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Automatic Detection of Inorganic Substances in Vegetables and Fruits

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ABSTRACT

As the expectation for higher quality of life necessity increases, consumers have greater demands for quality food. Food authentication is the technical means of ensuring food is what it expresses on the labels. A popular approach to food authentication is based on spectroscopy method .This approach is non-destructive and efficient but not cost-effective. This paper presents a computer vision-based sensor system for food authentication, i.e., differentiating organic from non-organic Fruits. This sensor system consists of pattern recognition software and cost-effective Hardware. These diffraction images are then converted into a data matrix for classification by pattern recognition algorithms, including *k*-nearest neighbors (*k*-NN) and support vector machine (SVM) .In this methodology we carry out experiments on a reasonable collection of fruit and vegetable samples and employ a proper pre-processing, which results in a highest classification accuracy in class. Our studies conclude that this sensor system has the potential to provide a viable solution to empower consumers in fruits and vegetable authentication.

Keywords: Sensor System, Diffraction Grating, Computer Vision, Pattern Recognition, Organic Fruits

I. INTRODUCTION

In this paper, we present a low-cost sensor system based on computer vision techniques for authentication purposes, i.e., differentiating organic apples from non-organic ones. This sensor system consists of simple components which are consumer-friendly and do not require expert knowledge to operate. It aims to provide rapid and non-destructive way that can effectively reveal the relationship between fruits data and its categorical information. In particular, the data acquired by our sensor system exhibits strong nonlinearity when the categorical information is based on organic and non-organic. We use SVM, k-NN methodology to achieve classification capability that is comparable to portable NIR spectrometers in differentiating organic apples from non-organic ones. Since NIR spectrometers are costly and require knowledge to operate on them.

Sensor System

The given sensor system aims to acquire image data from diffraction images, i.e., organic and non-organic fruit samples, by coupling low-cost method with computer vision techniques. Using a simple flashlight to illuminate the subject, a diffraction image is generated and captured by a diffraction grating sheet and camera, respectively. Then we apply a series of computer vision techniques, including image pre-processing, segmentation and rainbow generation to convert the diffraction image into a sample vector for analysis, given is the main Architecture of this model.

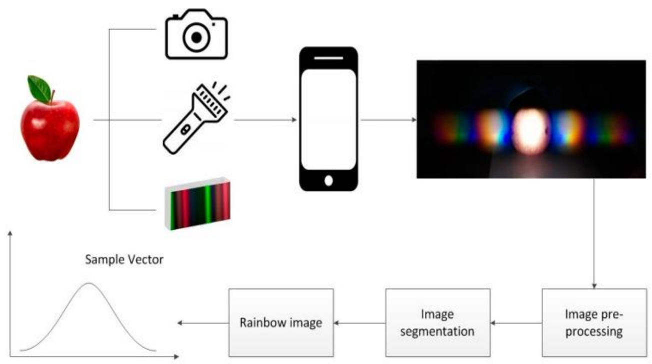

Fig-1: System Architecture

A pattern recognition framework for classifying organic and non-organic data.

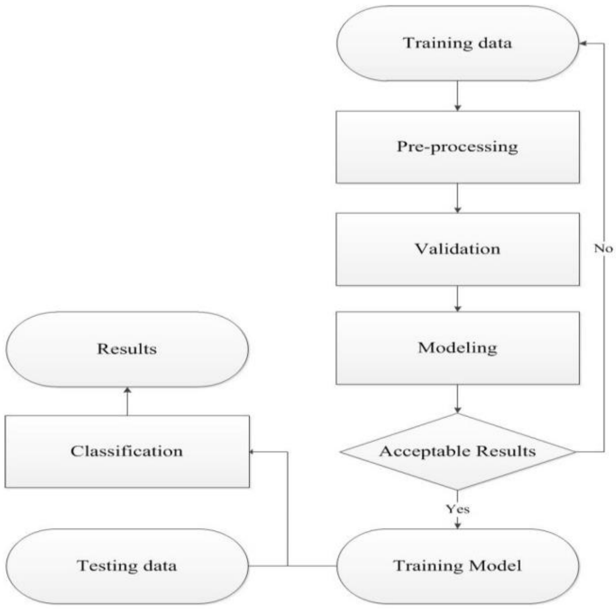

Fig-2: System work flow

II. LITERATURE SURVEY

The table given below shows various existing system or models used so for in the context of fruit classifications.

TABLE I: LITERATURE SURVEY

Sr. No.	Methodology	Advantages	Limitations
1.	Gas Chromatography (GC) with ECD(Electron capture detector)	High Resolution Quick analysis Small sample needed	During injection of sample proper attention required Fixed gas analysis
2.	Reaching High Performance Liquid Chromatography (HPLC) along with Mass Spectrometry (MS)	High accuracy High speed Good sensitivity	High Cost Complex Method
4.	Field scout chlorophyll meter 1000	Portable Easily available online	Costly(approximately 20,000rs per unit) Needs information about software

III. TAXONOMY CHART

TABLE II: TAXONOMY CHART

	Portable	Cost effective	No prior Knowledge	No Lab Setup	Accuracy
Gas Chromatography (GC) with ECD	✗	✗	✗	✗	✓
HPLC with Mass Spectrometry (MS	✗	✗	✗	✗	✓
Field scout chlorop	✓	✗	✗	✓	✓

hyll meter 1000					
PROPOSED SYSTEM	✓	✓	✓	✓	✓

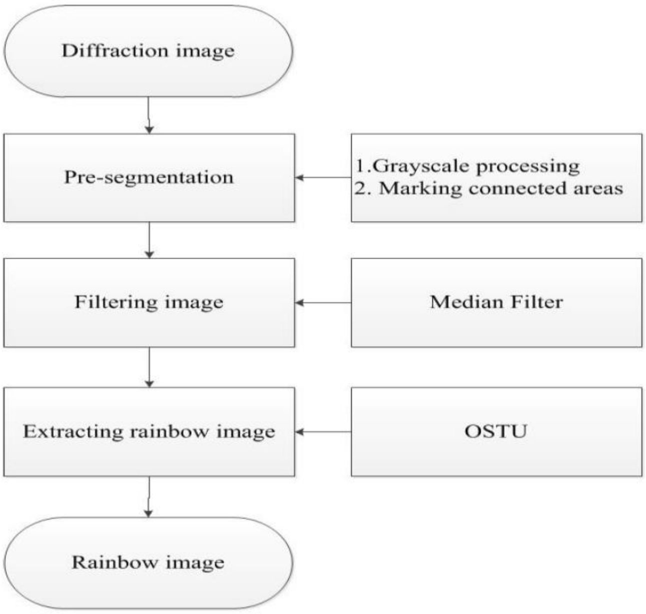

Fig-4: Framework For extracting Rainbow Images

IV. ALGORITHM

A. Diffraction Grating and image Acquisition

Input: Placed Fruit.

Output: Raw unprocessed Rainbow images on Diffraction Grating.

Steps:

1. Place the fruit and click picture with diffraction grating.

2.Use the rainbow Images for further Processing.

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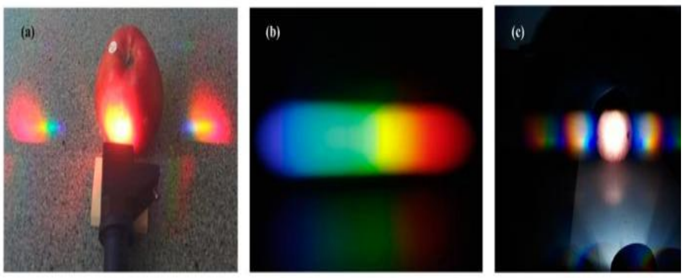

Fig-3: Static Pictures of Setup

B. Rainbow Images Segmentation

Input: capture the image.

Output: Rainbow image file

Steps:

1.Use the Diffracted Image.

2. Process using Otsu, Grey Scale method.

3.Extract the Rainbow Image.

Framework of extracted Rainbow Images:

Framework of Extracted Rainbow Images

By using OTSU (Nobuyuki Otsu) method, a single rainbow image is extracted from the original image and converted into colour histogram vectors in RGB colour space. Figure shows the original and processed images by the above procedures

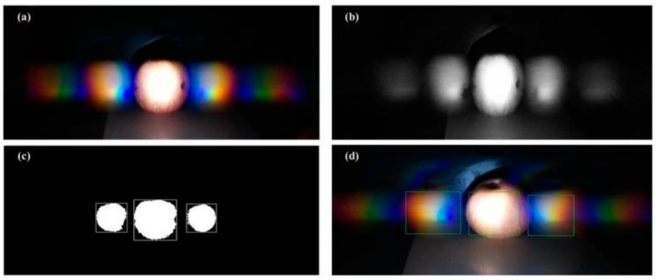

Fig-5: (**a**) The original image; (**b**) gray scale processed image; (**c**) binary image; (**d**) the resulted image.

C. Feature Vector Representation

Input: Rainbow Images.

Output: Feature vectors of Given Image.(RGB)

$F = W1 \cdot R + W2 \cdot G + W3 \cdot B$,

Following image shows the image patterns on organic and inorganic apple respectively.

$$F = W1 \cdot R + W2 \cdot G + W3 \cdot B$$

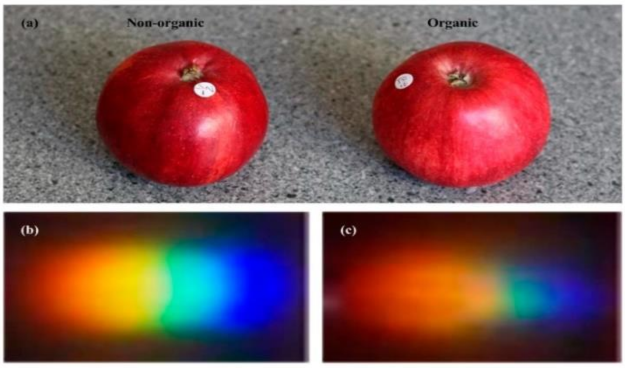

Fig-6: Non-Organic Image(left),Organic Image(right)

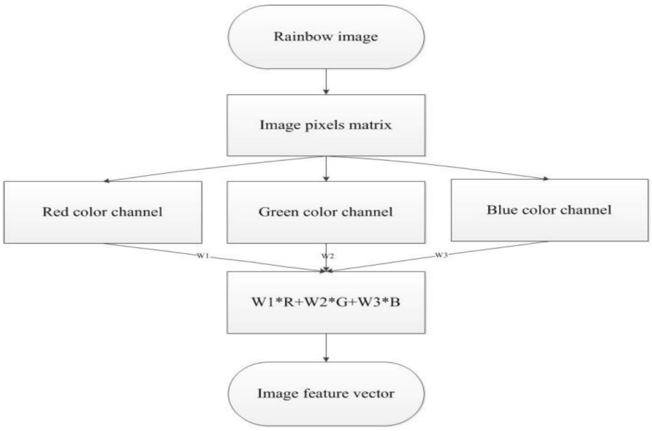

Fig-7: The framework of converting the rainbow image into the image feature vector in RGB colour histogram.

D. Pre-processing

Input: Processed Image Vectors.

Output: Smooth Noise free Data Format.

Steps:

1. Convert the Raw Data vectors into Smooth data points.

2. Represent the Normalized points.

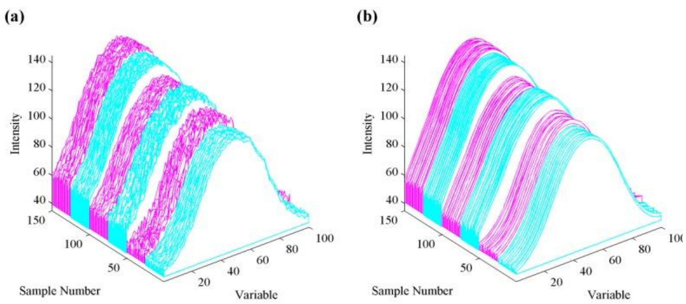

Fig-8: Raw(left) and Preprocessed data(right)

E. Data Analysis

Input: Processed data

Output: Classification into Organic or Inorganic Data using PCA

Steps:

1.Use the sample to Distinct between Organic and Inorganic.

2.Perform Given Algorithms on the data

V. RESULT

Now we compare the given output if the used Algorithms and determine the best and Most Accurate method.

TABLE III: RESULT

Algorithm	Raw	PP	Overall	Non-org.	Org.	Parameter
Knn	72	91	84	75	90	NN-1
SVM	80	89	92	92.7	86.5	C-4

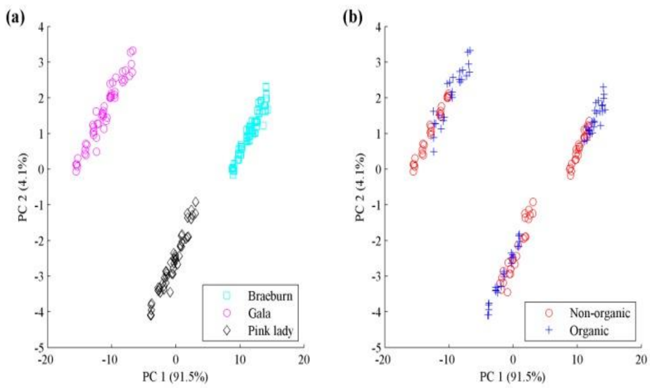

Fig-9: Score plots of the first two dimensions of PCA of apple data

VI. ADVANTAGES

1. Accurate results.

2. Easy to Implement.
3. All Individuals including Buyer and Seller of fruits and vegetables.

VII. LIMITATIONS

Requires a dark environment to capture the Rainbow picture.

VIII. FUTURE WORK

1. To Increase the amount of fruits and vegetable samples in database, which would give a better scope for all specifications of fruits and vegetables.

2. To apply more of the Future algorithms on the data to get even better accuracy in prediction.

IX. CONCLUSION

Based on all the data that have been explained in the earlier sections we can understand that Automatic detection of inorganic substances in vegetables and fruits is profitable for the shop owners and reliable way for customers as there is no such system developed to determine the organic terms of fruits and vegetables.

X. ACKNOWLEDGEMENT

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