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ARM Controller-Based Edible Oil Quality Measuring Instrument

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ABSTRACT

In today's world, frying has become an inevitable process in cooking. Fried foods are very famous worldwide, and it can be observed by an increasing number of fast-food restaurants in the last few decades. Deep frying of foods at high temperature enhances sensorial properties, including unique fried flavor, golden brown color, and crispy texture. The oils are exposed to atmospheric oxygen and food moisture at temperatures for extended periods during the various cooking processes. As a result, hundreds of chemical reactions such as oxidation, which produces hydroperoxide, and low molecular weight volatile compounds such as ketones, aldehydes, carboxylic acid. When the oil is exposed to high temperatures, it undergoes polymerization, which produces polymers and dimers. Hydrolysis increases the amount of mono &diacylglycerols and free fatty acids. In this study, an ARM controller-based device is to be implemented to test the oil's quality. To test this oil, different oil parameters are measured using sensors like temperature sensors, transparency sensors, and capacitive sensors.

Keywords—*ARM processor, Edible oil detection, Capacitive sensor, Temperature sensor, Edible oil quality.*

I.INTRODUCTION

In our world today, fast food has become a convenient means of having breakfast or lunch, or even dinner. Many such foods are served fried. Reusing cooking oil in households and even in fast-food restaurants is a common practice. Some studies show repeated recycling of cooking oil can post health risks [1,2]. During frying, the oil undergoes several changes due to the heat it is subjected to and the chemical reaction of the food being processed with the oil. Repeated recycling of cooking oil can lead to the formation of surfactant compounds, which affects the quality of food being cooked [3]. To assess oil quality; people in the eatery business may mistakenly rely on personal judgment. This can make a judgment either uneconomical or health hazardous. Some oil could be disposed of prematurely, which would be a waste economically.

Similarly, some oil could be disposed of too late, which would increase the health risks to people. Some researchers have investigated the quality of cooking oil based on certain parameters. One of these is the polar compound. It was noted that as oil is repeatedly recycled, the polar compound increases [4]. Another parameter is the oil's smoking point. The maximum temperature at which oil can be heated before it breaks down and starts to smoke. As oil gets repeatedly used, the smoking point decreases [5]. Polar compounds and oil's viscosity have been proven to have a relationship based on researches and data [6]. In this research, a prototype is designed to regularly sample and test the quality of cooking oil that is assumed to be used continuously in fast food restaurants. The system is automated from sampling to providing an output indication of good, fair, or bad for the oil quality.

II.RELATED WORK

Edible oils play a very important role in human beings in the third generation because lots of people suffer from fat, asthma, blood pressure due to consuming a lower quality of oils in their daily life, so we decided to design and develop an instrument which can easily display the quality of oil-based on some parameters. One of the main reasons for lowering down the quality of the oil is carbon due to heating, so if we can measure the amount or percentage of carbon in the oil, we can prevent so many bad things to happen. So we are planning designed a low-cost microcontroller-based instrument that measures the amount of carbon in oil by measuring the capacitance of oil with the help of a capacitive sensor. This instrument can also be used by various food departments, where they can check various

samples of different companies and decides the price of oils, and can check the quality whether the quality of the oil is in safe range or not[8].

The intake of adulterated and unhealthy oils and trans-fats in the human diet has had negative health repercussions, including cardiovascular disease, causing millions of deaths annually. Sadly, a significant percentage of all consumable products, including edible oils, are neither screened nor monitored for quality control for various reasons. The prospective intake of adulterated oils and the associated health impacts on consumers is a significant public health safety concern, necessitating the need for quality assurance checks of edible oils. This study reports a simple, fast, sensitive, accurate, and low-cost chemometric approach to the purity analysis of highly refined peanut oils (HRPO) that were adulterated either with vegetable oil (VO), canola oil (CO), or almond oil (AO) for food quality assurance purposes. The Fourier transform infrared spectra of the pure oils, and adulterated HRPO samples were measured and subjected to a partial-least-square (PLS) regression analysis. Importantly, the PLS regressions accurately determined percent compositions of adulterated HRPOs, with an overall root-mean-square-relative-percent-error of 5.53% and a limit-of-detection as low as 0.02% (wt/wt). The developed PLS regressions continued to predict the compositions of newly prepared adulterated HRPOs over two months, with incredible accuracy without the need for re-calibration. The accuracy, sensitivity, and robustness of the protocol make it desirable and potentially adoptable by health departments and local enforcement agencies for fast screening and quality assurance of consumable products [9].

The present invention relates to a process and device for the monitoring of fats and oils in the preparation of food, which provides for the exchange of oil or fat promptly before they have become harmful for human consumption. The proposed process for measurement distinguishes itself by the fact that the measurement is already taking place during the temperature adaptation of the sensor, whereby a measurement can take place which is particularly fast and thus suitable for use in practice. An embodiment of the invention provides a process for measuring the state of degradation of oil or fat comprising, measuring the dielectric constant of oil or fat with a Sensor, wherein the sensor is brought into contact with the oil or fat in a liquid state, wherein the sensor is at a lower temperature than the oil or fat, and the dielectric constant of the oil or fat is measured while the sensor is adapting to the temperature of the oil or fat [10].

III. BLOCK DIAGRAM DESCRIPTION

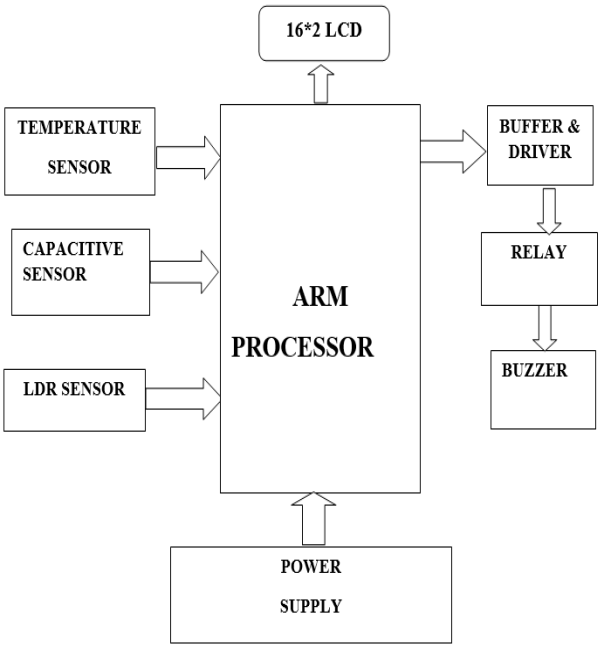

Fig.1. Block diagram of proposed work

Power supply unit

These two voltages, +12 V & +5 V, are used to make the overall system functionality.

ARM processor

ARM Processor architecture is based on RISC technology, which is used for embedded programming. It takes the input signal from sensors and provides output to the LCD to display.

Analog to Digital Converter

The output from the sensors is in analog form. It is necessary to convert this analog voltage into digital form because the ARM processor accepts only digital input values.

Temperature Sensor LM35

LM35 is a precision IC temperature sensor with its output proportional to the temperature (ºC). The sensor circuitry is sealed, and therefore it is not subjected to oxidation and other processes. It also processes low self-heating and does not cause more than 0.1ºC temperature rise in still air. The operating temperature range is from -55ºC to 150ºC. The output voltage varies by 10mV in response to every rise/fall in ambient temperature, i.e., its scale factor is 0.01V/ºC

Capacitive sensor
This sensor is used to measure the amount of carbon in edible oil by measuring the oil's capacitance; carbon is conductive, so capacitance value changes by the change in the dielectric constant of the carbon [8].

Transparency sensor
This sensor is used to detect the oil's transparency so that it is easy to differentiate the adulterated oil from pure oil.

Buffers
Buffers do not affect the logical state of a digital signal (i.e., a logic 1 input results in a logic 1 output, whereas logic 0 input results in a logic 0 output). Buffers are normally used to provide extra current drive at the output and regularize the logic present at an interface.

Drivers (Acts as an inverter)
This section is used to drive the relay where the output is the complement of input applied to the drive, but the current will be amplified.

Relays (Electromagnetic switch)
It is an electromagnetic device used to drive the load connected across the relay, and the o/p of a relay can be connected to the controller or load for further processing.

IV. METHODOLOGY
In our proposed idea, an instrument is designed to regularly sample and test the quality of cooking oil that is assumed to be used continuously in fast food restaurants. ARM processor-based instrument will be implemented to test the quality of the oil. The quality is centered on measuring the carbon content, temperature & transparency of oil using a capacitive sensor, Temperature sensor & LDR sensor, respectively. The quality of oils is influenced by the percentage of carbon present in it. One of the main reasons for lowering the quality of edible oil is carbon due to repeated heating, which can cause serious health risks. The capacitive sensor will detect the dielectric constant using polar compounds in the oil, which will determine the carbon content in the oil. The capacitance value obtained from this sensor will be converted to voltage using a suitable capacitance to voltage converter. LDR sensor is used to detect the transparency of oil. The transparency of oil helps to determine whether the oil is adulterated with some other liquids in the oil, which reduces oil quality. Another parameter is the oil's smoking point. The maximum temperature at which oil can be heated before it breaks down and starts to smoke. As oil gets repeatedly used, the smoking point decreases. To detect this temperature sensor is used. The output from sensors, which is analog, is converted to digital form using ADC, then fed to the ARM Processor. The output from the ARM processor will be given to the LCD.

V. CONCLUSION
Deep frying and using the same oil for frying are generally a general practice, mostly in commercial and sometimes in domestic cooking processes. This practice generates lipid peroxidation products that may be harmful compounds that cause health risks such as asthma, blood pressure, cardiovascular diseases. Therefore, this study contributes towards the development of an instrument that monitors the edible oil quality so that human health risks can be prevented to some extent, and also the waste/degraded oil can be used in biodiesel production.

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