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Develop Nondestructive Database of Seasonal Fruits and Reviews on spectral preprocessing techniques.

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Abstract: ***The sufficient nutrient is one of the most important factor in producing quality of fruits. This requires analysis of a large number of fruit samples using expensive and time consuming chemical techniques. The most popular alternative is NIR Spectroscopy to wet chemistry procedure for determine concentration of major groups of chemical compounds. It has a combination of speed, accuracy and simplicity. The NIR is a noninvasive technique increasingly used in pharmaceutical, agricultural, food and beverage industries. This paper present process of acquire spectral data of fruit, visualize this spectral data and review of preprocessing method to remove physical interferences of spectral data.***

Keywords: Non- destructive, spectral Signature, Spectroradiometer.

1. INTRODUCTION

The difficulties in food and fruits study is highly complicated and feel necessity of an coordinated creation of aware, intended for particular purpose for many practice of accepting the guess of metal in fruits have the look of deceptively simple yet this is not case Metal determination give an explanation of many are generally archives to answer three question

i. How much of nutrient mineral is available in fruit?
ii. Is the product is secure to eat or it has been infected?
iii. Is the product what it declare to be and does it follow trade laws or not?

In recent researcher has been focused to answer above question using nondestructive techniques for measuring fruits metal and quality attribute. [1] The purpose of this work is how to acquire a fruits spectral database using nondestructive technique called ASD FieldSpec4 standard Spectroradiometer .The next objective is after create database of spectral signature of fruit how to visualize and analyzed different fruit signature.

2. DATA ACQUISITION

In our experiment aim is to create a database of the Seasonal fruit using reflectance taken by Spectroradiometer. For studying this we need to take individual reading of particular fruit. Database of seasonal fruit is generated after taking reflectance of each fruits using View Spec pro application we can open and visualize the created database this application shows the collected spectral reflectance graph and also used for preprocessing.

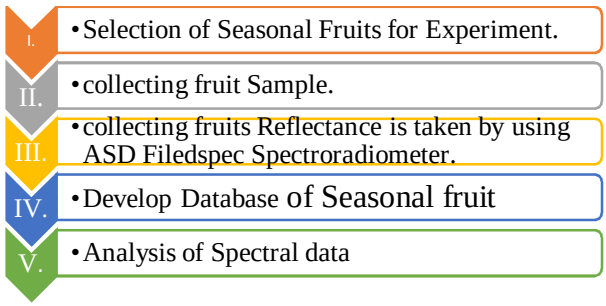


Figure 2.1 Conceptual Model of Data Acquisition.

The above figure shows the conceptual model to acquire the data of different fruits. The model having five step are explained as follows.

I. Selection of Seasonal Fruits for Experiment

In this work we used six type of seasonal fruits they are

- **Mango** (Amba name in Marathi is a summer season Fruit (March - April -May)),
- **Grapes** (Draksha name in Marathi is a summer season Fruit (June - July -August)),
- **Banana** (Kela name in Marathi is a Year Round Fruits January - December),
- **Orange** (Santre name in Marathi is a winter season Fruit March – April - May (December - January – February)),
- **Guava** (Peru name in Marathi is a Post Rainy and winter season Fruit. (September - October - November).
- **Apple** (Safarchand Year Round Fruits January - December). The chosen fruits are more edible fruits in Maharashtra (India).

II. Collecting fruit Sample.

For our study we collect all fresh fruits sample in local market of Aurangabad city is one district Maharashtra state in India. The market area name is gulmandi and shah gang which is located in main city in Aurangabad having the latitude and longitude 19.8762° N, 75.3433° E (19° 53' N, 75° 23' E).

III. Collecting fruits Reflectance is taken by using ASD FieldSpec Spectroradiometer.

In remote sensing Analytical Spectral Device (ASD)

FieldSpec 4 Standard-Res portable Spectroradiometer is used for detection, identification and Quantification of materials on the earth surface. Which covers the 350 – 2500 nm spectral range. It designed to collect solar reflectance, radiance, and irradiance data. Filed Spectroscopy is an investigation of interrelationship within the spectral attributes and biochemical element of the object. In the field and in the laboratory we can use different types of detector to get the spectral data. To check the spectral assessment we can used two categories such as

(i)Point spectroscopy: spectra are measured one point at a time.

(ii) Imaging spectroscopy: spectra are recorded as a two dimensional array of measurement. [3, 4]

Figure 2.2 working of ASD FieldSpec 4 Standard-Res Spectroradiometer.

Table 2.1: Specification of ASD FieldSpec 4 Standard-Res Spectroradiometer. [5] [6]

ASD FieldSpec 4 Standard-Res Spectroradiometer Specification	
Spectral Range	350-2500 nm
Spectral Resolution	3 nm @700 and 10 nm @ 1400 /2100
Spectral sampling	1.4 @ 350-2500 and 1.1 @ 1001-2500
Scanning Time	100 MS
Channel	2151
Weight	5.44 kg

The above table 2.1 shows the details specification about the ASD FieldSpec 4 Standard-Res Spectroradiometer. The FieldSpec 4 Spectroradiometer have three detectors such as VNIR detector, SWIR 1 detector and SWIR 2 detector. The figure 2.3 shows that the modular concept of FieldSpec 4 Spectroradiometer.

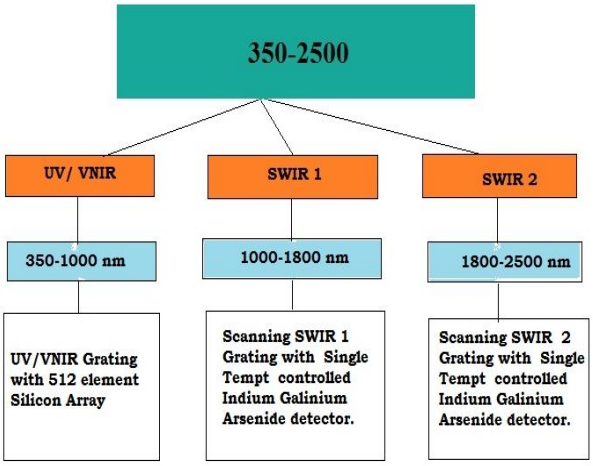


Figure 2.3 Modular concept of FieldSpec 4 Spectroradiometer. [7]

IV. Develop Database of Seasonal fruit

- **Sampling Strategy:**

To trace the metal content from the fruits we take six different fruits name as Apple, Banana, Mango, Grapes, Orange and Guava. Ten (10) sample of each fresh fruits is collected in morning time according to color uniformly and size and the weight of each fruit is measured using electrical weight meter. After that fruits sample was kept or stored in clean polythene bag and taken for lab procedure studied averaging 1and half hours after picking.

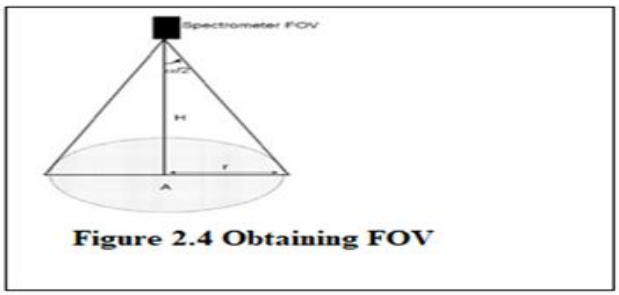


Figure 2.4 Obtaining FOV

- **Spectral Measurement**

Reflectance Spectral signature of fruits is measured using Analytical Spectral Device (ASD) FieldSpec 4 Standard-Res portable Spectroradiometer which covers the 350 – 2500 nm spectral range using RS3 software for windows in Multispectral Research laboratory, Department of computer Science and IT, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad. The reflectance is collected in dark room to control the inside condition and reduce the effect of unwanted noise.

Before taking the actual reading the instrument is need to warm up in 20-25 min. Then the following some step is carried out:

i. Firstly we need to calculate the estimated area of

Sample using formula i.e. $r = \tan\left(\frac{\alpha}{2}\right) * H$

Where r = radius of with circular FOV with area A.
H = height of the spectrometer is held above the target Surface.
α = Angular FOV for spectrometer.
$A=\pi r^2$ Where A = Area of sample.

ii. 75 W halogen lamp (Analytical Spectral Devices, Inc.USA) is used pointing at an angle of 450 to the vertical was mounted on a tripod about 40 cm above the nadir to provide uniform delivery of incident light. The distance between the light source and the detector fiber is 42 cm.

iii. The 1.5 m fiber optic cable with 80 field of view was pointed in a pistol grid and mounted on a tripod 15 cm above the observed sample to eliminate the influences the background scattering on the fruits reflectance spectra.

iv. White reflectance panel is used to get the near 100 % reflectance is systematically measured under the same conditions before the spectral measurement.

v. 10 number of scan were performed for each sample and save as .asd file for further procedure.

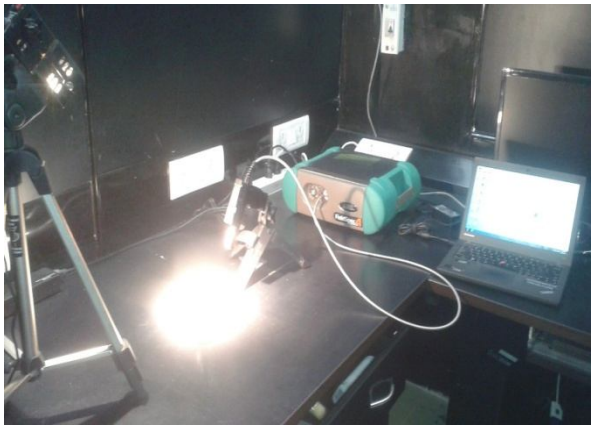
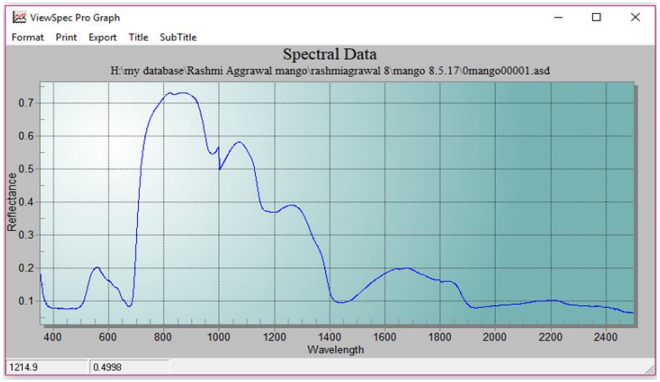


Figure 2.5 Lab setup to obtain spectral signature.

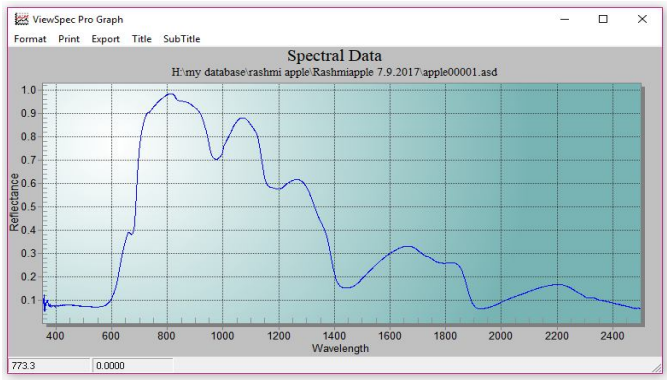
- **Obtaining spectral signature**

The collection of all spectral data is save in .asd file format and visualize using ViewSpec pro software and .asd file into the excel file and save the each sample value as corresponds to its wavelength and used for further process.

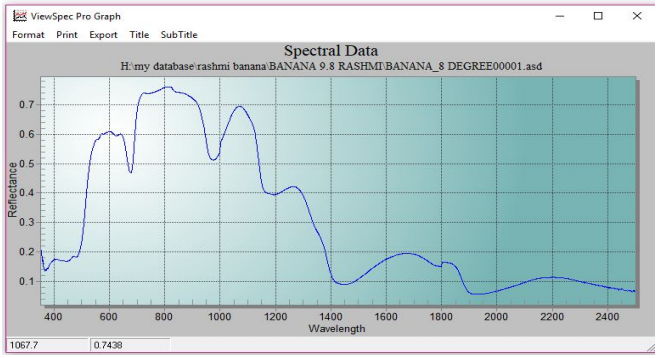
Table 2.2: Spectral Signature of Fruits.



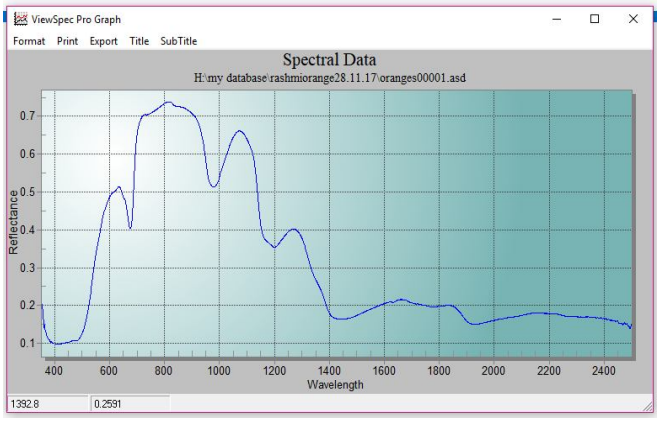
(i) spectral signature of Mango



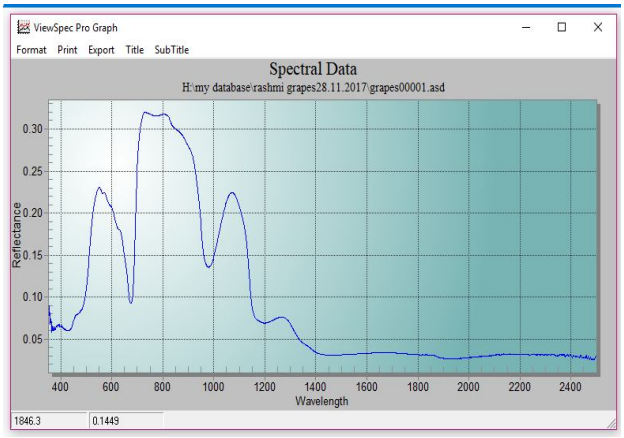
(ii) spectral signature of Apple



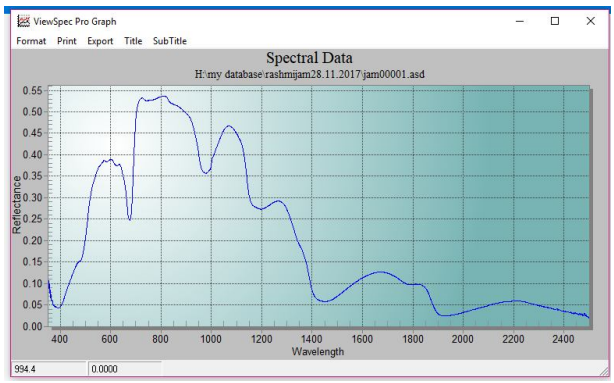
(iii) spectral signature of Banana



(iii) Spectral signature of Orange.



(v) Spectral signature of Grape.



(vi) Spectral signature of Guava (Jam).

The above table shows different Spectral signature of fruits in which
(i) Shows the spectral signature of mango, (ii) shows the spectral signature of apple, (iii) shows the spectral signature of banana, (iv) Spectral signature of orange, (v) shows the spectral signature of grapes and (vi) shows the spectral signature of Guava. Each fruit spectral signature is different with other fruits the apple shows the different spectra than other fruits in visible and infrared region.

V. Analysis of spectral data

NIR spectroscopy gives the multivariate data during collecting each sample spectral data. The multivariate data analysis techniques is used to take out satisfactory information from the spectra that correspond with the measured property under inspection. This techniques is necessary for functional use of NIR spectroscopy because of the complication and slight change between the inequalities of samples.

3. SPECTRAL PREPROCESSING TECHNIQUES

Pre-processing or pre-treatment of spectral data are often required to reduce noise or unwanted background information and increases the signal from the chemical information. The most common pre- processing methods include the moving average method. [Savitzky-Golay], Normalization, derivatives (Savitzky-Golay), Multiplicative Scatter Correction (MSC). And so on. [8]

3.1 Smoothing

The first step is smoothing which is used to reduce noise from spectrum and enhance the signal to noise ratio. there are different smoothing method are available such as moving average smoothing, Gaussian filter smoothing, median filter smoothing and Savitzky-Golay smoothing (S-G smoothing). Smoothing is mainly used to get the best assessment value through the “Averaging” or “fitting” of many point in a window. The Savitzky - Golay filter is continually used to remove spectral noise picks when chemical information can keep it.
The core formula of the S-G algorithm

$$g_i = \sum_{n=-n_l}^{n_r} c_n f_{i+n}$$

Here fi is the original data, gi is the data after smoothing, nr is the number used to the right, i.e., later than i, nl is the number of points used to the left of a data point i, i.e., earlier. [4][9][10][11]

3.2 Baseline Removal

The second category of preprocessing is the baseline removal it is also known as “background signal” that is far away from the zero level. This preprocessing is used to correct and measure the influences such as peak area as well as height. One of the best method for removing baseline effect is spectral derivative transformation such as the first derivative (FD) and the second derivative (SD).

3.3 The First Derivative (FD) and Second Derivative (SD)

1st D is a method that removes the baseline from spectra while stressing absorption features. The first derivative was calculated via a Savitzky-Golay smoothing filter. The second derivative (SD) is very effective for both the baseline offset and linear trend from a spectrum. The 2nd D has been applied many times in remote sensing and spectroscopy. The most basic method for derivation is finite differences: the first derivative is estimated as the difference between two subsequent spectral measurement points; the second order derivative is then estimated by calculating the difference between two successive points of the first-order derivative spectra.

$$x_i' = x_i - x_{i-1}$$

$$x_i'' = x_i' - x_{i-1}' = x_{i-1} - 2 \cdot x_i + x_{i+1}$$

Where x_i' denotes the first derivative and x_i'' the second derivative at point (wavelength) i. [9] [12]

3.4 Normalization

Normalization is a very important technique of preprocessing spectral data which is used to reduce the effect of source power instability, disparity in sample thickness, scattering and so on. Some normalization techniques are divided into 1-way normalization and n - way normalization. Means the method is applied onto individually each spectrum are called as 1- way normalization and some method take more than one spectrum at a time to develop the model are known as n-way normalization. There are many normalization are available such as Min-Max normalization, SNV normalization, MSC and so on. [13]

4. CONCLUSION

This paper has covered some of the process to create a spectral database which is useful for evaluation of quality and quantity analysis of the fruit study. This techniques have advantage is that it is nondestructive assessment method. Where sample preparation time is reduce, and having more advantages like reduced the labor coast, creation of data in real time and many more. To get accurate sample the instrument setup and measurement of height of the gun , weight of the sample , distance between the sample and the probe, which filed of view is used , calculate the estimated area of sample are important as well as for more accurate result we need to select a preprocessing technique.

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AUTHOR

Rashmi V. Agrawal. Stayed in Multi Spectral Research Laboratory (MSL), Department Of Computer Science And Information Technology, Dr. Babasaheb Ambedkar Marathwada University Aurangabad to study Trace the Metal Content from the Seasonal Fruit in the Market of Aurangabad using ASD Filed Spectroradiometer.