they trained the machine using the Kaggle dataset. Then using Convolutional Neural Network for collecting features of input fruits, image categorizing with Max Pooling, Average pooling and MobileNetV2. For detection and differentiation between fresh and rotten fruits, CNN (Convolutional Neural Network) method is implemented here.

Equations

The following formulas are used here,

$$Precision = \frac{TP}{TP+FP}$$

$$Recall = \frac{TP}{TP+FN}$$

$$Accuracy = \frac{TP+TN}{TP+FP+TN+FN}$$

$$F1 - Score = \frac{Recall * Precision}{Recall + Precision}$$

Findings

Here they find out some accuracy rate and validation rate using CNN, MobileNetV2 and max pooling.

Novelty

The novelty of this paper is they integrated an architecture using both Convolutional Neural Network and Max pooling with MobileNetV2 for detecting rottenness of fruit.

Algorithm Used

Stochastic gradient descent algorithm and KNN clustering algorithm is used here.

Analysis

If deep CNN and Max pooling methods are applied simultaneously, then the highest accuracy rate of training data is 94.49% and validation set is 94.97%. After applying MobileNetV2, the validation accuracy reached 99.61%.

Research Gap

They only proposed an architecture for CNN using Max pooling but there is no architecture described for MobileNetV2 and CNN.

Problems Faced

The components used for this research are not clearly given here.

Future Work

In future, there is a chance of combining both Convolutional Neural Network and MobileNetV2 for better accuracy rate since MobileNetV2 has higher accuracy rate than Mix.

- **Food Spoilage Detection Using Convolutional Neural Networks and K Means Clustering**
  (Link: https://ieeexplore.ieee.org/document/8979114)

Summary

This research paper encompasses food spoilage detection by observing the color change in spoiled food. Since most of the spoiled foods change color and appearance at the time, therefore, using artificial intelligence along with image processing with Convolutional Neural Network, k cluster algorithm (a machine learning algorithm) and Hue Saturation Value (HSV) can detect the spoilage percentage of food even it is a vegetable or fruit. This system is developed for reducing food poisoning issues as well as to help the colorblind people to identify whether food is safe to eat or spoiled as they can not differ within colors.

Methodology

First of all, after collecting pictures of fresh and rotten foods, then these photos are being processed through image processing (using CNN and k cluster algorithm) and Hue Saturation Value can detect the percentage of different colors. After that, researchers can come to a conclusion by analyzing the final highest color percentage and using HSV values that can detect the spoiled food percentage.

Findings

If Convolutional Neural Network along with k means clustering and HSV values are combined together for detecting food spoilage, then it is easier for us to find whether our food is fresh or not. Moreover, this will help colorblind people to detect spoiled food using this prototype.

Novelty

The innovative part of this paper is that they combined CNN and k means clustering algorithms with Hue Saturation Value (HSV).

Algorithm Used

Here, machine learning algorithms like k means clustering algorithm and Convolutional Neural Network is used for the entire observation.

Analysis

Here, they have analyzed some pictures of spoiled and unspoiled bananas, masoor lentils and unspoiled bread. They detected color codes from different areas of food skin using k-means clustering and found the spoil percentage by analyzing the highest percentage color code.

Research Gap

They only provide three types of food's k-means clustering here.

Future Work
In future work, they can use Gaussian elimination method for noise elimination from the collected dataset and they can use histogram equalization for enhancing picture size.

- **Hybrid computational intelligence algorithms and their applications to detect food quality**

  Link: https://link.springer.com/article/10.1007/s10462-019-09705-8?fbclid=IwAR1ypV6zQn-K3iPAnQ3vQgfncPUfbL6sPumeMjox2F78koalwJmvWqeRuMk#citeas

Summary
Food quality inspection is essential for the safety of our health and identifying spoiled foods can go a long way to enhance food storage life. This paper develops an algorithm combining other three algorithms, for instance, Moth Flame Optimization (MFA), Particle Swarm Optimization (PSO) and Gravitational Search Algorithm (GSA). The combination of the MFA-GSA-PSO hybrid algorithm contains 83.33% accuracy rate which is way more than implementing only one algorithm for rotten food detection.

Methodology
The authors used algorithms 'MFA-GSA-PSO' altogether with K-means clustering for better detection of defective parts or disease (moths/ fungi can develop disease on food skin) on food skin. At the time of image processing, k means clustering can easily detect the spoiled parts and this algorithm generally breaks down images into smaller parts. Therefore, rotten food detection has a higher accuracy rate.

Equations
- Each moth travels around a flame in a logarithmic spiral, S:

  $$S(M_i, F_i) = D_i e^{bt} \cos(2\pi t) + F_i$$

- Newton’s gravitational law the force is calculated by dividing the masses by R2 instead of R,

$$F_{ij} = G \times (M_{aj} \times M_{pi})/R$$

$$a_i = \sum_{j=1\, and\, j \neq i}^{n} F_{ij}/M_{ii}$$

- The velocity of the search agent at time t is given by,

$$v(t) = v(t-1) + c_1 r_1 (p(t-1) - x(t-1)) + c_2 r_2 (g(t-1) - x(t-1))$$

Algorithm Used

The researchers used here as follows:

- Moth Flame Optimization (MFA)
- Particle Swarm Optimization (PSO)
- Gravitational Search Algorithm (GSA)
- K-means clustering

Findings

The accuracy rate of identifying rotten foods can rapidly increase if the 'MFA-GSA-PSO' hybrid algorithm is used with K-means clustering for clearly identifying rotten areas on fruit peel or upper surface of food.

Novelty

Authors of this paper used the hybrid form of 'MFA-GSA-PSO' algorithm for better rotten image detection, they also provide a previous list of various algorithmic differences in terms of food quality inspection.

Analysis

In the analysis phase, they depicted the convergence curves for benchmark functions while clearly identifying every single clustering stage of ripe mango.

Research Gap

They didn't give a brief idea about IoT based hybrid algorithmic usage for calculating the shelf life of food.

Future Work

In future, using 'MFA-GSA-PSO' altogether with K-means clustering can be implemented with IoT devices.

Problems Faced

It is not clearly written here which type of components are used in times of conducting this research.