RIPENESS DETECTOR OF BANANA

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Abstract: Knowledge of dielectric behavior and conductivity is important in the detection of banana ripening treatment [7,9]. In this study, a capacitive sensing system is designed and developed [8]. In this method, a banana fruit is placed in the capacitive sensor as a dielectric material and then the charging time (T_{ON} time) of sensor is measured. This system has the following characteristics: rapid response, simple operation and low cost [1-3].

Keywords: banana fruit; dielectric constant; electronic circuit

1. Introduction:

Traditionally, we may determine the ripening of banana by viewing the color of the peel of the banana. [1,4].But it is time consuming and the process is tiresome for large no. of samples. Here, we will try to automize this process.

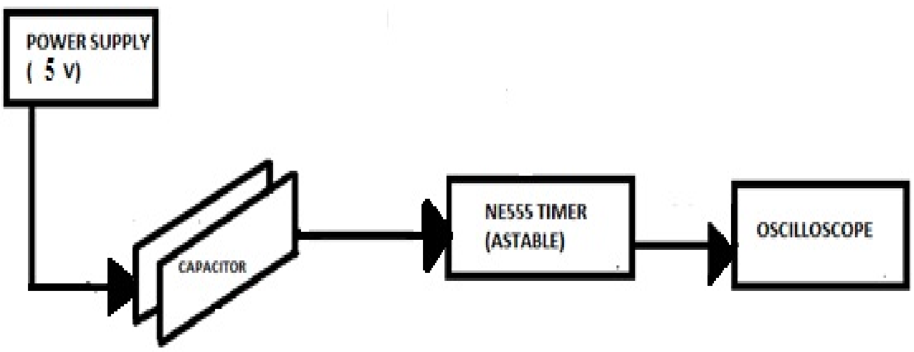

Figure 1: Block diagram.

2. Principle of operation:

If, C_0 = Capacitance of air filled capacitor, C=Capacitance of capacitor with banana in between the plates, A=Common area of intersection of the two plates of the capacitor, d=distance between the capacitor plates, then $C_0=A\varepsilon_0 / d$ (ε_0 =absolute permittivity of charge in air/free space/vacuum) or, $C=A\varepsilon_0\, \varepsilon_r / d$ (ε_r=relative permittivity of charge in the medium).

The sensor to be made is based on the fact that the dielectric constant of air/a material mixture between two parallel plates increases with material volume concentration [1,2,5,6]. Keeping all other factors constant, viz common area of intersection (A), distance between the capacitor plates (d), relative permittivity of charge in the medium (ε_r); as the dielectric property of the material mixture goes on reducing, it starts conducting and hence charging time of the capacitor gradually reduces [10].

3. Experimental setup:

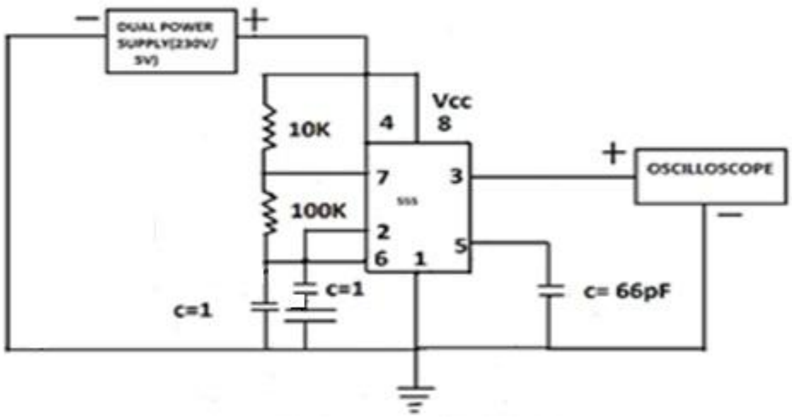

Figure 2: Circuit diagram.

4. Theory involved:

<u>Distinguishing factor of an unripe and a ripe banana (used in this experiment) and its relation to charging time of the capacitor</u>

Here, the amount of water (Water Content), present in the Banana is used as the distinguishing feature/character between an unripe banana and a ripe banana.

Initially, the water content in a banana is very-very less (unripe stage). The banana-air mixture serves as a strong dielectric as the dielectric constant is high because conduction between the plates of the capacitor occurs at a slow rate due to less water (good conductor of electricity) content, present in the banana. Hence, the time required for chargingthe capacitor is high. During its journey from unripened to ripened stage, the water content in the banana increases, thereby reducing the dielectric constant and hence increasing the rate of conduction between the plates of the capacitor. Therefore, the charging time of the capacitorreduces.

<u>Reason for Connecting 555 Timer IC in Astable Mode</u>

There is a huge fluctuation in the output due to which readings cannot be noted. In order to minimize the fluctuation, so as to note down the output readings, we have connected a 555 timer IC in astable mode because in astable mode we are able to control the charging and discharging time of the capacitor, using different values of resistance and capacitance.

Here, in order to reduce the fluctuation in the output we have to design a timer circuit, whose time of switching of every complete cycle (from high to low state and again back to high state) is a bit more than that of the time of switching (fluctuating) of the output readings but the switching of every cycle of timer circuit should be less than twice the time of switching of the output readings otherwise a reading may get lost.The switching is given of the astable mode 555 timer circuit is given by the following formula (s): $T_{ON}=0.693(R_A+R_B)\times C$, $T_{OFF}=0.693\times R_B\times C$; $T=T_{ON}+T_{OFF}$; here, T=Time of switching of one complete cycle, T_{ON} =Time of remaining in high state, T_{OFF} =Time of remaining in low state. Here, R_A =10 KΩ, R_B =100KΩ, C =1μF.

5. Working of the model:

Banana sample is placed in between the plates of the parallel plate capacitor (capacitive sensor). A banana-air mixture will thus act as the dielectric medium between the plates of the parallel plate capacitor. Supply is switched on. Charging time of the capacitor is obtained from the oscilloscope, which gradually reduces as the bananasample ripens slowly; depicting the increase in the water content of banana.

6. Assumptions and calculations:

It is assumed that our banana sample is already ripened by 20% naturally. (Percentage of ripeness for 1st reading). We consider our banana sample is already ripened by 20% naturally; so during our experiment, the banana sample ripened by 80% in 48 hours (Refer to the observation table). Therefore in 1minute, the banana ripens by {80/ (48*60)} %. Hence, amount of ripening attained in "N" minutes= [{80/ (48*60)}*N] %. Therefore, Total amount of ripeness after N^{th} reading= [[{80/ (48*60)}*N_n] + (Percentage of ripeness from previous reading)] %. (NOTE:-Here, N_n=time between N^{th} and $(N-1)^{th}$ reading)

7. Observation table:

Table 1: Percentage of Ripeness of Banana (NOTE:-The observation table is for green banana).

Date of Taking the Reading	SL no.	Time of Taking the Reading	Time of Remaining in high State(T_{ON}) (in seconds)	Amount of Time between two consecutive observations	Percentage of ripeness of Banana Sample at a Given Time (%)
13th Nov 2013	1	11:48 A.M	0.6	-----(Initial Reading)	20
	2	02:03 P.M	0.5	02 hours 15 min	23.75
	3	04:19 P.M	0.4	02 hours 16 min	27.5278
14th Nov 2013	4	09:00 A.M	0.25	16 hours 41 min	55.33
	5	11:15 A.M	0.2	02 hours 15 min	59.08
	6	01:47 P.M	0.15	02 hours 32 min	63.302
	7	04:19 P.M	0.1	02 hours 32 min	67.5242
15th Nov 2013	8	09:00 A.M	0.075	16 hours 41 min	95.3298
	9	11:48 A.M	0.05	02 hours 48 min	100
Total time Required for Ripening of the Banana Sample				48 Ours	

8. Ripeness detecdtion plot of banana:

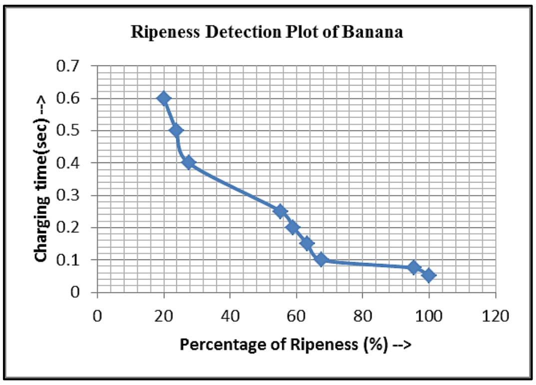

Figure 3: Ripeness detection plot of banana

Table 2: Ripeness at different times.

%age of ripeness	Time (sec)
20	0.6
23.75	0.5
27.5278	0.4
55.33	0.25
59.08	0.2
63.302	0.15
67.5242	0.1
95.3298	0.075
100	0.05

9. Advantage over traditional method:

Traditionally ripeness of banana is detected just by observing the texture or color of the peel or by touching the bananas [1]. But this method is tiresome when we have to deal with large number of bananas specially in food processing industries. Moreover even ripening of the fruit is one of the important factors in food processing industries. This method helps to know the approximate percentage of ripeness hence makes the entire process easier for us. Cost of labor can be reduced due to the application of the sensor designed. The sensor is very simple to design and all the components are easily available which helps to achieve cost effectiveness. The sensor is easy to operate and due to automation it saves time.

In the market generally bananas are artificially ripened. This involves application of different chemicals specially ethylene. Ethylene is naturally present in the banana trees and helps it in the ripening process. The amount of ethylene to be applied has to be optimum in order to produce healthy fruits artificially. Once the percentage of ripeness is known it helps to proportionate the amount of chemicals to be applied to achieve the ripeness of the fruit. Thus it serves health benefits too.

10. Applications:

It helps in producing better quality of fruit juice ,jams ,jellies etc. It is useful in food processing industries where banana is used as raw material and even ripening of banana is of prime importance. Since exact or approximate percentage of ripeness of the fruit is known it minimizes loss of inventory by reducing buffer stock of fruits. This method gives amount of time for a particular percentage of ripeness thus while transporting the fruits from one place to another optimum time can be estimated thereby preventing over ripening process and spoilage of the fruit. This sensor can be used in local shops as it will help to know which batches of bananas to be sold soon in order to prevent wastage of the fruit.

11. Conclusion:

This method gives a measuring factor to detect the ripeness of banana which was earlier sensed mainly through our senses. This method provides accuracy and exactness in knowing the ripeness of banana. Finally this will be a low cost device for predicting the ripeness level of banana fruit. This experimental setup estimates the ripeness level of banana by its variation in dielectric constant.

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