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Non-Invasive Fruit Analyser_1.7

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Abstract*: *Fruit quality is an important parameter in the food processing industries. It is necessary to analyze internal and external characteristics of the fruit sample. Standardizing the quality of fruit in Agro industries is essential. There is a need of standardizing equipment of affordable price because it involves huge man power. In this project, quality of the fruit is analyzed based on the capacitor concept in which the fruit will act as a dielectric medium between two parallel plates. The obtained output voltage is proportional to the condition of the fruit sample. The color variation in the outer layer of the sample is also determined using the image processing techniques. To find the quality, it is also that considered volume and weight as important parameters. All these three data are combined together in order to give the desired results at an affordable price. This product will also reduce the labor cost and the losses possibly occurred due to the destructive analysis and so on.

Keywords* : *capacitor, parallel plate ,RGB sensor, load cell.

I. INTRODUCTION

Generally, fruits are exported to foreign countries with various standards prescribed by ISO. During export, there is a problem in determining the internal and external characteristics of samples. In many industries, the testing of the samples is carried out by invasive method which leads to economic loss of the company. In our country, most of the companies implement more human power to sort the samples. This will lead to increase in labor cost and also leads to error. This problem will also affect the economic status of the country. The existing technologies applicable for this problem are more costly and are highly inaccessible by the small scale industries. If the number of sample increases, the man power and the time required for sorting of the samples are also increases. So there is a need to provide an affordable technology to solve this problem effectively.

Non-destructive methods used in the quality analysis can be classified as Mechanical method, Optical methods, Electromagnetic method, and Dynamic method. Among this Due to its efficiency, NIR photo spectroscopy is most prefered. Near Infrared Spectroscopy (NIR) lies in the range of (780-2500) nm. It is helpful in sorting and grading of fruits. In this method fruit maturity is evaluated by measuring the skin color of fruits like as banana, apple, tomato and mango. Chlorophyll determines the colour of fruit Skin. The Maturity is assessed through the color change in skin. Chlorophyll content decreases with the fruit ripening. NIR method is used in fruit firmness measurement and detection of visible blemishes. Soluble solid content, drymatter, hygroscopicity, firmness, sugar content, acidity etc., are measured using this method. It doesn't require sample preparation. Estimation of soluble solid content (SSC) by using NIR is satisfactory and consistent, whereas, the results for soluble solid content (SSC) by using NIR is satisfactory and consistent, whereas, the results for firmness and acidity were found to be more variable.

II. PROPOSED METHODOLOGY: CAPACITANCE BASED FRUIT QUALITY ANALYSIS

A.Block Diagram

Quality analysis process involves three major sections one is weighing, another is colour sensing and other one is measuring the output capacitance value. A block diagram as shown in Figure 1 represents the process flow and also how the components used such as load cell, RGB sensor, parallel plate capacitor are controlled by Arduino Mega 2560 and the NodeMCU.

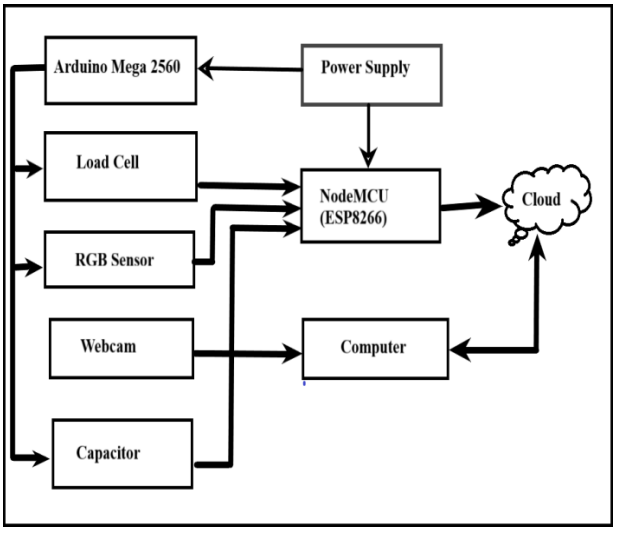

Figure1 Block Diagram for Non-Invasive Fruit Analyser_1.7

The major objectives of the proposed project are listed as follows:

- To detect the internal characteristics moisture of the fruit

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- To detect the external characteristics Color, Weight, Volume
- To reduce the manual work and
- To establish life time for fruit sample

B. Circuit Diagram

The circuit diagram of Non-Invasive Fruit Analyzer1.7 is shown below in the Figure 2 It gives the complete circuit connections for the Non-Invasive Fruit Analyser1.7. The connections of the dc motor, load cell and rgb sensor to the Arduino control along with the wiring have been neatly illustrated.

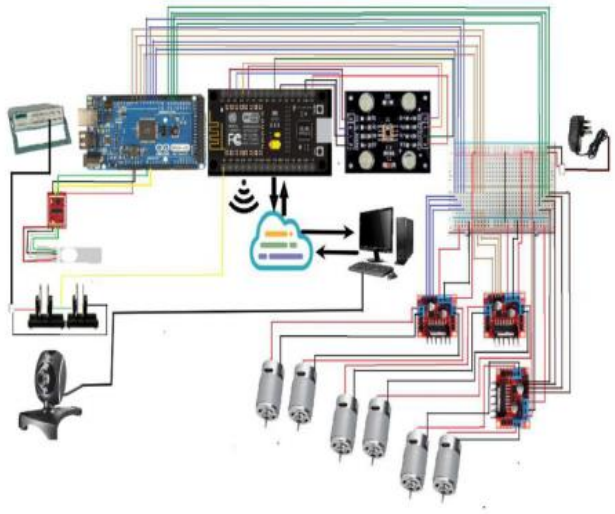

Figure2 Circuit diagram for Non-Invasive Fruit Analyser_1.7

C. Components Used for the Proposed Work

In order to develop the hardware assembly of NIFA1.7, various components are to be used, they are discussed in the following sections:

i) Load Cell

A load cell is a sensor that is used to measure weight whose magnitude is directly proportional to the mass of object acting on it.HX711A ADC module used to convert acquired Resistance variation in Load cell

ii) RGB Sensor

The TCS230 sensor is embedded of 8 x 8rray of photodiodes.Optical pulse is generated through Crystal oscillator .Photodiodes record the reflection from the target. Then employing a Current-to-Frequency Converter the readings from the photodiodes are converted into a square wave with a frequency directly proportional to the sunshine intensity. Finally, using the NODEMCU 12E the square wave output and the results for the color are executed.

iii) DC Motor

A DC motor may be a class of rotary electrical machines that converts DC electricity into Rotational motion. The most common types believe the forces produced by magnetic fields.

iv) Webcam

webcam, may be a video camera that feeds or streams a real time recording. Webcams is attached to a user's monitor, or are built into the hardware. Webcams is used to capture live image of fruit sample and analysis HSV value in it surface.

v) NodeMCU (ESP8266)

ESP8266 NodeMCU is used for wireless data communication. This small module allows microcontrollers to attach to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands.ESP8266 is Wi-Fi enabled system on chip module developed by Espressif system

vi) Arduino Controller

It is an Microcontroller of CISC architecture.It have both analog and digital input or output pin.It is embedded with debugger IC. The project products are distributed as open-source hardware and software.

vii) Parallel Plate Capacitor

The capacitor may be a component which has the power or "capacity" to store energy within the sort of an electrical charge producing difference across its plates, very similar to a chargeable battery. Capacitors are available in various range according to its dielectric medium .

In Parallel plate capacitor, two conducting material is placed opposite to each other. Dielectric medium might be air or by some sort of an insulators like waxed paper, mica, ceramic, plastic or some sort of a liquid gel as utilized in electrolytic capacitors. The insulating layer between capacitors plates is usually called the Dielectric. A parallel capacitor plate is shown in Figure 3

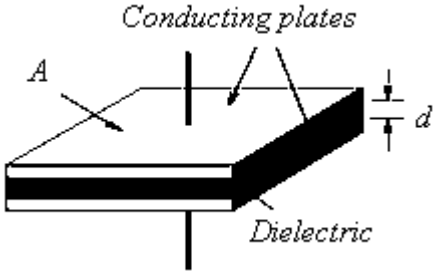

Figure 3 Parallel Plate Capacitor

Due to this insulating layer, DC current can't flow through the capacitor because it blocks it allowing instead a voltage to be present across the plates within the shape. The parallel plate may be in various shapes according to its usage. It determines the voltage rating and contact with dielectric Medium

III. RESULT ANALYSIS

The parallel plate capacitor is that the simplest sort of capacitor. It are often constructed using two metal or metalized foil plates at a distance parallel to every other, with its capacitance value in Farads, being fixed by the surface area of the conductive plates and therefore the distance of separation between them. Altering any two of those values alters the worth of its capacitance and this forms the idea of operation of the variable capacitors. The larger capacitor plates, smaller distance gives more capacitance value.

The capacitance of a parallel plate capacitor is proportional to the area, A in meters^2 of the smallest of the two plates and inversely proportional to the distance or separation, d (i.e. the dielectric thickness) given in meters between these two conductive plates.
The generalized equation for the capacitance of a parallel plate capacitor is represented as,

$$V_c = \frac{1}{C}\int I(t)dt \quad (1.1)$$

$$I(t) = \frac{dq}{dt} = \frac{d(CV)}{dt} \quad (1.2)$$

$$I(t) = C\frac{d(V)}{dt} \quad (1.3)$$

$$I(t) = C_w V_m \cos\omega t \quad (1.4)$$

$$I(t) = C\sin(\ \omega t + \frac{\pi}{2}\ ) \quad (1.5)$$

$$I(t) = \frac{V_m}{\frac{1}{\omega C}}\sin(\omega t + \frac{\pi}{2}) \quad (1.6)$$

$$I(t) = I_m \sin\ \ \omega t + \frac{\pi}{2} \quad (1.7)$$

where

$\varepsilon_0 = 8.8541\times10^{-12} Fm^{-1}$ ε_r = Fruit sample variable

ε_r = 1 // For Air

ε_r = Variable // For Fruit Sample

A=area of square aluminum plate

A=169 cm^2

D= 8 cm (Average diameter of apple fruit in cm)

Substituting known values, it will be,

$C = 1.7nF$ (For air medium)

After attaining the weight value, RGB Colour values and capacitance value of the sample fruits, the quality of the fruit can be indicated effectively. The following Table-1shows the result analysis for fruit samples.

Table-1 Non invasive fruit analysis by capacitance based measurement

S.No	Components	Normal Value	Abnormal value
1.	Weight	142g	128g
2.	Output voltage based on Capacitance	1.2V (Note: Input voltage =10V)	6.3V (Note: Input voltage =10V)
3.	Color	RGB decimal= 255,8,0	RGB decimal= 91,255,91

The hardware prototype model developed based on the concept of capacitance change is represented in Figure-4.

Figure-4 Hardware model development for non-invasive fruit quality analysis

IV. CONCLUSION

The proposed project work has been done in order to analyze the each and every apple available in the export and the food processing Industries. This project reduces the cost involved in the transportation of the defective fruit and samples that is being rejected at the receiving end. It helps to reduce the error produced due to the manual sorting process and it is more accurate and precise than the manual sorting. The prototype of the project is modular and can be customized based on the industry requirements. The existing solutions were more costlier which makes the solutions highly inaccessible by the small scale industries. So the proposed project will be more suitable for the small scale industries.
The industry demands to analyze the different quality of fruit samples without destructing and also cost effectively. Simple modification in the prototype helps the industries to analyze different varieties of sample. However the is no intervention of any harmful radiation and chemicals are not used in this project in won't affect the existing structure or quality of the fruit sample. Everything happens automatically so it will increase the reliability of the process. This project will have the scope to revolutionize the quality analyzing and sorting process in the food processing and export industries in the upcoming years.

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