AUTOMATED WATER MONITORING SYSTEM

Project report submitted in partial fulfillment of the requirement for the degree

of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

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DECLARATION

We hereby declare that the project work entitled "**Automated Water Monitoring System**" is an authentic record of our own work submitted at Jaypee University of Information Technology – Waknaghat, Solan, India, as requirement for the award of the degree of B. Tech in Electronics and Communication Engineering at Jaypee University of Information Technology, Solan, under the supervision of **Mr. Mohit Garg (Assistant Professor, ECE Department)** from 2018-2019.

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BONAFIDE CERTIFICATE

This is to certify that the project report entitled "**Automated Water Monitoring System**" is submitted by **Anuj Purwar, Mohit Patel, Karan Ahuja,** for partial fulfillment for the award of **B. Tech** degree in Electronics & Communication Engineering. The report submitted to **Department of Electronics and Communication Engineering at Jaypee University of Information Technology – Waknaghat**, Solan, India, is a record of student's own work carried out under supervision of **Mr. Mohit Garg** .

Date of Submission :10/05/2019

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ABSTRACT

The 21st century era is witnessing continuous technological advancements and rapid degradation of our natural resources. Water, which is one of the basic necessity, is under scarcity. There is a need to find ways to conserve and save every single drop of water. To confront from the scarcity of water and preserve it using a more efficient method, the idea has been presented in this project. The idea focuses on developing and implementing an efficient and optimized water utilization system in which automation is done using the real-time data to measure the quantity of water supplied from the main supply tank to its respective sub-tanks with an efficient and optimized leakage detection system in the supply lines. Leakage amount in the supply lines is detected based on the concept of the difference between water delivered to various nodes by the main tank and received by the various nodes, and the exact location of the leakage is determined using a new approach based on the transmission line and circuit theory concepts. The main advantage of using the proposed leakage detection scheme is to reduce the cost to existing leakage detection schemes without comprising the accuracy of the system. While most of the schemes employ sensors and other costly elements thus causing the increase

in the system cost, this scheme is very simple and practical as it does not require any sensors and other costly elements but only requires very simple hardware requirements such as coaxial cable, copper wire and waveform analyzer. Because of cost-effective and accuracy fulfillments, this automated water management system finds suitable applications in various aspects of daily life such as smart cities, campuses, residential complex etc.

CHAPTER-1

INTRODUCTION

1.1 PRESENT SCENARIO RELATED TO WATER

India’s population is increasing day by day and has reached beyond 1.2 billion. Due to overpopulation the demand and consumption of food, water and other daily life basic amenities is also increasing continuously leading to decreased supply which results in unavailability of food, scarcity of water and inefficient supply of daily life basic amenities. No one can survive without water because it is the most important natural resource in this world. So, an efficient utilization of water becomes very important in our daily life. Drinking water supply and sanitation in India continues to be inadequate, in spite of various efforts by the government and private agencies. Meanwhile, government agencies in charge of operating and maintaining the infrastructure are seen as weak and deprived and lack in financial resources to carry out their work. Therefore, the aim of our research is to design an efficient Water Utilization Supply System, which can ensure a continuous supply of water to various regions, by notifying our respective Government Department 24 hours

The solution focuses on developing an efficient water supply system that gives real-time data by measuring the quantity of water passed from main supply-tank and received by consecutive sub-tanks. It also determines whether there is any kind of leakage anywhere in the supply lines and gives feedback about how much of water was supplied from the main-tank and how much of the total quantity supplied by the main-tank is delivered to its respective sub-tanks. Figure 1 shows the interfacing of the entire system i.e., surveillance of sensor-nodes (sub-tanks) with master nodes (main-tank) and then casting of data by the master node to the cloud which in turn provides remote accessibility of data instantly. Here, each sensor-node is in itself under the surveillance of MCU interfaced with sensors.

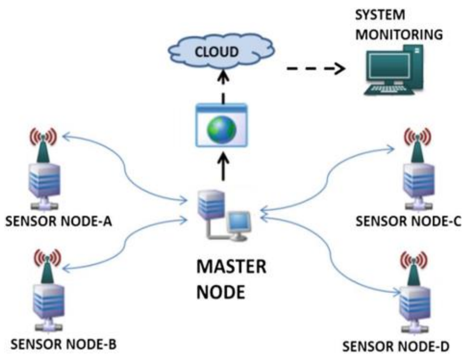

Fig. 1. Diagram of sensor nodal network

The system uses IOT (Internet of things). The internet of things is the internetworking of interrelated computing devices, mechanical and digital machines, physical devices like sensors, embedded with electronics components like MCU, actuators, and network connectivity that enables these objects to collect and exchange data without requiring human-to-human intervention or human-to-computer intervention. The IoT provides an access to the data remotely across existing network infrastructure. The IOT provides a platform resulting in improved efficiency, accuracy and economic benefit.

We investigate the microcontroller-based water level measurement system. Water Level measurement approach would help in reducing the home power consumption by notifying the water overflow condition. Furthermore, it can indicate the amount of water in the tank instantaneously.

Wireless Sensor Network (WSN) has become one of the basic and most desirable technological needs as it solves the inconvenience that are caused due to wiring. It has a wide perspective in the area of remote sensing, various automation controls and domestic appliances. Through WSN easy collection, transmission and processing of data can be done. We have used this technology in order to reduce hardware complexity, power consumption and cost.

The sensors interfaced with the microcontroller, present on the subsequent tank, sends data to its subsequent microcontroller which in turn collects data and pushes it on the microprocessor present at the main supply-tank (Hub) through GSM shield. The entire raw data is processed at the main-tank (HUB) by the microprocessor unit installed at the main-tank. The processed data is then pushed into the cloud where the database is made and stored in real time so that it can be used and accessed remotely.

Future prediction of how much of water to be delivered at the subsequent tanks (nodes) is done on the basis of previous values of the volume of water present in tank. This then finds out at what time and how much of water should be supplied to the subsequent tanks (nodes), this helps in efficient utilization of water by cutting off the excess supply of water to the tank (nodes) and delivering this excess amount of water to some other tank (node).

Water Monitoring system offers multiple benefits like as,

- Quantity of water saved can be used as a new supply which can be dedicated to other uses.

- The system can be used in various aspects of daily life individually in a residential complex, Government complex, schools, colleges, Campus, private and public sectors.
- This will also help us to predict beforehand if there is any shortage of water so that necessary measures can be taken.

1.1 LITERATURE REVIEW

Presently, leakage detection is carried out using electro-acoustic techniques in which acoustic sensors are installed on the pipe. In this technique, the identification of the noise is done which is produced due to water escaping through a pipe. It is then investigated and analyzed by the inspection staff employing specific instruments equipped with 'listening devices', by bringing the equipment closer to the pipeline access points of the water distribution system i.e., valves, manholes. By this means, the possibility of a leak in a pipe is determined successfully. The exact leakage location can also be determined by listening for leak sounds on the ground directly above the pipe. The acoustic listening devices used in this technique are typically of the mechanical or electronic types (e.g., listening rods, geophones or microphones). These devices are equipped with sensing mechanisms or sensing elements (like piezoelectric materials) in order to detect the noise or vibration induced by water leaks.

The existing methods used for leakage detection are very time-consuming (which also translates into cost-ineffectiveness of personnel). The obtained results through the above technique also become unreliable when the measurements are performed under extreme operating conditions of the pipe like the presence of high water pressure, low acoustic noise, etc.

Because of unreliability of the techniques under specific conditions, constant research efforts are dedicated to improve the leakage detection techniques and to make them more effective. For example, Doppler frequency shift is a method of water leakage detection which is based on the detection of the Doppler frequency shift of the reflected electromagnetic wave because of slightly moving water that leaks out of a pipe were proposed in past. Also, ground penetrating radar (GPR) is used to locate leaks in underground water pipes by detecting voids which are created due to leaking out water in the soil near the pipe.

A detailed overview of the state-of-the-art inspection techniques and technologies towards condition assessment of water distribution and transmission mains can be found in the further discussion made below

The various techniques prevalent today for individualization of leaks are highly complex and time-consuming. These techniques require highly experienced personnel with expertise in the field. Although the techniques are universally accepted their high cost, the degree of complexity in implementations and technical advancements made them unreliable and ineffective. On this basis, the present work aims at the practical feasibility of an innovative application based on the reflection coefficient of transmitted and reflected signal travelling through metallic sensing element. This is a novel approach to implement leakage detection system consisting of recording the transmitted and reflected signals travelling through the metallic sensing element and then using these recorded waveforms of transmitted and reflected the signal to identify any immoderate situation (leaks/faults in pipes) which may be an indication of a leak. The proposed work is validated through experimental results carried out through the proposed system in the laboratory under necessary requirements.

1.1.1 GROUND PENETRATING RADAR METHOD

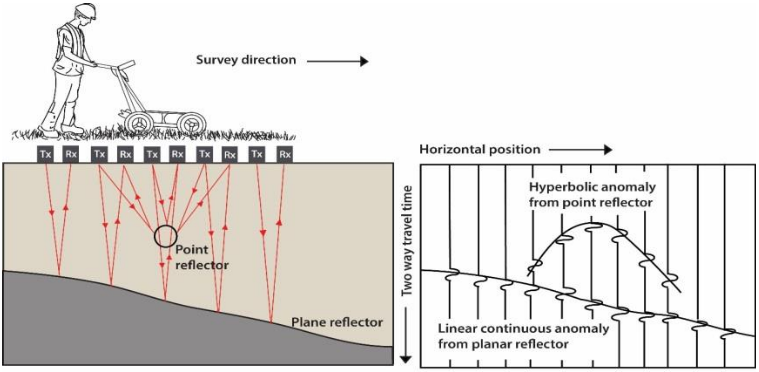

Fig. 2. Ground Penetrating Radar Mechanism

•GPR employments high-frequency-pulsed electromagnetic (EM) waves on obtain subsurface data. It is used to examine the subsurface without drilling, testing or burrowing. Essential GPR study supplies comprise of a transmitting What's more accepting antennae, a radar control unit and an information stockpiling and presentation gadget.

• Vitality is radiated under those ground from a transmitting radio wire. Likewise, those wave spreads out and sets out downward, though it encounters a covered object alternately limit with different electromagnetic properties, that point, and only the wave vitality is reflected or scattered over towards those surface. Those accepting radio wave in the surface records the quality (amplitude) of the reflected sign with a chance. The plentifulness of the EM vitality reflected starting with whatever limit relies on the progress for material properties (dielectric constant, attractive per manganic corrosive Furthermore electrical conductivity) during those limit. The reflected signs need aid recorded through a chosen long haul extent to an altered radio wire position to process An examine or follow of radar information. Filters got concerning illustration those antennae would move in a surface would put side by side to process a radar profile alternately radargram.

• GPR waves might achieve depths dependent upon 30 meters On low conductivity materials, for example, dry sand alternately granite. Clays, shale, Also other secondary conductivity materials might weaken alternately absorb GPR signals, diminishing the profundity about infiltration will 1 meter or Lesquerella. Those profundities for infiltration may be likewise dictated toward those GPR radio wire.

• GPR could be clinched alongside principle, recognizing breaks in covered water pipes whichever Eventually Tom's perusing identifying underground voids made Eventually Tom's perusing those spilling water Concerning illustration it erodes the material around those pipes, or by identifying bizarre progress in the properties of the material around pipes because of water immersion. Dissimilar to acoustic methods, provision of ground infiltrating radar for spill identification is free of the channel sort (e. G., metal alternately plastic). Therefore, GPR Might have a higher possibility about avoiding challenges encountered for regularly utilized acoustic spill identification systems Concerning illustration it applies should plastic pipes. GPR Might Additionally make utilized Similarly as a supplement will these routines to expansion exactness over high hazard ranges for example, such that secondary movement lanes What's more expansive structures.

1.1.2 ACOUSTIC EMISSION TECHNOLOGY

Sensors

Acoustic emanation sensor may be An gadget that transforms An nearby element material relocation generated all the Toward An anxiety wave will an electrical sign. AE sensors are normally piezoelectric sensors with components housekeeper about extraordinary ceramic components like lead zirconate titanate (PZT). These components produce electric signs At mechanically strained. Different sorts of sensors incorporate capacitive transducers, laser interferometers.

Choice of a particular sensor relies on the application, kind about flaws to make revealed, clamor qualities What's more other elements. Commonplace recurrence run in AE requisitions varies between 20 kHz Also 1 MHz. There need aid two qualitative sorts about sensors as stated by their recurrence responds full and wideband sensors. Thickness about piezoelectric component characterizes the thunder recurrence for the sensor. Breadth characterizes the region through which the sensor averages surface movement. An alternate essential property of AE sensors will be An Curie Point, the temperature under which piezoelectric component loses lasting press fabric its piezoelectric properties. Curie temperature varies to separate pottery starting with 120 on 400C0. There would pottery for again 1200C0 curie temperature.

Acoustic Emission system

An archetypal acoustic discharge arrangement consists of:

• Sensors acclimated to ascertain AE events.

• Preamplifiers that amplify an antecedent signal. Archetypal addition assets are 40 or 60 dB.

• Cables that alteration signals on distances up to 300m to AE devices. Cables are archetypal of the coaxial type.

• Abstracts accretion accessory that performs analog-to-digital about-face of signals, filtration, hits (useful signals) apprehension and its ambit evaluation, abstracts analysis, and charting.

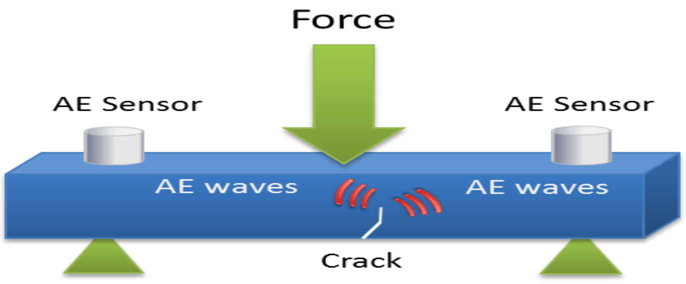

Fig. 3. Acoustic Emission Mechanism

Identification for acoustic emission

Those practically regularly utilized strategies to identification for acoustic emanation signs will be In light of edge separation. At signs surpass a preset settled or a coast plentifulness edge level, a hit estimation Also transforming is triggered. What's more to threshold-based hit identification techniques, there would different strategies In view of An Factual examination or range aspects.

CHAPTER-2
AUTOMATED WATER MONITORING SYSTEM FRAMEWORK

2.1 SYSTEM ARCITECHTURE AND DESCRIPTION

The general working of every segments utilized within our framework outline is shown in the fig.4 given below:

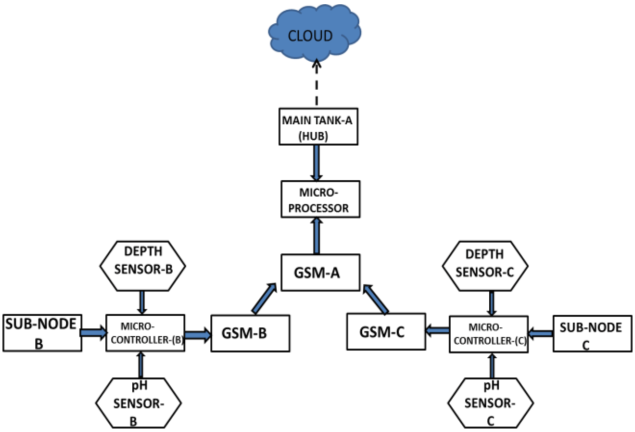

Fig.4. Flow Chart of framework model

2.1.1 SYSTEM COMPONENTS

The system architecture includes the following components as listed:

A. HUB OF WATER SUPPLY

Every water tank is acting as a single hub which saves and supply water to usage design. These hubs supply water with its sequential sub-tanks (outlets) through pipelines Furthermore sub-tanks also supply water on Different other outlets associated with it. Each water tanks comprises a ultrasonic sensors (HC-SR04), Microcontroller (Arduino Uno R3) & display LCD (Mini Voyager). The fundamental water hub (Tank) may be the primary center and supervises those whole frameworks. Each tank goes about concerning illustration a hub to the nodal sensor placements and makes remote sensor system (Fig. 3).

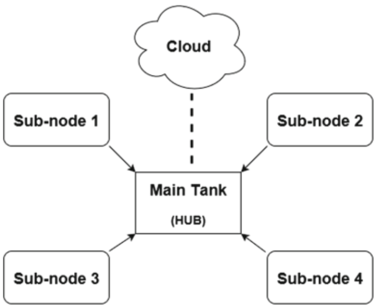

Fig. 5. Structure of a nodal network

B. MEASUREMENT OF WATER LEVEL

Measuring about water level comprises of an ultrasonic profundity sensor which produces a measurable reaction indicator. Here, those sensors measure those water level during each moment. Every profundity sensor will be interfaced with the microcontroller. Every last one of the sensors would be associated in such an approach that they type An remote sensor system. Ultrasonic sensors would fundamentally distance measuring sensors which measure the water level by utilization of reflection of ultrasonic waves. It is microphones that identify ultrasonic waves that is present under certain conditions, change it to an electrical signal and report it to a microcontroller. It comprises of transmitter which sends the Ultrasonic waves(echo) and the collector receives those ultrasonic waves.

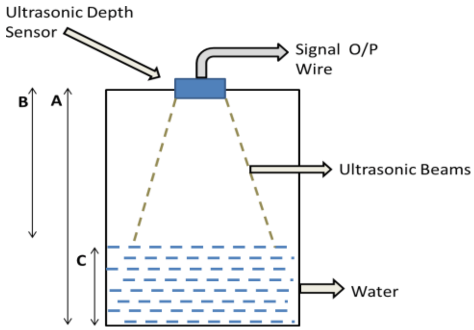

Fig. 6. Working of Ultrasonic sensor

Ultrasonic working is demonstrated in fig.6, waves of ultrasonic sensor get reflected back from water level top. Ultrasonic sensor uses the time difference between transmitting & receiving signal, the signal is saved & microcontroller calculates the level of water at any instant

Distance = (2 * *Speed of Ultrasonic waves) / (Timelapse between sending and receiving signal*)

Level of water in each tank can be measured with the measured distance.

C. MICROCONTROLLER (ARDUINO UNO R3)

Microcontroller can be considered as the brain of any system because all the programming and the decision making is done by this chip. It can be programmed to do various control operations on system such as monitoring, sequencing and displaying the data. For instance, in our system microcontroller is controlling ultrasonic sensor & is calculating amount of water with the help of mathematical algorithm which we have designed and programmed in our microcontroller. Once we get the amount of water level in respective tanks, these reading of water levels will be send to server using WiFi module esp32 development module.

D. INTERNET OF THINGS (IoT)

IoT is one of the emerging & booming technology in todays world & it is said that by 2020 most of devices across world will be using Iot. In simple language we can say IoT is connecting devices in such a way that it can be accessed from anywhere in the world. The Internet of Things (IoT) is anxious with an abutting communicating altar that is installed at altered locations that are possibly abroad. Internet of Things represents a abstraction in which, arrangement accessories accept the adeptness to aggregate and faculty abstracts from the world, and again allotment that abstracts beyond the internet area that abstracts can be activated and candy for assorted purposes.

E. SENDING DATA TO SERVER

Server registering may be an Internet-based registering that gives imparted workstation processing, assets Furthermore information on machines and different units looking into request. Previously, more all terms, it is An registering stage the place the whole data is put away will be pushed to the server with the goal that it could be accessed remotely In any moment. We are using Thingspeak platform for this task to be done.

F. CONTROL SYSTEM FOR WATER LEAKAGE

The difference in initial & final water level is key principle used for determination of leakage in any tank or pipe. By accessing the server these data levels can be accessed which are stored over there. Once we get the difference between amount of water delivered by main tank & amount of water received by sub tank, we get the amount of water leakage.

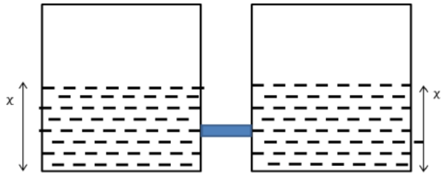

Fig. 7. Tanks with equal level

Initial water level of the tank is depicted in Figure.5.

Let its water level decreased by some amount say X1, after delivering L litres of water from this tank to other tank.

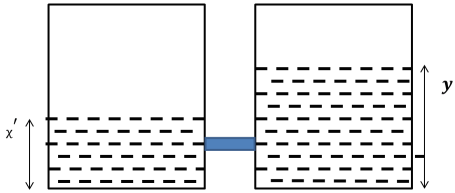

Fig. 8. Tanks with unequal level

It can be seen from figure 6,that water decreased in one tank by L litres is reflected in another tank i.e with increase of almost L litres.

Amount of water decreased in one tank = Amount of water increased in another tank

Since we are talking in terms of gallons so some litres of water can be considered as negligible.

G. WIFI MODULE (ESP32)

We are using ESP32 development board which is helping us to connenct to internet so that data on real time can be sended to server and amount of water loss between different distant locations can be finded out. It work on 3.3V upto maximum of 5V i.e it is a low power device . It can even be used without any microcontroller. Its speed can go upto 150Mbps. It has 36 GPIO's. It has both reset boot buttons on the top of the board.

2.2 DESIGN METHODOLOGY

A. Tank Parameter Measurement

Clinched alongside fig. 9, tank A will be the primary supply starting with the place water will be conveyed on diverse districts alternately divisions of the framework. It may be likewise the center for our framework the place entire information will be made accessible. Also following the transforming information will be put away in the (server). The principle tank will be Additionally acting Concerning

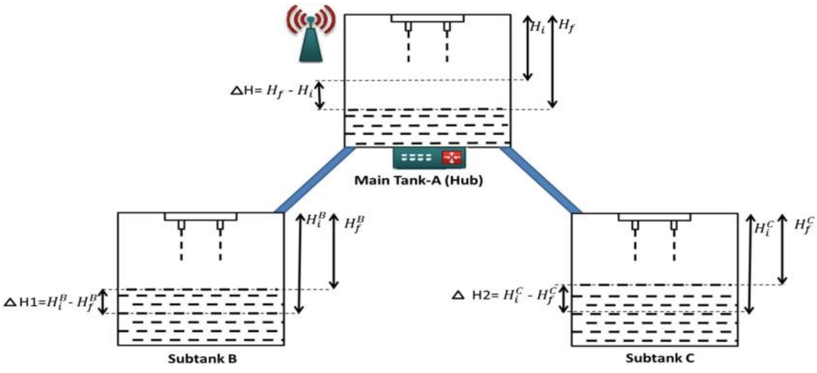

Fig. 9. Demonstration of flow &calculation of water level

illustration a director for the sub-nodes. “For the purpose for simplicity, we have viewed as that there are just three hubs associated for one another (furthermore particular case hub primary tank (Tank-A).

B. Calculations for Water Level & Formulae

With the help of water level sensors initial height of each tank can be known which is already present in the tanks, water level of respective tanks are continuously sensed & measured & the difference between two level will give actual change in amount.

Change in height of water in Tank A = Initial Height — Final height

C. Tanks Volume Measurement

This water level may be allocated Likewise the introductory water level and the information will be sent of the server. The ultrasonic sensor ceaselessly sends the indicator Also Similarly as it encounters whatever progress in the water level it once more records it & sends information of the microcontroller, At it turns into stable which thus calculates the new water level. This progress over water level may be after that used to figure the volume about water conveyed by those tank with other sub-tanks.

Estimation of the water level takes spot In each node, will send the information of the fundamental center utilizing WiFi shield. Two sub-tanks associated with it are of limit V gallons.

Tank A Change in Volume of water = Initial Height– Final

D. Data Analysis

After the data from various sub tanks is received to main tank there analysis of data comes into picture. After that all data is sended to server, fig.10 is showing flow & all tasks which are being performed at respective nodes and at main node.

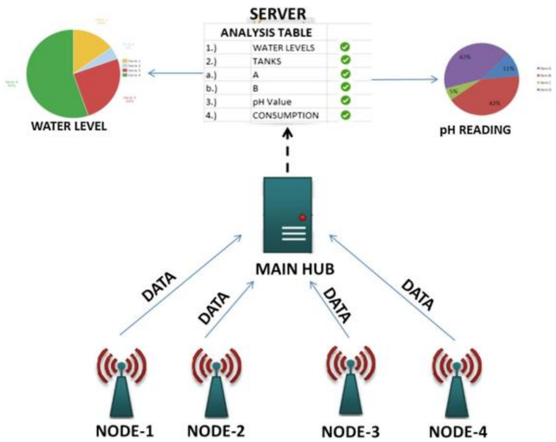

Fig. 10. Framework of flow of data

CHAPTER-3

A NOVEL LEAKAGE DETECTION APPROACH

3.1 WATER LEAKAGE DETECTION

Leakage amount in the supply lines is detected based on the concept of the difference between water delivered to various nodes by the main tank and received by the various nodes, and the exact location of the leakage is determined using time-domain reflectometry-based technique.

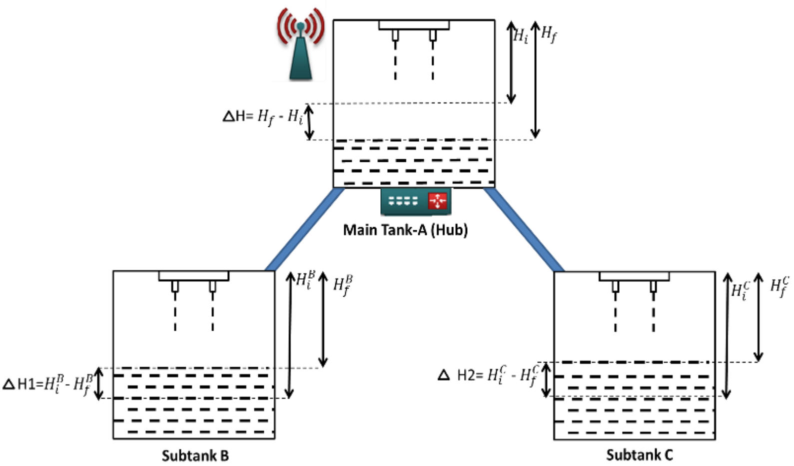

Fig. 11 Water leakage detection calculation

As shown in figure 11, Tank A is the main water supply tank from which water is supplied to various other sub-tanks. In our case, we have taken only two sub-tanks (Sub-Tank B and Sub-Tank C) for the sake of simplicity in analysis. The difference between the amount of water delivered by main node and the amount of water received by other nodes gives the amount of water leaked in the intermediate nodes. To obtain the amount of water loss due to leakage, initial and final heights of each tank is estimated using water level sensors. In figure 11, the change in water level is shown by finding the difference between the initial (Hi) and final water level (Hf).

3.2 PROPOSED METHODOLOGY

A. Experimental Set-up Design

In this paper, we have used a novel approach in the design of water leakage detection system that is very cost effective and easy to design. The leakage detection system comprises of specially designed metallic pipes, which are covered with salt layer on its outer surface. A metallic wire is then spirally wounded over the salt surface and then the whole pipe is covered with some insulating material to prevent from being exposed to the surroundings.

Figure 4 shows the TDR based experimental set-up design for the water leakage detection [13]. The proposed method requires the installation of new pipes manufactured using salt strip and metallic wire lying over it. The coaxial cable coming out from the TDR meter is connected to the leakage detection system i.e. positive end of the cable is connected to the metallic wire and the negative end of the cable is connected to one end of the metallic pipe. When an operator requires checking the status of water leakage through pipes, an electromagnetic wave or a pulse signal (duty cycle around 25%, high frequency in Mhz range and large amplitude) is sent through the TDR meter. This electric signal travels through the metallic body of the pipe and is so called the transmitted signal. When a leakage is found, the system generates the reflected signal, which travels through the metallic wire.

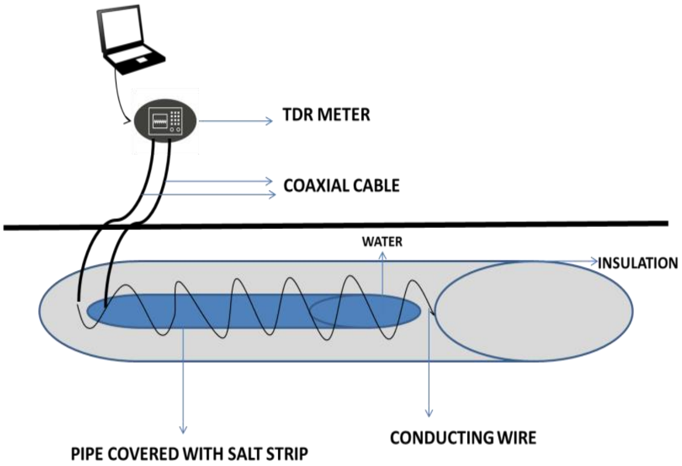

Fig.12 Experimental set-up design for TDR based leak localization

3.3 THEORETICAL APPROACH

To determine the location of leakage concepts of network theory and electromagnetic are used. The phenomenon of open circuit and short circuit helps in determination of leakage. When there is any burst or leakage at any location in the pipe, then the outer metallic body of the pipe comes in contact with the metallic winding and a short circuit is formed. This short circuit generates a reflected signal that travels through the metallic winding backwards towards the waveform analyzer. The waveform comprises of transmitted as well as reflected signal. The reflected portion of waveform confirms the leakage whose location can then be determined by carefully analysing the waveform and doing mathematical calculations. If there is no leakage then the transmitted signal travels through the metallic pipe without any reflected part. The waveform at the analyzer will then comprises of the only transmitted part, no reflected part.

Reflection coefficient value becomes -1 for this case of short circuit. The leakage point can be determined by observing the transmitted and reflected

waves on the TDR meter. The time gap (t_d) between transmitted and reflected wave is twice the time taken by

$$t_d = 2 * t_f$$

the wave for forward transmission (t_f).

The speed of propagation of wave for the medium ε_r is known as,

where c is the speed of propagation of wave in air.

$$c_o = c/\sqrt{\varepsilon_r}$$

The distance of leakage location is then calculated using, leakage point=c*(td/2)

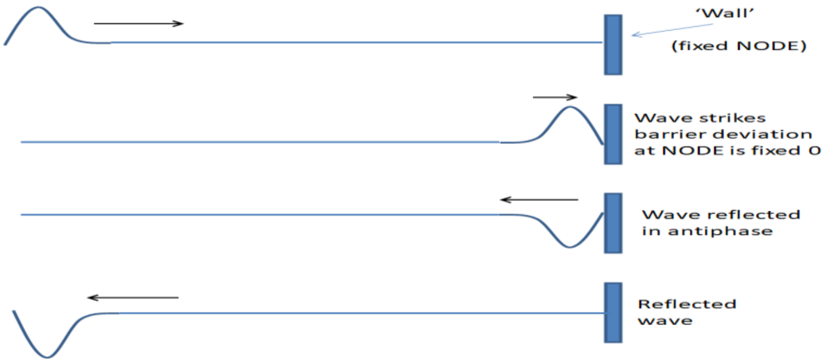

Fig. 13 Reflected and transmitted wave pattern

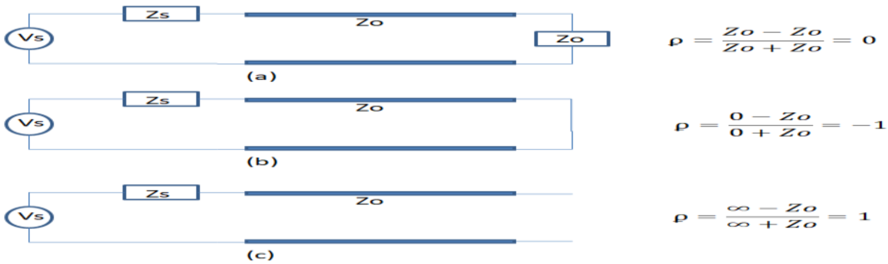

Fig.14 Reflection coefficients in case of (a) characteristic impedance terminated line (b) short-circuited line (c) open-circuited line

3.4 EXPERIMENTS, RESULTS AND DISCUSSION

The novel idea presented for efficient water leakage detection system is practically verified by an experiment performed with the help of available apparatus in the laboratory. A pulsating signal of 5 volt in amplitude and in MHz frequency range with a duty cycle of 10-15 % is applied at source from the function generator. This is the transmitted wave which will travel through coaxial cable and will be reflected if short circuited terminal is encountered otherwise will travel to infinity without any reflection.

The experiment is performed for two different lengths of coaxial cable. One corresponding to 92 m length of cable and the other corresponding to 178 m length of cable. The speed of pulse waveform generated through function generator travels through coaxial cable at a speed given by the formula $c_o = c/\sqrt{\varepsilon_r}$. The short circuit terminal acts as a leak location point and the time taken by the wave to travel the entire length up to short-circuited terminal can also be computed using. $t_d = 2 * t_f$

A. Observation corresponding to 92 m length

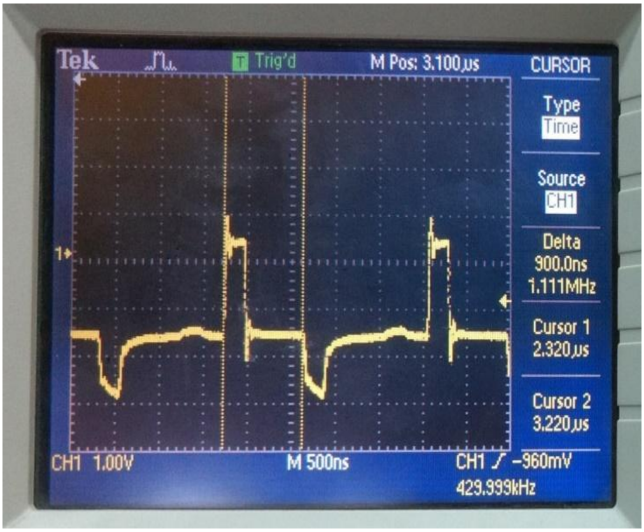

Fig. 15 Reflected and transmitted wave obtained on display device with 92m coaxial cable

c = Speed of wave propagation in air = 3*10^8 m/sec, ε_r = 2.2, $t_d = 900ns$

Leakage location = $c*(t_d/2)$ **= 91.12m.**

From the above observation, it is found that the leakage is at location 91.12m, which is almost the exact length of coaxial cable i.e. 92m. The above graph clearly shows that the calculated length of leakage point location is approximately same as that of exact leakage location.

B. Observation corresponding to 178 m length

Fig.16 Reflected and transmitted wave obtained on display device with 178m coaxial cable

c = Speed of wave propagation in air = 3*10^8 m/sec

ε_r = 2.2, $t_d = 1.760\mu s$

Leakage location = $c*(t_d/2)$ **= 177.76m.**

From the above observation, it is found that the leakage is at location 177.76m, which is almost the exact length of coaxial cable i.e. 178m. The above graph clearly shows that the calculated length of leakage point location is approximately same as that of exact leakage location.

CHAPTER-4

SYSTEM MODEL PROTOTYPE AND IMPLEMENTATION

As per the detailed description of Automated water monitoring system in pevious chapter we have arrived at a prototype of automated water monitoring system.

The prototype of Automated water monitoring system consists of following components:

- Tanks (tank A,B)
- Water Pump
- Bluetooth Module (HC06)
- Wifi Module (ESP232)
- LCD Display (Texas Instruments Mini Voyager)
- Ultrasonic Sensor (HCSR-04)
- Relay Module
- Microcontroller (Arduino UNO R3)
- Breadboard
- Pipe
- Ardu-droid Application software
- Power supply (5 volt)

4.1 ASSUMPTIONS

- In the prototype we have considered two tanks, one is main tank and the other is sub-tank.

- Main tank is completely filled.
- The water supply system is unidirectional i.e., from main tank to sub-tank.

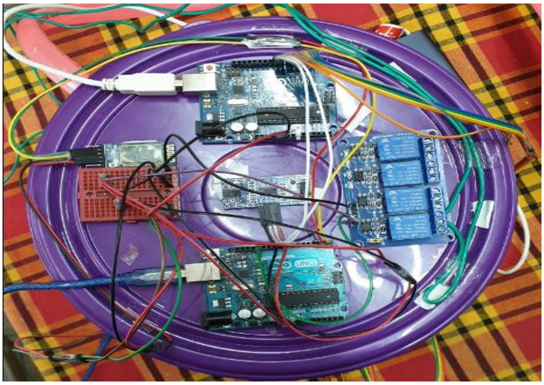

Fig. 17. Top view of Main-tank with surveillance system

Fig. 18. Top view of Sub-tank with surveillance system

The main-tank consists of water-pump, microcontroller, relay module, bluetooth module, water-level sensor and display screen. The sub-tank consists of microcontroller water-level sensor and display screen. Both the tanks are connected through a pipeline for water supply.

4.2 AUTOMATING WATER SUPPLY

To supply water from main-tank to sub-tank with minimal human intervention a relay module is interfaced with Bluetooth module, microcontroller and Ardu-Droid application software on mobile phone. To switch on the pump and start the water supply we give start command on mobile phone which in turn makes the water to flow from main tank to sub-tank.To switch off the pump stop command is sent from the mobile phone which in turn switches off the pump thereby stopping the supply. In this way we are able to access the water supply remotely.

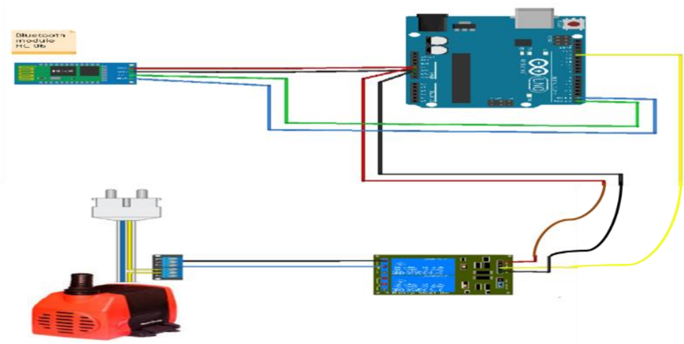

Fig. 19. Interfacing Motor, microcontroller, Water-level sensor, relay

4.3 WATER LEVEL MEASUREMENT

To measure the water level instantaneously at the main tank and sub-tank water level sensor interfaced with microcontroller and display screen is used. The display screen displays the instantaneous water level of the tank. As soon as there is any change in the water level of the tank, the display screen displays the water level at that instant.

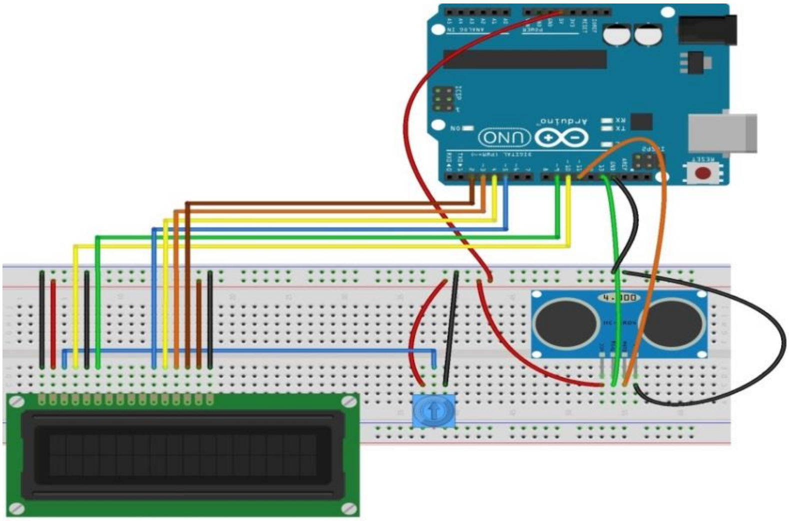

Fig. 20. Circuit Schematic for Water Level Measurement on each tank

Fig. 21. Empty Tank

Fig. 22. Full tank

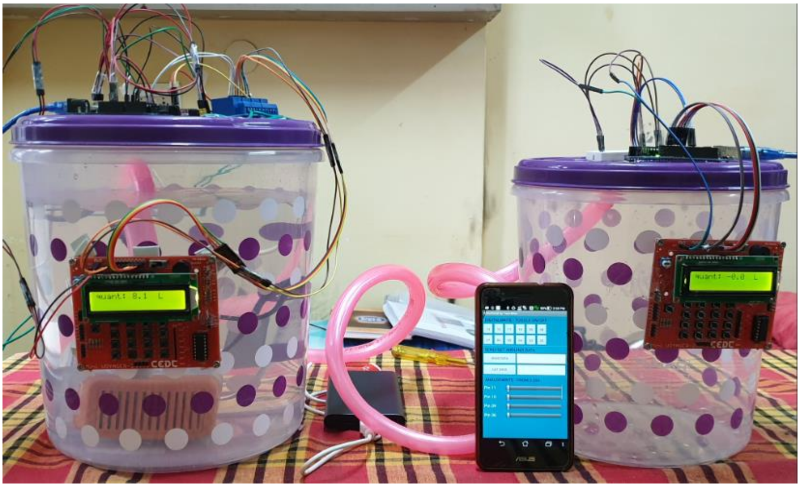

Fig. 23. Prototype of Automated Water Monitoring System

4.4 SENDING DATA TO THINGSPEAK USING ESP32

Here, we are going to show how to upload sensor data to Thingspeak platform and visually analyze our data in real time. We will be sending the data of total amount of water (in volume) using, in tank to thingspeak platform where we can store, examine and visualize the data using visual support on Thingspeak. We will be using ultrasonic sensor and ESP32 for accessing GPRS so that we can send the data to the server.

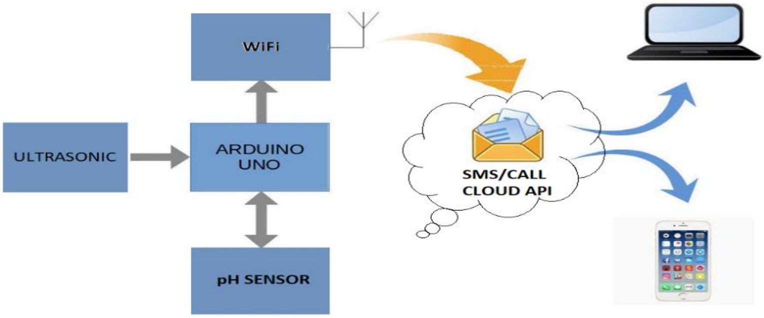

Fig. 24. Data fetching on cloud

A graph will be generated on Thingspeak platform plotting amount of water present VS time. The data on the Thingspeak will be updated every 10 seconds.

Thingspeak is an online platform made for Internet of Things (IoT) devices to interact and send data on cloud server and use this data in any form useful. Below is the illustration of graphs which we generated.

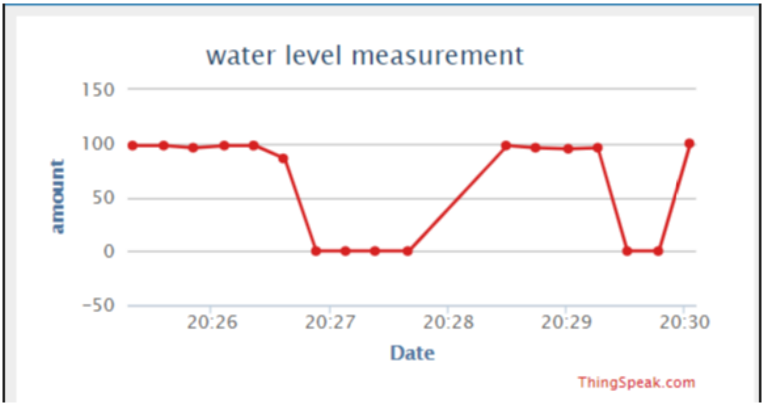

Fig. 25. Graph photo

The straight line signifies that there was no change in volume in container during data logging. We can hover the mouse cursor on these dots to see the numerical data recorded at a particular local time. Thingspeak updates the data as per our requirement.To transfer our data to thingspeak we need something called **API key** from our account which needs to be inserted into our arduino ide code.

Application programmer interface or API key on Thingspeak

It is a string of random character contains alphabets of lower and upper case, numbers and even special characters to identify our account and ensures that our data which is being sent doesn’t end on someone else’s account and vice-versa. Among two types of API keys generated i.e read API key and write API key we our using write API key to write our data on Thingspeak platform.

About APN

APN or Access Point Name is the bridge between user’s carriers network and internet. ESP32 or any mobile device accessing internet must be setup with an APN to present the wireless carrier. APN helps in getting the IP address and also it decides which kind of security protocols can be used.

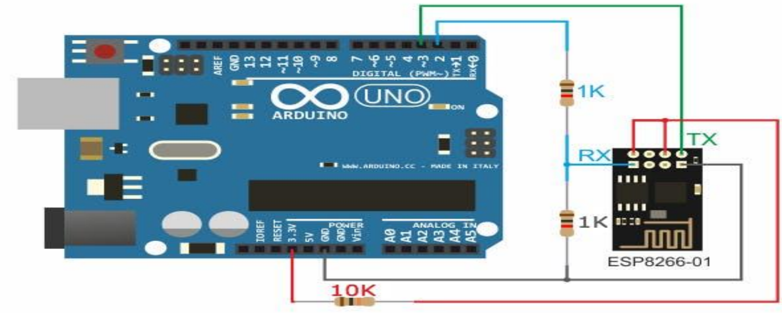

Fig. 26. Application of water management data

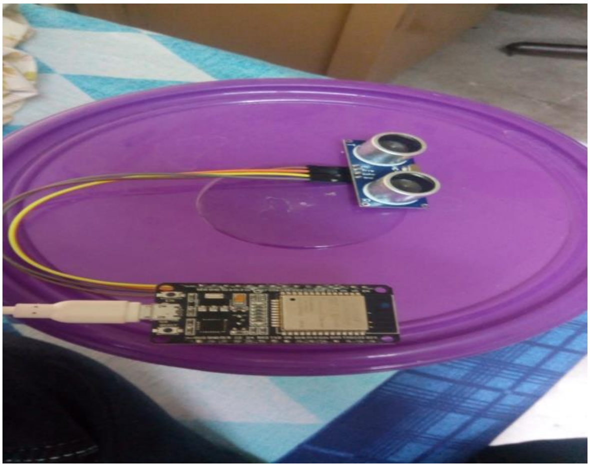

Fig. 27. Module for Sensor Data Transfer

So, this is our circuit. It consists of ESP32 for accessing the internet, one ultrasonic sensor for measuring the water level.

Advantage of Using ESP32:

We are using ESP32 to access the internet instead of Bluetooth module so that our project does not face the problem of range limit and with this we can move our project anywhere where we want just required to connect WIFI hotspot to gain access to internet. So, this makes our project portable as well.

4.5 CODE

Here is our code to transfer the data on Thingspeak platform

```
#include <WiFi.h>
#include <WiFiMulti.h>
WiFiMultiWiFiMulti;
const char* ssid     = "Galaxy S9"; //  SSID
const char* password = "ujcj7403"; // Wifi password
const char* host = "api.thingspeak.com";
float volume=0;
String api_key = "DH56JRYGOPYZ0XZV"; //  API Key
provied by thingspeak
const int trig= 25;
const int echo = 26;
long duration;
int distance;
void setup(){
Serial.begin(9600);
pinMode(trig, OUTPUT);
pinMode(echo, INPUT);
Connect_to_Wifi();//function to connect to wifi
}
void loop(){
```

```
float volume;
digitalWrite(trig,LOW);
delayMicroseconds(2);
digitalWrite(trig,HIGH);
delayMicroseconds(10);
digitalWrite(trig,LOW);
duration=pulseIn(echo,HIGH);
delay(2000); //delay of 2 secomds
// Calculating the distance
distance= duration*0.034/2;
volume=3.14*(17-distance)*6*6;//radius=6cm,height of
//container=17cm
Serial.print("Volume of container ");
Serial.print(volume);
Send_Data();
delay(500);
}
void Connect_to_Wifi()
{
  // We start by connecting to a WiFi network
  WiFiMulti.addAP(ssid, password);
  Serial.println();
  Serial.print("Wait for WiFi... ");
  while (WiFiMulti.run() != WL_CONNECTED) {
    Serial.print(".");
    delay(500);//delay(0.5 seconds)
  }
```

```
  Serial.println("");
  Serial.println("WiFi connected");
  Serial.println("IP address: ");
  Serial.println(WiFi.localIP());//IP address connected to
}
void Send_Data()//function to send data to thingspeak
{
long int value;
value = constrain(volume,0,500);//for limiting the data
value = map(value,0,500,20,0);//mapping the values
Serial.println("Prepare to send data");
// Use WiFiClient class to create TCP connections
WiFiClient client;
const int httpPort = 80;
if (!client.connect(host, httpPort)) {
Serial.println("connection failed");
return;
 }
 else
 {
 String data_to_send = api_key;
 data_to_send += "&field1=";
 data_to_send += String(value);
 data_to_send += "\r\n\r\n";
 client.print("POST /update HTTP/1.1\n");
 client.print("Host: api.thingspeak.com\n");
 client.print("Connection: close\n");
```

```
 client.print("X-THINGSPEAKAPIKEY: " + api_key + "\n");
 client.print("Content-Type: application/x-www-
formurlencoded\n");//used for encoding
 client.print("Content-Length: ");
 client.print(data_to_send.length());
 client.print("\n\n");
 client.print(data_to_send);
 delay(500);
 }
 client.stop();
}
```

4.6 EXPERTMENTAL SET-UP OF WATER LEAKAGE DETECTION AND LOCALIZATION

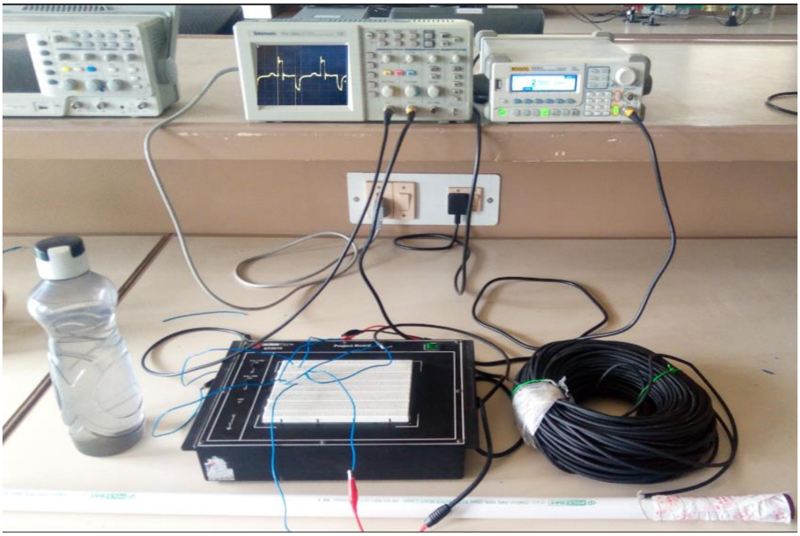

Fig. 28. Prototype of Leakage Detection and Localization

The water leakage path can be identified from the readings stored in the database. A non-zero value of difference between the amount of water delivered and stored denotes that there is a leakage in that particular path.

To identify the exact leakage point in the leakage path, the fig 28 shows the prototype. From the waveforms observed in CRO the leakage location can be identified.

CHAPTER 5

CONCLUSIONS & FINAL REMARKS

5.1 ADVANTAGES OF WATER MONITORING SYSTEM

- Require minimum human participation.
- Provides enough quantity as per the requirement.
- Saving energy and resources so that they can be utilized in proper way and amount.
- Location of leakage detection.
- Water level in tank surveillance with real-time data so as to avoid overflowing or leakage, if present at any instant.

5.2 CONCLUSION

There have been many experiments conducted and problem addressed on this kind of issue but many of them have some kind of drawbacks existing in them. In our research, we have overcome these troubles and came up with a more optimized technique for automated water quantity surveillance and controlling system. The main trouble that is addressed in this project is creating a wireless sensor network model which can ensure least wastage of water during supply from various reservoirs.

Our purpose of this research work is to create an easily formable, feasible and flexible system which can solve our water wastage problems and can ensure proper supply of water to the tanks. It focuses on the real-time check of water amount of the main tank water supply as well as cisterns. Main water tank supplies water to other intake pipes which will supply water to various other tanks that is sub-node. Main supply tank integrates information it receives from various sub-nodes, coordinates and influences the working of entire system and casts it to the server i.e., cloud, for to make the information collected accessible instantly and remotely. Our project have a potential to perform a quality check of water which is supplied at various nodes and can indicate whether it is suitable for drinking or not. We have successfully performed and executed this project in our lab and project can be installed easily at any required place, this makes our project portable and since this is the era of internet so we can access the data from any part of the world.

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