Development of Volume Measurement System for Liquid for Industrial Tank

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***Abstract*— Industries mostly use large tanks or underground tanks for storing the liquids required in processing and manufacturing the product. These are mostly overhead tanks in many industries and mostly underground tanks in industries which deals with volatile and combustible liquid on large scale. It is a tedious and dangerous task of monitoring the liquid level from this tanks. To eliminate this problem at industries a product is developed. The product is made by interfacing a micro-controller with ultra-sonic sensor, LCD and a Wi-Fi module. The controller, with the help of ultra-sonic sensor, measures the height of the tank. Controller process height to calculate the volume of the tank the calculated volume is available to the user in 3 ways: LCD display, Wi-Fi and Browser. This advanced monitoring product gives flexibility to the user to select, based on their requirement. Advanced monitoring product developed will reduce man power, reduce time consumption, power consumption of product and eliminate error occurred in low light.**

Index Terms— Industrial liquids, Power saving, Tanks

I. Introduction

Tank measurements are taken for purposes like inventory control or stock accounting, some operations and custody transfer. There are numerous methods used to measure fuel levels within storage tanks in the fuel storage industry. All of those have advantages as well as shortcomings, but none the less all are reputable level measurement systems in use in the industry. The most commonly used level measurement technologies are Dip tape level measurement [1].

The need for accurate and reliable level measurement systems is increased by the demands of advanced automated processing systems, more stringent process control and strict regulatory requirements. By improving the accuracy of level measurement, the variability in chemical-processes can be reduced, which, in turn, helps to improve product quality and reduce costs and wastes. The regulations laid down for electronic records are stricter in terms of electronic reporting, accuracy and reliability. These requirements are met using new level measurement technologies. Variety of level sensing, monitoring and control capabilities available. A large number of physical principles are adopted for realizing liquid level sensors. Generally the choice of most suitable level sensor for specific application is based on following requirements: 1) measurement range, 2) resolution, 3) accuracy, 4) characteristics of liquid and of, 5) environment. The great interest is focused on last two requirements and in particular developing reliable and safe sensors for hazardous and explosive liquids and environments. It is proposed to model a level sensor that can be used to sense the fuel level digitally. Consequently which will indicate the fuel level in the tank and display using LCD display and also to prevent overflow and avoid wastage of fuels. So in order to measure the exact amount of fuel in a tank micro controller is needed.

Considering the goal of the project there can be many ways to find out height of liquid. The options available for measuring height of fluid are as follows:

- DIP TAPE LEVEL MEASUREMENT [1]
- SERVO-OPERATED FLOAT SYSTEMS [2]
- RADAR TANK GAUGES [3]
- HALL EFFECT SENSOR [4]

Existing technologies are:

- GUARD MAGIC
- LABKOTEC (LABKOMONITOR 8)
- FUEL MONITORING SYSTEM BY IVETEL TECHNOLOGIES PRIVATE LIMITED

II. Methodology

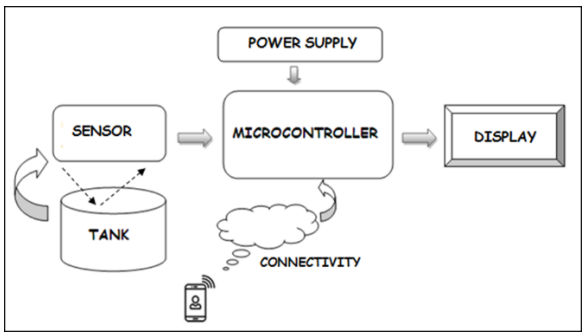

Fig. 1. Block Diagram

When power is applied through Power Jack. First, it is converted to a constant 5 volt dc supply using voltage regulator IC 7805. IC1117 (voltage regulator) is used to power up Wi-Fi module ESP8266 D1. The constant 5V output is used to power up PIC16F877A, ultrasonic sensor and LCD. A LED is used to indicate that power supply is proper and controller is in working state. A switch is used for resetting the device in case of error. With initialization of controller, ultrasonic sensor starts transmitting a sound wave to detect an obstacle.

Ultrasonic ranging module HC - SR04 provides 2cm-400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules includes ultrasonic transmitters, receiver and control circuit. The basic principle of work:

- Using IO trigger for at least 10us high level signal.

- The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back.
- If the signal back, through high level , time of high output IO duration is the time from sending ultrasonic to returning.

Test distance = (high level time × velocity of sound (340M/S))/ 2 (1)

It generates high frequency sound wave and evaluate the echo which is received back by the sensor. The sensor calculates the time interval between sending the signal and receiving the echo to determine the distance of liquid level. Controller processes this data to obtain the height. This value is now used for calculating the volume of liquid in the tank.

With initialization of controller, LCD and ESP8266 is initialized. The calculated value is displayed on LCD using LCD commands. As well as ESP8266 is used to transmit data from controller to remote device connected through this module. Telnet protocol is used to connect ESP8266 to remote device through router. A web page is used and value is displayed on user's screen after configuring the remote device i.e. mobile phone or a personal computer. After particular span, the value of height is again obtained and volume is re-calculated. The obtained value of volume is again displayed on LCD and end user devices on web browsers.

III. Experimentation

A) Testing of ultrasonic sensor (HC-SR04):

We had tested ultrasonic sensor with solid objects, stable liquid and unstable liquid and the results are shown.

Ultrasonic sensor was first tested with solid object and distance between sensor and the object was measured using the sensor. The results are shown in Fig. 2. Which shows that the actual distance and measured distance are same. Similarly the sensor was tested with stable liquid and results are shown in Fig. 3. and the actual distance and measured distance are same. The sensor was used with flowing liquid at a constant distance. The result for this test shows that the distance measured for flowing liquid is neither consistent nor accurate as shown in Fig. 4.

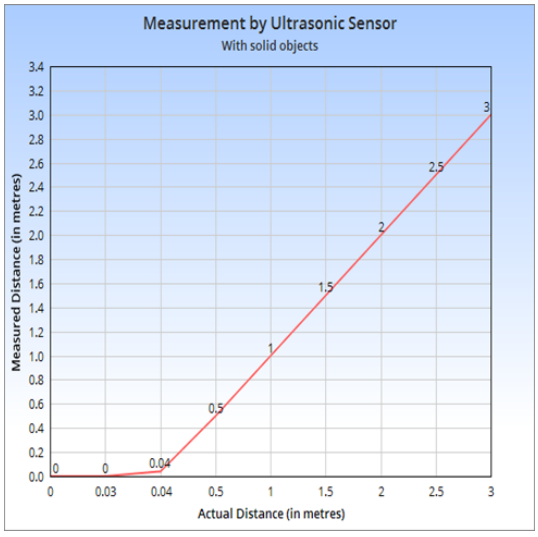

Fig. 2. Response of ultrasonic sensor in open-air.

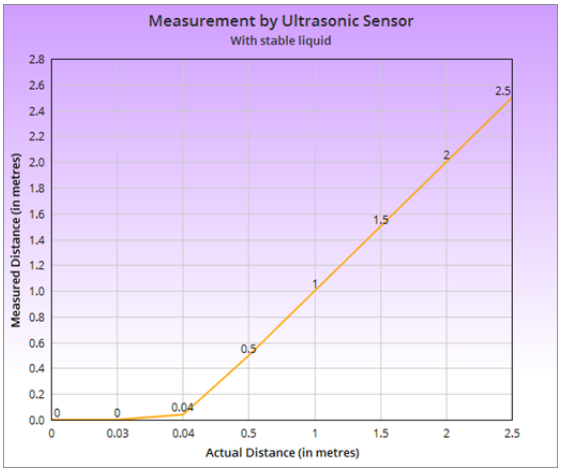

Fig. 3. Response of ultrasonic sensor with stable liquid

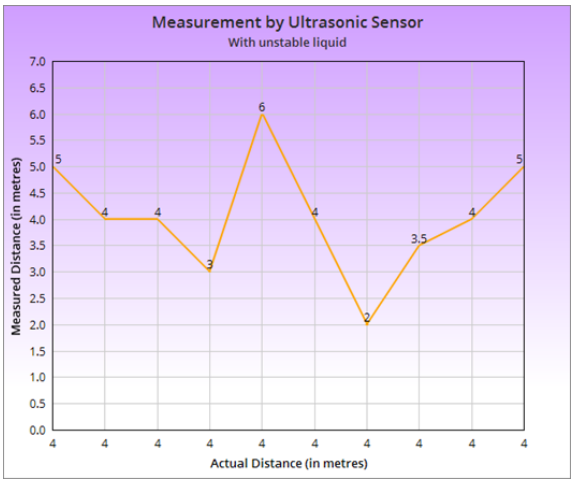

Fig. 4. Response of ultrasonic sensor with unstable liquid.

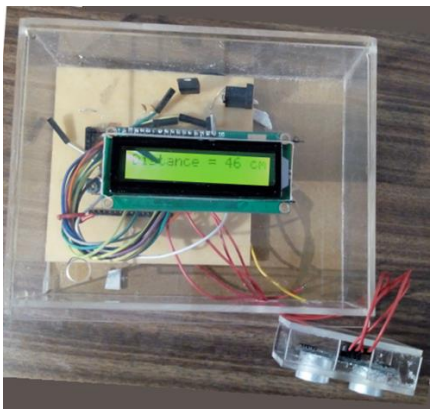

Fig. 5. Top view of the Product

Fig. 6. Display of the output on the web browser

TABLE I
POWER CONSUMPTION OF PIC16F877A

Parameters	Without Power Saving Mode	With Power Saving Mode
Current	4 mA	3.4 mA
Power	0.95W	0.80W

IV. CONCLUSION

A prototype for measuring liquid volume in underground tank wirelessly has been developed with two different facilities: - For handheld purpose and Wi-Fi connectivity. The product developed is tested in both still and flowing water. Using this product in place of existing system error in the reading can be reduced. Also an automated system reduces the manpower required. In comparison with the available systems the circuit designed was found to be cost effective and user friendly. Apart from these advantages, the product gives flexibility to the user to select the module available. This product can also be used in case of domestic tank to maintain the level of water in household tank.

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