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LABVIEW IMPLEMENTATION OF CIGARETTE FILTER QUALITY CHECK USING FUZZY LOGIC

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Abstract - A cigarette filter has the purpose of reducing the amount of smoke, tar, and fine particles inhaled during the combustion of a cigarette. Filters also reduce the harshness of the smoke (Nicotine) and keep tobacco flakes out of the smoker's mouth. It's very important to maintain the quality of the cigarette filter so as to reduce the hazardous effect posing on human body. This paper aims at implementation of an automated system used to check the quality of the cigarette filter using fuzzy logic algorithms. The results obtained by the proposed system indicate that the system has fulfilled its objective of checking the quality of cigarette filter. The proposed system plays a vital role in the social being of human since it is impractical to make smokers quit smoking. At least this system reduces the ill effects of smoking.

Keywords-Dielectric; Capacitance Measurement; NIELvis; LabVIEW; Fuzzy logic;

I. INTRODUCTION

Nicotine is a powerful insecticide and among the deadliest of all plant products in its pure form. According to the US Department of Health and Human Services, it raises blood pressure, affects the central nervous system, and constricts blood vessels in humans. Nicotine is a colorless liquid that is highly soluble in water, and is readily absorbed through the skin in its pure form. Such Nicotine is found in Cigarette [1]-[4]. Cigarette filters are specifically designed to absorb vapors and to accumulate particulate smoke components. Filters also prevent tobacco from entering a smoker's mouth and provide a mouthpiece that will not collapse as the cigarette is smoked. Filters generally have the following components: 95% of cigarette filters are made of cellulose acetate and the balance are made from papers and rayon. The cellulose acetate tow fibers are thinner than sewing thread, white, and packed tightly together to create a filter; they can look like cotton. Other materials have been tried and rejected in favor of the taste that acetate produces. Filters vary in filtration efficiency, depending on whether the cigarette is to be "light" or regular. The white face of the cigarette filter with the naked eye and compression of the filter column with the fingers would suggest that the filter is made of a sponge-like material. However, opening the cigarette filter, by cutting it lengthwise with a razor, reveals that it consists of a fibrous mass. Spreading apart the matrix reveals some of the more than 12000 white fibers. Microscopically, these fibers are Y shaped and contain the delustrant titanium dioxide. The fibers are made of cellulose acetate, a synthetic plastic-like substance used commonly for photographic films. A plasticizer, triacetin (glycerol triacetate), is applied to bond the fibers [1],[5].

Now, it's very clear that the percentage of cellulose acetate present in the cigarette filter decides the amount of resistance offered by the filter for the hazardous components like nicotine and other chemicals to enter the mouth of smoker. Measurement of cellulose acetate percentage would indicate the quality of the cigarette filter. To measure the percentage of cellulose acetate in the filter we make use of one of the basic properties of cellulose acetate i.e. its acts as dielectric [1],[5]. This paper aims at design of an Instrumentation system which can measure the dielectric strength indirectly to indicate the quality of cigarette filter using fuzzy logic algorithms.

The paper is organized as follows: After introduction in section –I, a brief description on sensor is given in section II. The output of the sensor is capacitance; A brief discussion on data conversion i.e. capacitance to frequency and frequency to voltage, is done in section III, Section IV deals with the problem statement. Section V deals with problem solution and finally, results and conclusion is given in section VI

II. SENSOR

To measure cellulose acetate content in the cigarette filter a structure is designed making use of capacitance principle. Fig. 1 shows the design used for the same purpose. We know that the capacitance is given using (1). That is clear that by measuring the capacitance we can relate it to the cellulose acetate [6]-[8].

$$C = \frac{\epsilon_0 \epsilon_r A}{D} \quad (1)$$

Where: ϵ_0 = Permittivity of free space

ϵ_r = Permittivity of dielectric

A = Area of the plate

D = Distance between plates

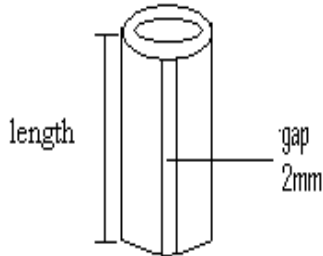


Figure 1. Graphical representation of Capacitance sensor

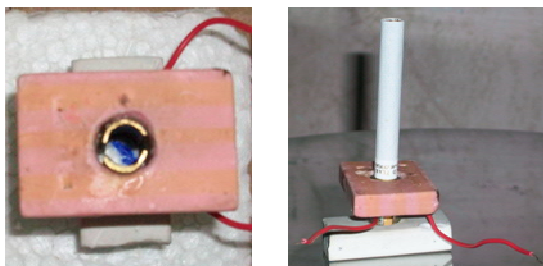


Figure 2. Picture of Capacitance sensor without and with cigarette

Derivation for capacitance:

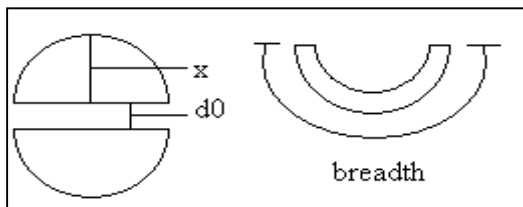


Figure 3. Top view of capacitance sensor

D is found out using integration, since its value is not same at all points as in Fig.3

$$d_0 = 2\text{mm},$$

Maximum value of x as shown in Fig.3 = 3.5mm

$$D = d_0 + 4 \int_0^{3.5\text{mm}} X$$

$$= 2\text{mm} + 4 \left(\frac{X^2}{2} \right)_0^{3.5\text{mm}}$$

$$D = 2.0245\text{mm}$$

III. DATA CONVERSION UNIT

The block diagram representation of the proposed instrument is given below.

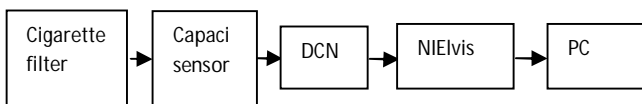


Figure 4. Block diagram of the measuring technique

A: TIMER CIRCUIT

In Astable mode, the 555 timer as shown in Fig.5 puts out a continuous stream of rectangular pulses having a specified frequency. Resistor R_1 is connected between V_{CC} and the discharge pin (pin 7) Resistor R_2 is connected between the discharge pin (pin 7) and the trigger (pin 2). Threshold pin (pin6) is connected with trigger pin. Hence the capacitor is charged through R_1 and R_2 , and discharged only through R_2 , since pin 7 has low impedance to ground during output low intervals of the cycle [9].

The frequency (f) of the pulse stream depends on the values of R_1 , R_2 and C_0 , as shown in (3).

$$f = \frac{1}{1.38(R_1 + 2R_2)C_0} \text{ Hz}$$

(3)

Thus the capacitance from the sensor corresponding to the content of cigarette filter is converted to frequency.

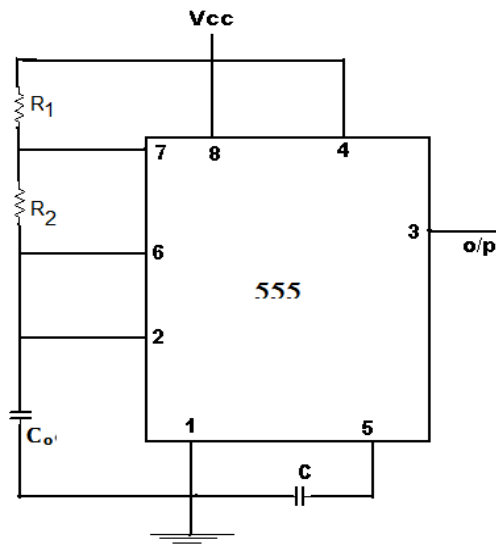


Figure 5. 555 as a Astable Multivibrator

B: FREQUENCY TO VOLTAGE (F/V) CONVERTER

TC 9400 frequency to voltage converter circuit is shown in Fig. 6. When used as a F/V converter, the TC9400 generates an output voltage linearly proportional to the input frequency waveform. Each zero crossing at the threshold detector's input causes a precise amount of charge ($q = C_{REF} * V_{REF}$) to be dispensed into the operational amplifier's summing junction. This charge in turn flows through the feedback resistor, generating voltage pulses at the output of the operational amplifier. A capacitor (C_{INT}) across R_{INT} averages these pulses into a DC voltage which is linearly proportional to the input frequency [10].

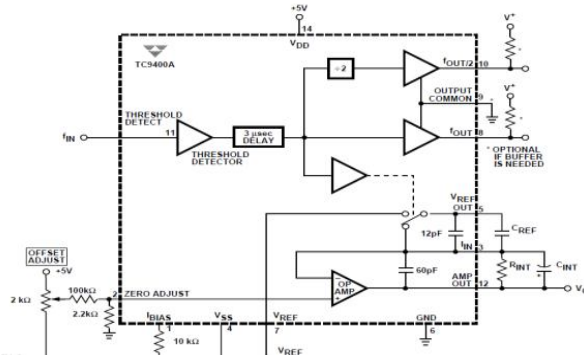


Figure 6. TC9400 Frequency to voltage converter

The output voltage in volts is related to the input frequency (f) by the (4):

$$V_{OUT} = (V_{REF} * C_{REF} * R_{INT}) f \quad \text{Volts} \quad (4)$$

C. NIElvis

The National Instruments Educational Laboratory Virtual Instrumentation Suite (NI Elvis), as shown in Fig. 7, is a hands-on design and prototyping platform that integrates the most commonly used instruments. It includes oscilloscope, digital multi meter, function generator, bode analyzer, and more into a compact form suitable for the laboratory experiments. It connects to PC through USB connection, providing quick and easy acquisition and display of measurements. Based on NI LabVIEW graphical system design software, NI Elvis offers the flexibility of virtual instrumentation and the ability of customizing any application [11],[12].

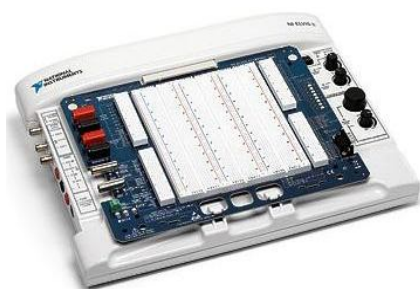


Figure 7. NI Elvis

In the proposed technique, the outputs of the data conversion unit are connected to the analog input signal port ACH0+ and ACH0-. Further, with help of NI Elvis and LabVIEW software, the signal from the capacitance sensor corresponding to the percentage of cellulose acetate relating to quality of cigarette filter. Further the data is processed using LabVIEW using fuzzy logic algorithm to display the actual percentage and quality in terms of fuzzy values.

IV. PROBLEM STATEMENT

Once the signal corresponding to percentage of cellulose acetate is acquired to the NIElvis, now the LabVIEW should be programmed to fulfill the following objectives:

- a) Display the actual percentage of cellulose acetate
- b) Indicate the quality of cigarette filter

V. PROBLEM SOLUTION

To fulfill the objectives discussed in the previous section a program is designed using LabVIEW. LabVIEW is a comprehensive development environment that provides engineers and scientists unprecedented hardware integration and wide-ranging compatibility. LabVIEW consists of two block namely front panel and block diagram. Front panel is what is visible to user and this vi consists of control and indicators (i.e. input and outputs for the program). The block diagram vi consists of the program used to achieve the desired objectives. LabVIEW is a graphically language, the program is established with the interconnection of available procedures called as palette [13], [14].

Fig 8 shows the picture of the front panel designed for the project. Fig 9 shows the block diagram.

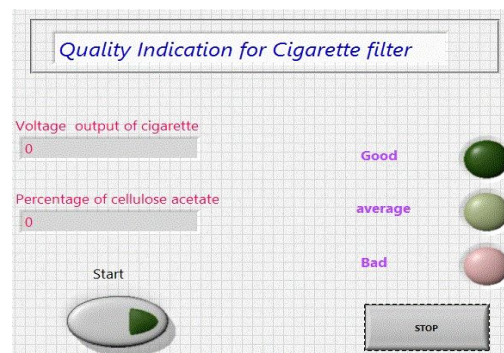


Figure 8 Front panel vi

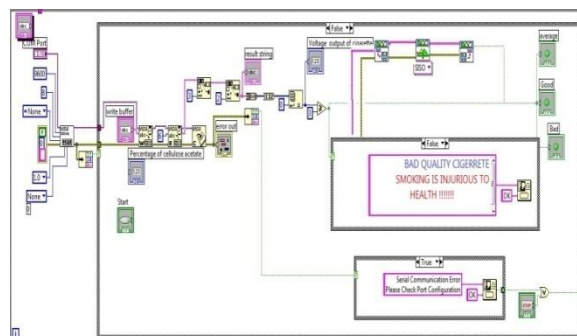


Figure 9 Block diagram vi

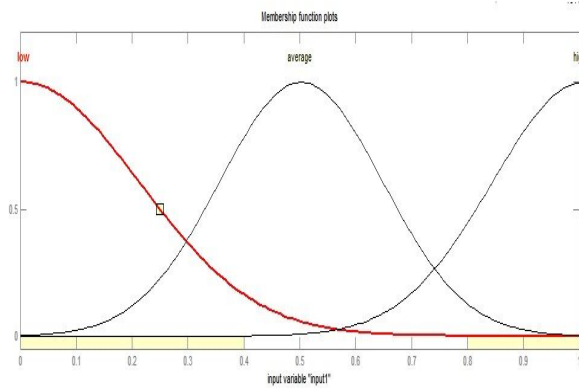


Figure. 10 Input membership function

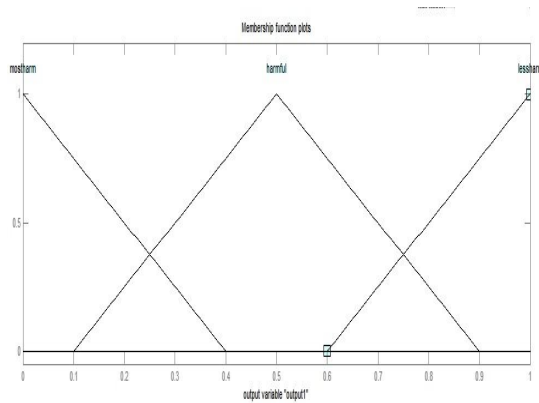


Figure. 11 Output membership function

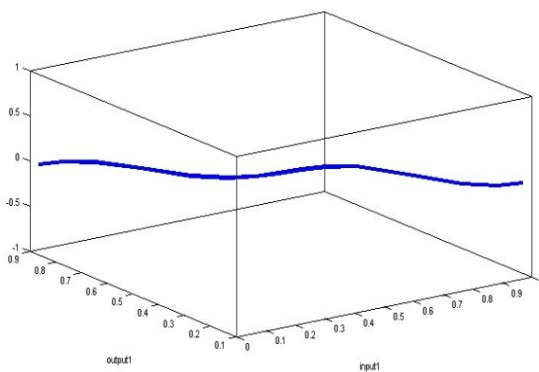


Figure. 12 Surface graph

Front panel vi consists of indicator and control palette. The control palettes like the start and stop buttons. Start button is used to initiate the actions and stop is used to halt the process. Two numerical indicators like the voltage display and percentage display. These two indicators display the voltage output of capacitance sensor and percentage of cellulose acetate content which is the indicator of quality of cigarette filter. Three logical indicators to indicate the quality of cigarette filter in terms of fuzzy variable like good, average and bad. Were good indicates less harmful, average indicates harmful and bad indicates most harmful.

Block diagram vi consists of the program written in LabVIEW to achieve the objectives of the proposed system. The block diagram vi consists of three stages first on acquiring the signals from NIElvis using the DAQAssit palette and followed by the conditioning state where the data is stored in a matrix and conversion and display of voltage and percentages is done. Thirdly we have a fuzzy block to perform the fuzzy operation for the proposed system. Fig.10, Fig.11 shows the input, output membership function used to achieve the objectives discussed. Fig.12 shows the surface graph [15]- [18].

VI. RESULT AND CONCLUSION

Samples of around 30 taken and were subjected to test, following results were got. The good cigarette filter showed the voltage values less than the standard, whereas the bad once showed more voltage then the standard. The table below shows the readings.

Type of Cigarette		Average		Good		Bad	
		Vol t	%	Vol t	%	Vol t	%
1	Indian King	3.40	55	3.38	69	3.48	35
2	Gold Flake	3.41	58	3.39	70	4.11	18
3	Flake Premium	3.43	59	3.42	71	3.49	27
4	Berkeley	3.42	63	3.40	72	3.49	32
5	Charms	3.43	68	3.42	70	3.57	31
6	Gold Coast	3.43	58	3.39	75	4.01	16

Here we have tried to check the quality of six brands of cigarette this can be further increased just by simple modification in the LABVIEW.

Smoking itself is injurious to health, but it's practically impossible to make everyone quit smoking. So an attempt has been made in this system to at least regulate the amount of harmful gas entering the human body.

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