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IOT BASED NON-CONTACT FUEL LEVEL MONITORING

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Abstract: In recent years, technology has advanced at a breakneck pace, making human existence simpler in a variety of ways. The Internet of Things is widely employed in daily objects, and its popularity is growing by the day. The design and implementation of an IoT and mobile-based vehicle fuel / tank level activities such as real-time fuel/water monitoring are covered in this article. Capacitance is used in the suggested IoT gadget to measure the amount of fuel/water. The driver receives a notification through mobile application when the vehicle's fuel/water reaches a specified level. A capacitive sensor for detecting water level has been created. As can be seen from the impedance (reactance) equation for a capacitor, it often has a high-impedance sensor, especially at low frequencies. In addition, in most cases, a capacitive sensor is a non-contacting device . In this study, copper plates were used to produce a capacitive fuel/water level sensor. The fuel/water level determines the dielectric constant between two plates. As a result, because it is inversely proportional to sensor impedance, it may be utilised to calculate fuel/water level from electrical characteristics. Signal conditioning for the system includes linearization, inverting amplifiers, and rectifier circuits.

Keywords: **ESP32**, **Capacitive sensing, Liquid level monitoring , Android Application.**

1.INTRODUCTION

Internet of Things (IoT) is a system of interconnected computing devices and machines with unique identifiers (UIDs) and the ability to transfer data without human intervention. IOT stands for the Internet of Things, which means they can transfer data between machines and other machines. Liquid storage tanks have been widely used in different industrial facilities and power plants as large-scale fuel and oil storage tanks, as well as small-scale water tanks for residential water and cooling or heating air-conditioning systems. Liquid storage tanks' dynamic characteristics are influenced by their geometry and materials, the types of fluids stored in them, their water level, and the excitation force applied to them.

Capacitive methods are widely utilised to measure various sorts of water levels. The majority of capacitors are built with a set physical structure in mind. However, many circumstances can cause the capacitor's structure to change, and the subsequent change in capacitance can be utilised to detect those changes. Changes in dielectrics alter the distance between the plates as well as their effective area. The different types of liquid level transducers for liquid level measurement in any process industry are designed using liquid properties such as pressure at depth, buoyancy, relative electrical permittivity, electrical and thermal conductivity, liquid surface reflection of sound or light waves, and radiation absorption. For measuring water level, there are two types of capacitive level sensors: contact-type and non-contact-type. In this study, we showed how a capacitive sensor may be developed to inspect the liquid level within any container without interfering with the liquid. We ensured an effective method of inspecting and monitoring liquid levels from outside the container. A significant benefit of the capacitive approach is that it detects the level without involving any insertion into our container.

The system consists of a continuous detecting or transmitting device that assesses the measurement level and transfers the data to a microcontroller. The liquid level indicator displays the height of the liquid contained in the tank's interior using a capacitive sensor. The liquid level is determined by measuring the change in capacitance of the fluid with a capacitive sensor and displaying the results on a display screen (LCD).

This project has now become paramount for vehicle activity. Real-time fuel-filled and fuel usage in automobiles is no longer maintained. When the driver begins filling the tank with petrol, the Capacitive sensor activates and stores data on the mobile application. Some drivers are permitted to drive without first obtaining permission from the owner of the vehicle. At the time, the driver was renting or using the automobile for personal reasons. The suggested vehicle activity monitoring system is dependable, simple to build, and user-friendly, and it continues to monitor via a mobile application.

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2. RELATED WORK

The specific origin of the capacitive water level sensor is unknown, but it appears to date from the beginning of the last decade. A low-cost non-contact-type capacitive approach for conducting liquid level sensing evolved in 2006.The liquid level is connected to qualities such as buoyancy, pressure at depth, relative electrical permittivity, electrical conductivity, thermal conductivity absorption or radiation, liquid surface reflection of sound or light waves, and so on.
Different inferential forms of liquid level transducers, such as float, displacer, pressure sensor, capacitive probe, partly submerged resistance wire probes, and so on, are designed using these liquid qualities. Contact-type liquid level detecting probes, such as floats, displacers, capacitive probes, and others, have the problem that their characteristic characteristics with liquid level may vary owing to physical or chemical reactions between the liquid and the probe material, limiting their life span.
Due to buoyancy, the float travels up and down in them. A magnet in the float activates a reed switch in the stem, which produces a detecting signal (see the figure below).The level metre, however, may not be able to measure liquids with certain viscosities and specific gravities. The float gets stuck easily and does not move. The float float type liquid level switch uses the buoyancy of the liquid to push the float of the magnet up and down, opening and closing the internal reed switch, limiting the minimum liquid level.

The magnetic float level switch has a loose structure and is not easy to clean. The magnet will adsorb impurities in the water and cause scale. The liquid level float switch can only be mounted on the upper or lower side, and the product's functionality is limited by the fixed installation technique. However, there are several electrical equipment, and the tanks are formed strangely.

So we employ a uniform right circular cylinder made of an insulating material such as glass, ceramic, nylon, PVC, and so on as the dielectric of the cylindrical capacitor in this technology to try to remove the faults of the convectional non-contact capacitance type level sensing probe. Three-electrode capacitive liquid level sensor is not only measure the liquid level of the vessel, but also to assess the vessel's gradient state. Identical electrodes are used in a traditional sensor to detect liquid levels in a non-metallic storage tank.

Fig1. Pictures of the foil paper assembled with the container to conduct the performance test.

Plates have ability to store electrical charges. The value of capacitor C obtains from equation where L is the distance between two plates, and ε is dielectric constants of the insulator materials between two plates (which it consists of o ε (permittivity of vacuum) and r ε (relative permittivity))(equation)
C=□ (A / L) (1)
From equation, the capacitance (C) value is affected by the value of ε , A , and l . Hence, equation 2 , which shows the influence of the variables to sensor's capacitance value, can be derived from equation.
C □ □ $_o$□ $_r$ (A / L) (2)
From equation , the capacitance (C) value is affected by the value of A , and l . Hence, equation (2) , which shows the influence of the variables to sensor's capacitance value, can be derived from equation (1).

$$S = \frac{\Delta C}{\Delta A} = \frac{1}{b}\frac{\Delta C}{\Delta x} = \frac{\varepsilon}{l} \quad (3)$$

Because of the level role as the measuring object, the ideal sensor's sensitivity can be written as equation (3) where l represents level of the liquid and b is width of the sensor. It shows the sensitivity of the sensor depends on water level is a constant if the values of ε and l are also constants.

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3. THEORY OF OPERATION

One of the numerous reasons why a owner instals a vehicle monitoring system for his or her long-distance vehicle is to reclaim control over road losses. As a starting step, he or she should concentrate on decreasing fuel waste and detecting route fuel theft efforts. Fuel theft is a risk for unmonitored automobiles, thus keeping an eye on the fuel tank level is crucial for catching thieves in the act. And also I Proposed a strategy for controlling and preventing petrol-pump fraud. When the agent starts filling the vehicle tank with fuel, the Capacitive sensor activates and sends out a sequence of pulses proportionate to the immediate flow rate.

The overall tracking and monitoring system has been integrated with Cloud computing and cloud-based application software. The data is sent to the cloud server via the ES32. The user application also uses GPS to find the user. The evaluated research uses a flow sensor to measure fuel, whereas the suggested system uses an capacitive sensor to measure fuel in tanks of varied sizes.

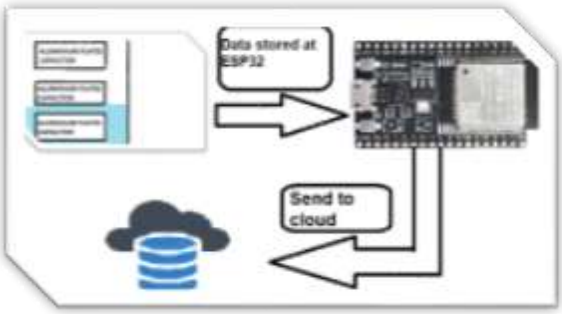

Fig 2.Process flow diagram of the proposed work

3.1 ESP32 MICROCONTROLLERS

ESP32 is a powerful SoC (System on Chip) microcontroller with built-in Wi-Fi 802.11 b/g/n, dual-mode Bluetooth 4.2, and a wide range of peripherals. It is an improved successor to the 8266 chip, especially in terms of the installation of two cores clocked at varying speeds up to 240 MHz in different versions. Apart from these improvements, it also increases the number of GPIO pins from 17 to 36, the number of PWM channels from 16 to 16, and includes 4MB of flash memory.

The Espressif Systems firm created the ESP32 chip, and it presently provides multiple ESP32 variants of the SoC, including the ESP32 Developer Kit, the ESP32 Wrover Kit, which contains an SD card and a 3.2" LCD display, and the ESP32 Azure IoT kit with USB Bridge and other built-in sensors. Other manufacturers, such as SparkFun with its ESP32 Thing DB, WeMoS with its TTGO, D1, Lolin32, and Lolin D32, Adafruid (with Huzzah32), DF Robot (ESP32 FireBeeatle), and many more, occasionally provide decent and sometimes awful clones of these chips.

4. HIGH-LEVEL DESIGN & IMPLEMENTATION DETAILS

Our research into employing capacitive sensing to externally assess the liquid level within a container is split into two parts. To begin, we investigate the usefulness of several capacitive sensor designs in containers composed of various materials. To accomplish so, we analyse several designs for a capacitive sensor in terms of the number, size, and positioning of the electrodes. Surfaces of conductivity in respect to dielectric materials (comprised of the container and the liquid inside it).

Second, we utilise the results of the first investigation to evaluate the usefulness of a certain capacitive sensor design for measuring the amount of liquid medication in a plastic container from the outside. This allows us to see if the data from the first phase can be used to measure a different type of liquid within a different shape and size container.

Aluminium foil was used to create the conductive surfaces. The conductive surfaces were then linked up to esp32 in order to measure the capacitance change when the liquid level in the cup changed. One conductive surface is linked to touch pins. In the circuit, these connections are the signal pin, respectively. To use any of the implemented sensors, we must first configure the signal pin to produce a high voltage while the sensor pin remains low. The electrical charge will then flow into one of the capacitor's conducting surfaces, charging it until the sensor pin and the signal pin are at the same voltage.

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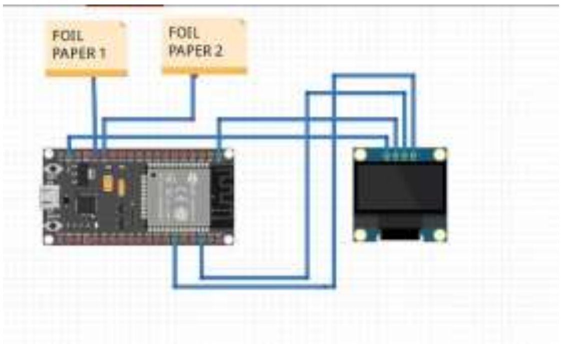
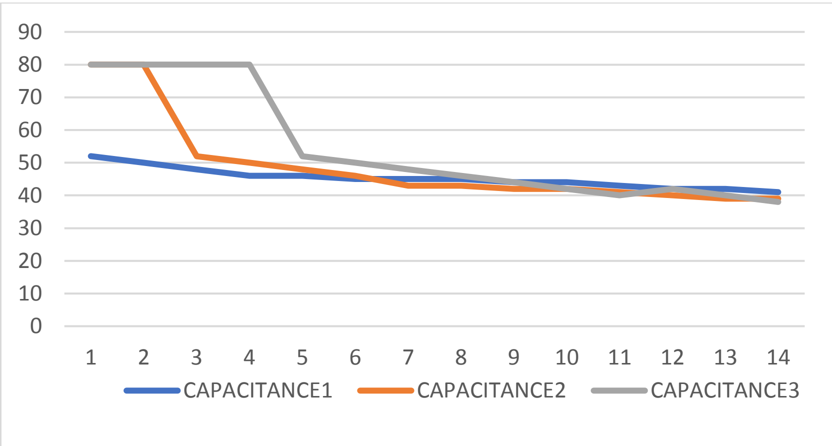


Fig 3.Circuit Diagram

Then, with the signal pin in a low voltage condition, we configure the sensor pin to produce a high voltage. Until the sensor and signal pins attain the same voltage, electrical charge will flow out of the capacitor's conducting surface. The capacitor is effectively charged and then discharged. Upon reaching the critical water level in the tank, an indication is sent through IOT module to the technician in charge for further.

5. RESULT AND DISCUSSION

The test was performed by measuring the water level while filling and emptying the tank. The acquired result depicts the variation in capacitance as the water level changes. On the serial plotter, the curve was noticed. . Figures depict the collected data waveform without and with 100 ml of water, respectively. The time duration of the signal rose as the amount of water in the tank climbed from 0 to 100 ml.



Similarly, measurements for varying levels of water were taken. These measurements were quantitatively analysed using embedded code and the look up table idea. Figure depicts a portion of the data gathered from the experimental setup. To study the behaviour of capacitance change, different sets of measurements were obtained.

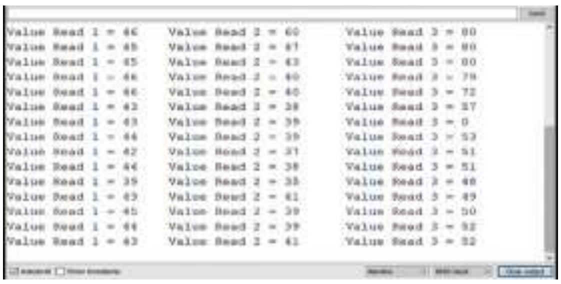


Fig.4 Experimental results of capacitance value measured by increasing the amount of water.

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The current research might be used for a variety of additional experiments. It comprises substance identification in the container as well as level detection for fluids other than water. For example, the dielectric constant of air is 1, that of water is 80, and that of petroleum is 2.2. The acquired data fluctuates as the dielectric constant of the material changes.

5. CONCLUSION

In this paper, we presented the results of a study on designing a capacitive sensor for developing an automatic water level measuring container. The proposed design differs from a traditional capacitive sensor with one pair of electrodes, because it has three pairs of electrodes as the main sensors for measuring the capacitance value of the water level in the tumbler. Without submerging the sensor. It finds widespread use in automobile fuel measuring systems, substance identification, and level detection, among other things. The data from a certain medium is gathered in the lookup table. The usage of lookup tables in software implementation allows for more efficient data analysis. As a result, the sensitivity of this sensor is determined by the medium's and container's dielectric properties.

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