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Water Flow and Monitoring System Based on IOT

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Abstract— For effective management and maintenance of tanks in industries one of the most important parameter is the measurement of liquid levels. The tanks used in the industries are generally spread across larger areas for this reason remote monitoring and data collection systems are the most successful tools which evaluate the status of the tanks periodically. In this paper we propose a novel method for measuring liquid level using ultrasonic sensor which are placed at a particular position in the tank at the remote station. The values collected from the ultrasonic sensors are sent to the base station using a Wi-Fi module. The data collected from Wi-Fi module is stored in the memory and the variation of the liquid levels over a period of the time is displayed using IOT.

Keywords— Dynamic Liquid Level, Remote Monitoring, IOT, Tanks in Industries, Ultrasonic Sensors, Arduino Atmega328 microcontroller, Wi-Fi Communication.

I.INTRODUCTION

Accurate, affordable and reliable liquid level measuring technology is of a great importance for industries [1]. There are two ways of measuring liquid level in general they are direct and indirect measurements. Direct level measurement includes the bob and tape method and sight glass method.

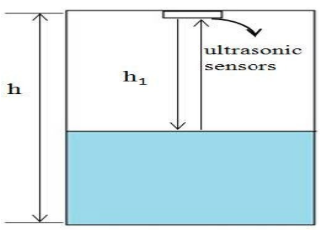

Fig.1. Liquid level measuring using ultrasonic sensor

Indirect level measurement includes pressure gauge, purge system, differential pressure meter, and displacer type level measurement. The tanks are generally spread across a large areas, the manual detection and measurement methods makes it more laborious and time consuming to monitor the tank liquid levels [2]. There are different methods of implementing level measuring processes among which are mechanical, capacitive, inductive, ultrasonic, acoustic and optical.

A simple and cost-effective method of measuring the height of liquid in a tanker is by using ultrasonic waves to optimize better controlling the liquid level within the tank. Figure 1 shows the liquid level measuring using ultrasonic sensor which is placed on top of the tank, the liquid level height “H” can be calculated by equation as shown below

[3].$H = h - h_1$ ------------------------------ (1)

This avoids under fill and overflow of liquid as well as down time during tank refill. It will provide a cost-effectivemeasuring the liquid level in real time, this facilitates user to know actual liquid level in a tank at that instant and as well as liquid level in the tank for past 24 hours by data logging

II .RELATED WORK

Quite a few researchers have worked on liquid level control systems with different approaches and results. S M Khaled Reza et al. [5] introduced the notion of water level monitoring and management within the context of electrical conductivity of the water and investigating the microcontroller based water level sensing and controlling in a wired and wireless environment. Jatmiko et al. [6] developed a prototype module using Ping sensor which is used as a distance sensor for detecting water level by measuring distance between sensor and water surfaces. Poh-Kiong Teo et al. [7] developed an automated water level management system which will monitor the water level in a main tank and reserve tank, these information’s are sent through SMS to the user when they fall below the critical states. Samarth Viswanath et al. [8] developed architecture of a low power wireless system for tank level monitoring using ultrasonic and GSM module.

2.1 NON CONTACT LIQUID MONITORING SYSTEM BLOCK DIAGRAM

The Non Contact Liquid Monitoring System block diagram is shown in Figure 2. It consists of the following hardware components as listed below:

- Arduino UNO (Atmega328 Microcontroller)
- Ultrasonic Sensor (HC-SR04)
- Wi-Fi Module (ESP8266)
- LED (BL-001)
- Power Supply
- Personal Computer/Laptop

To demonstrate the module, we make use of two ultrasonic sensors placed over the two containers to

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sense the liquid level and evaluate the container's depth. The ultrasonic sensor provides an output signal proportional to distance based on the echo. The sensor generates a sound vibration in ultrasonic range upon giving a trigger, after that it waits for the sound vibration to return. Now based on the parameters, sound speed (220m/s) and time taken for the echo to reach the source, it provides output pulse proportional to distance. The Arduino UNO microcontroller accepts this signal from ultrasonic sensor performs necessary processing and sends it to Wi-Fi module. Towards the receiver you have a laptop/personal computer with the internet access; the IOT Display is nothing but a web page which is built to show the status of the liquid level in the container to the user monitoring it. The web page gives a graphical view of the liquid levels in real time (A Plot is drawn where X axis indicating time and date, Y axis indicates liquid level measured). The LED is used to show the sign of the output and the delay occupied by the program module. The buzzer makes sound when the level of liquid collected crosses the set limit.To perform the above procedures an embedded c program codes has been written, built, compiled and debugged which generates a file (. hex file) which is burned into the microcontroller Atmega328 using AVR Studio Version 4. The Flash magic is a tool used for writing the machine language code into the microcontroller's flash memory.

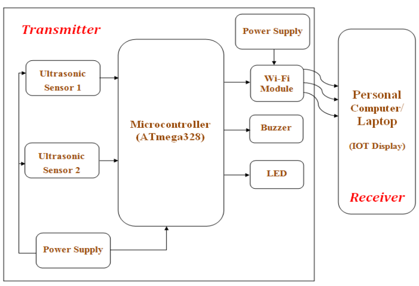

Fig.2. Block diagram of Non Contact Liquid Monitoring

III. HARDWARE DESCRIPTION

3.1 Arduino UNO: The Arduino UNO is a microcontroller board based on the ATmega328 as shown in Figure 3 below. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains

everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with AC-to-DC adapter or battery to get started. The UNO differs from all preceding boards in that it does not use the FTDIUSB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter [9].

fig.3.The Arduino UNO

3.2 Ultrasonic Sensors: Ultrasonic sensors are transducers that convert ultrasound waves to electrical signals or vice versa. Many ultrasound sensors besides being sensors are indeed transceivers because they can both sense and transmit. These devices work on a principle similar to that of transducers used in radar and sonar systems, which evaluate attributes of a target by interpreting the echoes from radio or sound waves respectively. Active ultrasonic sensors generate high-frequency sound waves and evaluate the echo which is received back by the sensor, measuring the time interval between sending the signal and receiving the echo to determine the distance to an object [10] which is as shown in Figure 4.

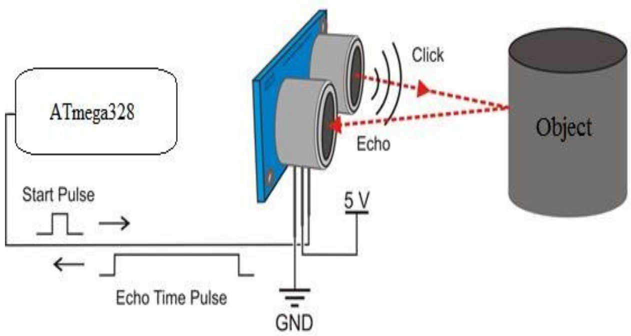

Fig.4. Interfacing Ultrasonic Sensors with ATmega328

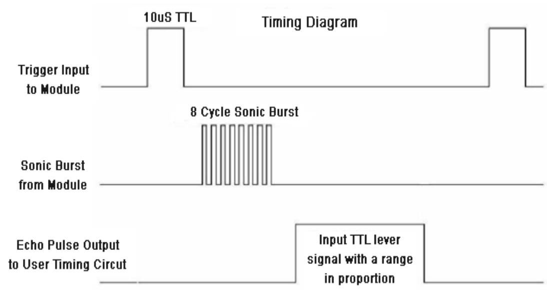

Fig.5.The HC-SR04 timing diagram

Figure 5 shows the HC-SR04 timing diagram and the basic algorithm in distance measuring using the ultrasonic sensor is shown in Figure 6.

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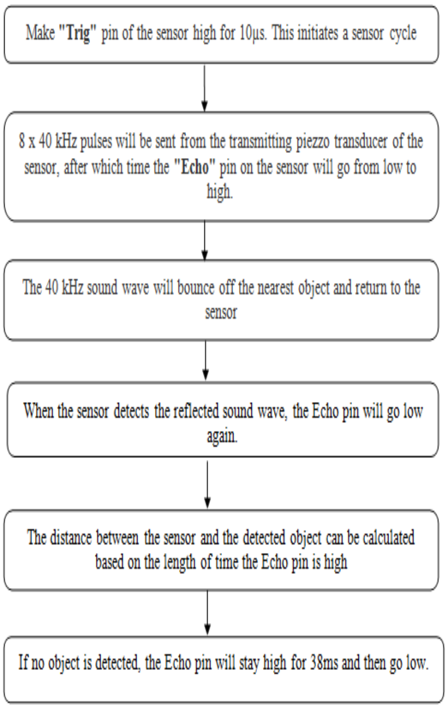

Fig.6. Basic algorithm in distance measuring using the Ultrasonic Sensor

3.3 Water flow sensor:

For continues,water flow rate measurement YF-S201 is used. Connections required for this flow rate sensor with respect to Arduino'sis very minimal.It has operating temperature range of -25°C 80°C which is wide enough for our application to operate successfully. Water flow sensor is shown in figure.

Fig.7. WaterFlow Sensor

3.4 Wi-Fi module: With the popularity of Wi-Fi IOT devices, there is an increasing demand for low-cost and easy-to-use Wi-Fi modules [11]. ESP8266 Wi-Fi module is having TCP/IP protocol stack integrated on chip so that it can connect microcontroller with Wi-Fi network. ESP8266 is a pre-programmed SOC and any microcontroller has to communicate with it through UART interface. Before connecting the module to a microcontroller,

Fig.8. Connection between Wi-Fi module and Microcontroller

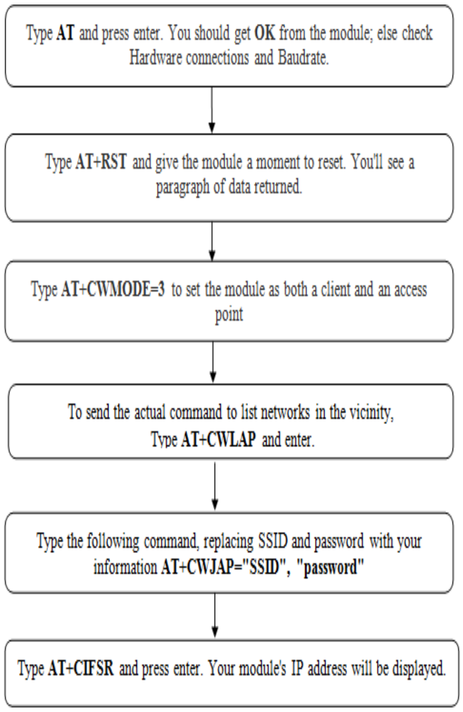

Fig.8. Connection between Wi-Fi module and Microcontroller

it's important to try it directly via a serial interface. An easy solution is to use a 3V3 FTDI cable. Note that the module is not designed for more than 3.6V, so a 3.3V power supply should be used both for power and logic. The interfacing of ESP8266 Wi-Fi module with ATmega328 is as shown in Figure 8 above.
sequence to configure the module in client mode [12]. The detail explanations for configuring the ESP8266 module are shown in steps using Figure 9.

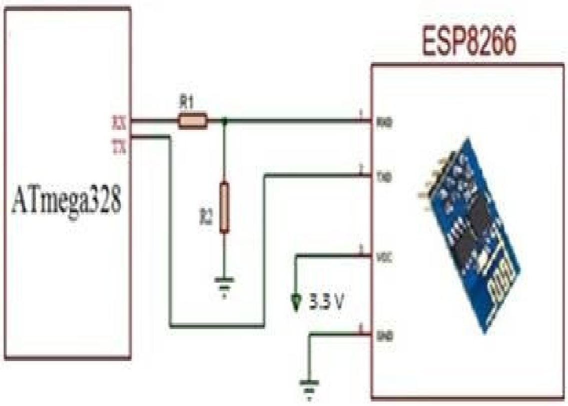

Fig.9. Configuring the ESP8266 Module

3.5 LED (BL-001): It shows the delay occupied by the program module. The LED BL-001 is connected to digital pin of the microcontroller via a resistor. The resistor is connected between the microcontroller & LED to avoid damage to the LED.

Power Supply: The Arduino UNO can be powered via

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the external power supply or with the USB. The power block contains a voltage regulator which provides various voltage levels to the system components like the ultrasonic sensor, Wi-Fi module and the microcontroller.

To implement the Non Contact Liquid Monitoring System we use some basic electronic components such as ATmega328 microcontroller, Crystal Oscillator, 2 capacitor having capacitance 22 pF, resistors, LED, Ultrasonic sensor, water tank, alarm and ESP8266 Wi-Fi module. The circuit diagram of the Non Contact Liquid Monitoring System is shown in Figure 10(a), where the pin Trig and Echo of Ultrasonic Sensor 1 are connected to pin 8 and Pin 7 of ATmega328 respectively. The pin Trig and Echo of Ultrasonic Sensor 2 are connected to pin 10 and Pin 9 of ATmega328. Both the Ultrasonic Sensors pins Vcc and Gnd are connected to 5V and Gnd, The pins RXD and TXD of ESP8266 Wi-Fi module are

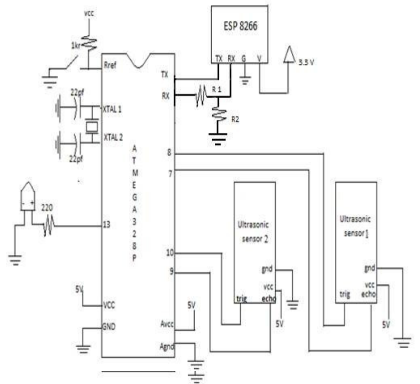


Fig.10 (a) Circuit diagram of Non Contact Liquid Monitoring System

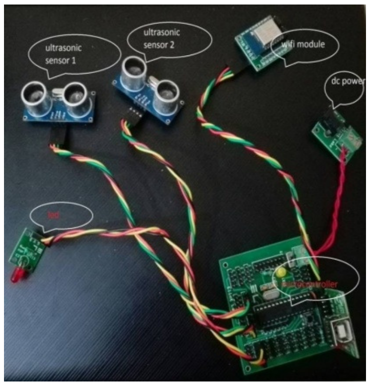
IV. SOFTWARE IMPLEMENTATION

The software used is Arduino which is the Embedded C compiler for Atmega microcontrollers. This has all the required library managers for Atmega328. It also has inbuilt editor, compiler and debugger for Embedded C. The complete system functionality includes the working process of the entire system after integrating all the peripherals along with the software. This is explained in steps which are given below along with the flow diagram as shown in Figure 11.

Step 1: Define all the pins that are used for interfacing hardware components.

Step 2: Initialize the ESP8266 Wi-Fi module by sending a few AT Commands this includes examining the communication between ESP8266 and Atmega328, searching for a Wi-Fi network within its range and linking Wi-Fi module to that network.

connected to pin 2 and pin 3 of ATmega328. In ESP8266 Wi-Fi module Vcc and Gnd are connected to 3.3V power supply and Gnd respectively. LED is connected to pin 13 of ATmega328. Once all the connections are done, then the actual set up of Non Contact Liquid Monitoring System



ig.10 (b) Actual setup of Non Contact Liquid Monitoring System

Step 3: Configuring Wi-Fi module as TCP/IP client. Check if the acknowledgment is received which ensure that the module is configured correctly.

Step 4: Initializing the ultrasonic sensors module and reading the ultrasonic sensor1 and ultrasonic sensor2 data.

Step 5: The obtained sensors values will be sent to "THINK SPEAK" server. A Plot is drawn where X axis indicating time and date, Y axis indicates liquid level measured. Updating of the values happen once in every 15 seconds.

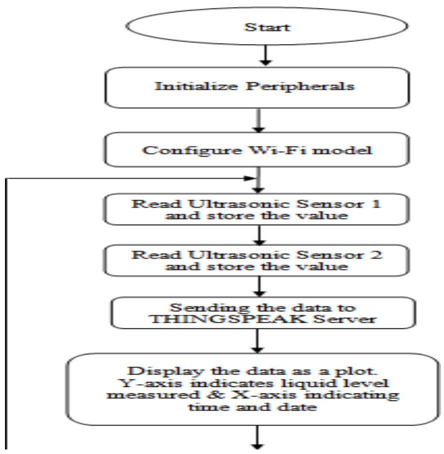


Fig.11. Flowchart for the Non Contact Liquid Monitoring System

V.EXPERIMENTAL RESULTS

ThingSpeak is an open source "Internet of Things" application and API to store and retrieve

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data from things using HTTP over the Internet or via a Local Area Network. With ThingSpeak, you can create sensor logging applications, location tracking applications and a social network of things with status updates [13].

Step 1: Open thing speak as shown in the below figure
Step 2: Click on the private view
Step 3: The output is as shown below and the data is synced using Wi-Fi. A Plot is drawn where X axis indicating time and date, Y axis indicates liquid level measured. Updating of the values happen once in every 15 seconds.

Fig.12 Online database Monitoring

VI. CONCLUSION

We propose a technique of using ultrasonic sensors and the microcontroller together to build a competent system which consumes low-power, easy to maintain and monitor the dynamic level of the liquid in real time. A graphical display interface using IOT is designed to facilitate remote monitoring and finally ESP8266 Wi-Fi Module is used to employ wireless data transmission. The pioneer module is designed, tested and found to be running as expected.

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Step 2: Click on the private view