VISVESVARAYA TECHNOLOGICAL UNIVERSITY

JNANA SANGAMA, BELAGAVI-590018, KARNATAKA

A Project Report
on

SMART WATER QUALITY MONITORING SYSTEM

Submitted in partial fulfillment of the requirements for the VIII Semester of degree of ***Bachelor of Engineering in Information Science and Engineering*** *of Visvesvaraya Technological University, Belagavi*

by

Shirisha S	**1RN18IS097**	**Shwetha B**	**1RN18IS105**
Sri Priya G	**1RN18IS108**	**Sagar A C**	**1RN19IS407**

Under the Guidance of

Mrs. Vinutha G K
Assistant Professor
Department of ISE

Department of Information Science and Engineering

RNS Institute of Technology

Dr. Vishnuvaradhana Road, Rajarajeshwari Nagar post,
Channasandra, Bengaluru-560098

2021-2022

RNS INSTITUTE OF TECHNOLOGY

Dr. Vishnuvaradhana Road, Rajarajeshwari Nagar post, Channasandra, Bengaluru - 560098

DEPARTMENT OF INFORMATION SCIENCE AND ENGINEERING

CERTIFICATE

Certified that the project work entitled ***Smart Water Quality Monitoring System*** has been successfully completed by **Shirisha S (1RN18IS097), Shwetha B (1RN18IS105), Sri Priya G (1RN18IS108) and Sagar A C (1RN19IS407),** bonafide students of **RNS Institute of Technology, Bengaluru** in partial fulfillment of the requirements for the award of degree in **Bachelor of Engineering in Information Science and Engineering of Visvesvaraya Technological University, Belgavi** during academic year **2021-2022**. The project report has been approved as it satisfies the academic requirements in respect of project work for the said degree.

Mrs. Vinutha G K
Project Guide

Dr. Prakasha S / Mrs. Kusuma S
Project Coordinator

Dr. Suresh L
Professor and HOD

Dr. M K Venkatesha
Principal

External Viva

Name of the Examiners	Signature with Date
1. ________________	**1.** ________________
2. ________________	**2.** ________________

DECLARATION

We, **SHIRISHA S [USN: 1RN18IS097], SHWETHA B [USN: 1RN18IS105], SRI PRIYA G [USN: 1RN18IS108], SAGAR A C [USN: 1RN19IS407]** students of VIII Semester BE, in Information Science and Engineering, RNS Institute of Technology hereby declare that the Project entitled ***Smart Water Quality Monitoring System*** has been carried out by us and submitted in partial fulfillment of the requirements for the *VIII Semester of degree of* ***Bachelor of Engineering in Information Science and Engineering*** *of Visvesvaraya Technological University*, *Belgavi* during academic year 2021-2022.

Place : Bengaluru

Date :

SHIRISHA S	**(1RN18IS097)**
SHWETHA B	**(1RN18IS105)**
SRI PRIYA G	**(1RN18IS108)**
SAGAR A C	**(1RN19IS407)**

ABSTRACT

The Water is a basic and important resource that is required for a variety of purposes including agriculture, industrial activities, and home use. Monitoring methods for water quality should be both cost-efficient and effective. As water utilities face more challenges, water is becoming increasingly valuable to all living beings. These issues arise as a result of rising population, dwindling water resources, deforestation, poor use, maintenance, and garbage disposal, among other factors. As a result, a variety of real-time water quality monitoring systems are employed. We must make certain that safe water distribution takes place, and that it is seen and noted in real time in order to project a new technique based on the "Internet of Things (IoT)" based water quality.

The proposed system shows how to monitor water quality using a variety of sensors such as temperature and humidity, pH, turbidity, soil moisture, water leakage indication, and water level sensors are among the sensors available. The sensors are connected to the NodeMCU Micro-controller Unit (MCU), and then the computer (PC) does the rest of the work. Using the Wi-Fi module in the Blynk application, the data is transferred to the cloud. In the application, we consider the water's standard before deciding whether to use it.

ACKNOWLEDGMENT

At the very onset we would like to place our gratefulness to all those people who helped us in making this project a successful one. This project to be a success was not easy. Apart from the shear effort, the enlightenment of our very experienced teachers also plays a paramount rolebecause it is they who guide us in the right direction.

First of all, we would like to thank **Management of RNS Institute of Technology** for providing such a healthy environment for the successful completion of project work.

In this regard, we express our sincere gratitude to the principal **Dr. M K Venkatesha,** for providing us all the facilities in this college.

We are extremely grateful to our own and beloved Professor and Head of Department of Information science and Engineering, **Dr. Suresh L**, for having accepted to patronize us in the right direction with all his wisdom.

We would like to express my profound and cordial gratitude to our guide **Mrs. Vinutha G K,** Assistant Professor, Department of information science and Engineering for having guided for project and all the staff members of our department for helping us out at all times.

We thank **Dr. Prakasha S** and Mrs**. Kusuma S,** Project coordinators, Department of Information Science and Engineering for supporting and guiding us all through.

We thank our beloved friends for having supported us with all their strength and might. Last but not the least; we thank our parents for supporting and encouraging us throughout. We made an honest effort in this assignment.

SHIRISHA S (1RN18IS097)
SHWETHA B (1RN18IS105)
SRI PRIYA G (1RN18IS108)
SAGAR A C (1RN19IS407)

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATION

IOT	Internet of Things
LCD	Liquid Crystal Display
RS	Remote Sensing
WQM	Water Quality Monitoring
MCU	Microcontroller Unit
PC	Personal Computer
WSN	Wireless Sensor Network
WHO	World Health Organization
DO	Dissolved Oxyzen
IDE	Integrated Development Environment

Chapter 1

INTRODUCTION

1.1 Background

"Internet of Things" is fast becoming a disruptive technology business opportunity, with standards emerging primarily for wireless communication between devices and gadgets in day to day human life, in general referred to. Internet of Things (loT) is an extension of the current internet to provide communication, connection, and internetworking between various devices or physical objects also known as "Things". IoT term represents a general concept for the ability of network devices to sense and collect data from the world around us, and then share that data across the Internet where it can be processed and utilized for various interesting purposes. The IoT consists of smart machines interacting and communicating with other machines, objects, environments and infrastructures. Nowadays every person is connected to each other using lots of communication way, where the most popular communication way is the internet so in another word we can say internet which connects people can connect things too.

An advanced network of IoT is being formed when a human being is in need of connecting with other things. IoTs technology is used to come up with innovative ideas and great growth for smart and secure homes to improve the living standards of life. The Internet helps us to bring in immediate solutions for many problems and is also able to connect from any of the remote places which contributes to overall cost reduction and energy consumption.

The IOT can be integrated by cloud computing. Cloud computing is a general term for anything that involves delivering hosted services over the internet. These services are divided into three main categories or types of cloud computing: infrastructure as a service (IaaS), platform as a service (PaaS) and software as a service (SaaS).Cloud infrastructure involves the hardware and software components required for proper implementation of a cloud computing model. Cloud computing can also be thought of as utility computing or on-demand computing. The name cloud computing was inspired by the cloud symbol that's often used to represent the internet in flowcharts and diagrams.

1.2 Existing System and Limitation

In the traditional water quality monitoring system, different instruments been used to monitor the quality of water which include “Secchi disks (measure water clarity), probes, nets, gauges, meters”, etc. The traditional method is just not enough to measure water quality and identify any drastic changes in it. This method not only impedes accurate water quality measurement but also at times fails to predict sudden changes in the water system. Hence, Information is also derived from satellite and aerial photographs by observing the surrounding environment and the changes in specific parameters such as flow of water, color in large overview, direction of water flow etc.

There are three major steps to execute traditional water quality monitoring. These three steps indulge different experts at different levels of the process. The major three steps are as follows:

- Water sampling
- Testing the samples
- Investigative analysis.

In Water Sampling, water samples collected in large mass using various tools. These water samples are then examined in the laboratories. Water sampling and analysis are only performed by ISO-certified laboratories. Unreliable results enhance issues concerning pollution when a corrective response cannot be performed within time. Sampling and monitoring tests can be conducted by expert technicians. Further to sampling, Testing is carried out. Testing procedures and parameters been classified into “Physical, Chemical, bacteriological and microscopic” categories.

Physical tests: These indicate properties that are detectable by the senses. They include Color, turbidity, total solids, dissolved solids, suspended solids, odor and taste.

Chemical tests: These tests determine the parameters in water like “pH, hardness, presence of a selected group of chemical parameters; biocides, highly toxic chemicals, and B.O.D”.

Bacteriological tests: This test shows the presence of bacteria, a characteristic of faecal pollution. These tests examine to identify the presence of microbial pathogen in the water that might occur with contamination. The presence of such organisms indicates the presence of faecal material and thus of intestinal pathogens.

Finally, the tested water samples are then thoroughly monitored and observed by an expert technician who can read through the lines of the resulted report. They then make an investigative analysis with a parallel consideration of the historical records of the previous water tests. Any similarity of the currently extracted results to the previous records will give way to an intense deliberation for prediction of any unknown changes or hazards to the water quality.

The limitation are:

- Collecting of water samples each and every time is a time taking process.
- Need man resources and expert to detect any impurities in water
- This technique is not fully reliable and gives no indication before hand on quality of water.
- This method is expensive too and less efficient.

1.3 Proposed System

We used six sensors in our proposed system: pH, turbidity, DHT-11, soil moisture, water level, water leakage. Microcontroller is the main processing unit and we used ESP8266 wifi module for data transmission. Because of its low power consumption and small size, the microcontroller is the most significant component used to test the quality of water. The proportions could be a suitable fit for an important point of sale technological criterion.

Three of the six sensors receive data in the form of analogue signals. The NodeMCU as inbuilt ADC chip that help us to convert analogue signals to digital format. Three sensors are connected to analogue pins of MCU to get output. The remaining three sensors' digital outputs are connected to the MCU's digital pins. Using ESP8266 all data from MCU will be transfer to the Blynk server.

The entire code is written in Embedded C++ and emulated using the Arduino IDE. Sensors are used to collect data of pH, turbidity, water level in tank, soil moisture, water leakage, temperature and humidity of the surrounding atmosphere. Authorized users can log into blynk app using ID and password to see collected data. Data will be collected, analyzed, and transmitted in real time.

M/S Espino's ESP8266 is a low-cost wi-fi module that includes a complete TCP/IP stack and a wi-fi chip. Because of their enhanced cache capacity, the code boots straight from external flash during program execution, enhancing system performance and reducing storage requirements. To send and receive data, change wireless module settings, and change serial query commands, the ESP8266 uses Tx and Rx serial transceiver pins.

To communicate, Tx or Rx pins must be linked between a wi-fi module and a microcontroller that are connected in opposing directions. Setting up an IoT application with the Wi-Fi Module through SPI and UART is simple.

1.4 Advantages of Proposed System

- Accuracy: The level of accuracy in the proposed system will be higher. All operation is done periodically.
- Reliability: The reliability of the proposed system will be high when compared to the present system. There is a proper storage of information.
- Cost effective: It requires low cost for implementation and design.
- Immediate retrieval of information: The main objective of proposed system is to provide for a quick and efficient retrieval of information.
- Immediate storage of information: In manual system there are many problems to store the largest amount of information.
- Easy to Operate: The system should be easy to operate and should be such that it can be developed within a short period of time and fit in the limited budget of the user.
- Monitoring: The proposed system consistently monitor the status of the water to be quality and conductive.
- Maintain a continuously healthy water supply with an IoT water quality monitoring system.

Chapter 2

LITERATURE REVIEW

A literature review is a type of review article. A literature review is a scholarly paper, which includes the current knowledge including substantive findings, as well as theoretical and methodological contributions to a particular topic. Literature reviews are secondary sources and so not report new or original experimental work. Most often associated with academic oriented literature, such reviews are found in academic journals and are not to be confused with book reviews that may also appear in the same publications. Literature reviews are a basis for research in nearly every academic field. A narrow scope literature review may be included as a part if a peer reviewed journal article presenting new research, serving to simulate the current study within the body of the relevant literature and to provide context for the reader.

An extensive review if the research undertaken in the domain related to face recognition along with the gender classification and facial age estimation from the face image. Every technical and IEEE papers have their own features which elaborate about particular technique with a certain methodology. It contains both advantages and drawbacks.

In [1] Smart Water Quality Monitoring System Using IOT Technology (2019) by Vennam Madhavireddy, B. Koteswarrao The economical and effective system of water quality observation is the most robust implementation of impure water. Drinking water could be precious for all people as water utilities face more challenges. These challenges arise due to the high population, fewer water resources, etc. So, different methods are used to monitor in the real-time water quality. To make sure that safe distribution of water is done, it must be observed in real time for a new method in the “Internet of Things (IoT)” based water quality has been projected. Realtime water quality observation is examined by data acquisition, method, and transmission with an increase in the wireless device network method in the IoT. Microcontroller and the processed values remotely to the core controller ARM with a WI-FI protocol are used to interface the measured values from the sensors. This projected the water quality observation interface sensors with quality observation with IOT setting. WQM selects parameters of water like temperature, pH level, water level and CO2 by multiple different device nodes. This methodology sends the information to the web server. The data updated at intervals within the server may be retrieved or accessed from anyplace within the world. If the sensors do not work or get into abnormal conditions, then a buzzer will be ON.

In [2] Smart Water Quality Monitoring System (2020) by Nageswara Moparthi Nowadays Internet of Things (IoT) and Remote Sensing (RS) techniques are used in different area of research for monitoring, collecting and analysis data from remote locations. Due to the vast increase in global industrial output, rural to urban drift and the over-utilization of land and sea resources, the quality of water available to people has deteriorated greatly. The high use of fertilizers in farms and also other chemicals in sectors such as mining and construction have contributed immensely to the overall reduction of water quality globally. Water is an essential need for human survival and therefore there must be mechanisms put in place to vigorously test the quality of water that made available for drinking in town and city articulated supplies and as well as the rivers, creeks and shoreline that surround our towns and cities. The availability of good quality water is paramount in preventing outbreaks of water-borne diseases as well as improving the quality of life. Fiji Islands are located in the vast Pacific Ocean which requires a frequent data collecting network for the water quality monitoring and IoT and RS can improve the existing measurement. This paper presents a smart water quality monitoring system for Fiji, using IoT and remote sensing technology.

In [3] IoT based smart water quality monitoring system (2021) by K. Rajalashmi, N. Yugathian Pollution of water is one of the main threats in recent times as drinking water is getting contaminated and polluted. The polluted water can cause various diseases to humans and animals, which in turn affects the life cycle of the ecosystem. If water pollution is detected in an early stage, suitable measures can be taken and critical situations can be avoided. To make certain the supply of pure water, the quality of the water should be examined in real-time. Smart solutions for monitoring of water pollution are getting more and more significant these days with innovation in sensors, communication, and Internet of Things (IoT) technology. In this paper, a detailed review of the latest works that were implemented in the arena of smart water pollution monitoring systems is presented. The paper proposes a cost effective and efficient IoT based smart water quality monitoring system which monitors the quality parameters uninterruptedly. The developed model is tested with three water samples and the parameters are transmitted to the cloud server for further action.

In [4] IOT based water quality control and filtration system (2020) by G. Manoj Kumar a, S.E. Goutham. Water is the basic and essential resource which is required for every need such as agriculture, industrial activity and for domestic purpose. Especially in the industrial areas although many water monitoring system were planted, the waste water disposal is minimally controlled. This project not only helps to monitor water at the industrial level but it can be used anywhere water quality plays a major role. The water quality is continuously monitored with the help of sensors (PH, Temperature, Turbidity, conductivity, water level indicator). It also indicates the level of the water and checking the quality of the water with the help of the valve control system, it sends the water with impurities for the filtration system. The entire system is completely controlled by IOT system and it is continuously monitored by the module.

In [5] Smart water quality monitoring system with cost-effective using IoT (2020) by Sathish Pasika, Sai Teja Gandla. Wireless communication developments are creating new sensor capabilities. The current developments in the field of sensor networks are critical for environmental applications. Internet of Things (IoT) allows connections among various devices with the ability to exchange and gather data. IoT also extends its capability to environmental issues in addition to automation industry by using industry 4.0. As water is one of the basic needs of human survival, it is required to incorporate some mechanism to monitor water quality time to time. Around 40% of deaths are caused due to contaminated water in the world. Hence, there is a necessity to ensure supply of purified drinking water for the people both in cities and villages. Water Quality Monitoring (WQM) is a cost-effective and efficient system designed to monitor drinking water quality which makes use of Internet of Things (IoT) technology. In this paper, the proposed system consists of several sensors to measure various parameters such as pH value, the turbidity in the water, level of water in the tank, temperature and humidity of the surrounding atmosphere. And also, the Microcontroller Unit (MCU) interfaced with these sensors and further processing is performed at Personal Computer (PC). The obtained data is sent to the cloud by using IoT based Think Speak application to monitor the quality of the water.

In [6] IoT Based Real-time River Water Quality Monitoring System (2019) by Mohammad Salah Uddin Chowdury, Talha Bin Emran Current water quality monitoring system is a manual system with a monotonous process and is very time-consuming. This paper proposes a sensor-based water quality monitoring system. The main components of Wireless Sensor Network (WSN) include a microcontroller for processing the system, communication system for inter and intra node communication and several sensors. Real-time data access can be done by using remote monitoring and Internet of Things (IoT) technology. Data collected at the apart site can be displayed in a visual format on a server PC with the help of Spark streaming analysis through Spark ML lib, Deep learning neural network models, Belief Rule Based (BRB) system and is also compared with standard values. If the acquired value is above the threshold value automated warning SMS alert will be sent to the agent. The uniqueness of our proposed paper is to obtain the water monitoring system with high frequency, high mobility, and low powered.

In [7] Real Time Internet of Things (IoT) Based Water Quality Management System (2020) by Mohd. Manjur Alam, Nurul Absar The rapidly transforming technologies and changing of people's expectations triggered the fourth industrial revolution, commonly referred to as Industry 4.0. Water is the core resource and a vital for life of all species, as it is a limited resource that needs to be utilized efficiently. Monitoring various aspects of the water quality leads to a clear understanding of the aspects that should be considered for a healthy life and to avoid wastage of water. Using Internet of Things (IoT) should allow for the integration of real time monitoring and controlling of water quality. The suggested system utilizes Internet of Things (IoT) through using sensors to measure the water quality factors such as (pH, temperature and turbidity) for home applications. The system should allow for autonomous decision making for controlling the water quality factors such as (acidity, alkalinity, temperature and amount of total suspended solids expressed by cloudiness or haziness) measured by mentioned sensors within the acceptable limits and keeping records of the historical readings on a cloud-based platform. The system will lead to real time data acquisition, transmission and processing of water quality data. This will give the ability to automatically react to the changes in the system outputs. Using Internet of Things (IoT) means the system can be accessed from anywhere through Internet, for example through a mobile application remotely. The objective of the system is to allow the water consumer in home to be able to judge the quality of the incoming water and to control it to the required levels. The system also utilizes the different filters used in home to enhance the water quality in an efficient way. As the filters will only be used once needed and not all the time. Utilizing such, a system should lead to improving the public health and the cost of controlling the quality of the consumed water. The system should eliminate the inconvenient and lengthy off line lab analysis of collected water samples. The system should provide a user-friendly interface with infographics and meters to illustrate the quality factors as Lower-Upper limits and the acceptable values. In addition, the system should provide an easy way for the configuration of the controllers and the communication with the sensors.

In [8] IoT based water quality management system (2019) by K. Rajalashmi, N. Yugathian, S. Monisha, N. Jeevitha A water treatment plant has to be shut down because of polluting the water flow in the plant. The water supply company was unable to find the reason for the contamination of polluted water in it. By using the sensors, the water quality can be monitored in each and every process after completing their individual process. The sensors can able to identify the quality of water and brings a safety solution for the consumers. Based on the pH level and oxygen O2 content in the water, the water purity can be easily calculated by the use of sensors. The sensors collect the data and upload it in the GPS data link.

In [9] Smart two-tank water quality and level detection system via IoT (2021) by Samuel C. Olisa, Christopher N. Asiegbu b, Juliet E. Olisa The two-tank water system is common practice for the storage and distribution of water in many homes. Water is transported via a pipeline network from the storage tank (lower tank) to the distribution tank (overhead tank) using an electric pumping machine. Due to limited control in the existing pumping system, water wastage becomes inevitable. Determining the quality of water in the overhead tank before supply in the home is still unaddressed. In this work, an integrated Android mobile App and a control system were developed to assess the water quality, perform level check in the overhead tank, and activate intelligent pumping control. An ultrasonic pulse echo technique was used for water level checks, while the water turbidity and pH signals were used for water quality checks. Three-level control conditions (LC_1, LC_2, LC_3) and two water quality check conditions (QC_1 and QC_2) were devised and used in the intelligent control algorithm of the system. Control valve1 regulates the flushable poor water quality while valve2 regulates the house's supply of good water quality. The absolute relative error between the expected time and the system time of filling the tank level was observed to be less than 10% when the water volume is less than 81%. Hence, distortion in the sensory signals increases and worsen as the water level approaches the ultrasonic sensor position. The poor internet signal network was observed to affect the real-time monitoring and automation of the system control through delay in system responses to commands. However, the average recorded response time of the system is 3 s, and it could be less in the situation of good internet network services.

In [10] Mobile Integrated Smart Irrigation Management and Monitoring System Using IOT (2019) by Vaishali S, Suraj S This system developed an automated irrigation system for the farmer on the basis of wireless sensor network. This system continuously monitors the parameters temperature, humidity, and moisture of soil. An algorithm was used with threshold values of soil moisture to be maintained continuously. System starts or stops irrigation based on moisture content of the soil. This system proposes low-cost moisture sensor-based data acquisition system required for automated irrigation system. The authors have developed an impedance-based moisture sensor. Sensors works on the change of impedance between two electrodes kept in soil. This paper represents irrigation management system using WSN and water pumps. Water level sensor is connected to main irrigation canals, and flow sensor is connected to water pump. These sensors are connected to wireless gateway which sends data periodically to web server. Database connected to web server monitors irrigation water level at all main. The web based IMS analyze the data stored in database and compares with specified values. Then it (IMS) sends SMS to farmers and engineers to make aware of water requirement. This system is smart irrigation techniques using internet of things (IOT). In this system sensors are placed in the agriculture field, measures the soil moisture value, water level in the tank and well-water through mobile data communication network. The web servers use intelligent software to analyze the data and act according to the result obtained to perform desired action. The system supports water management decision, used for monitoring the whole system using GSM module. The system continuously monitors the water level in the tank and provide accurate amount of water required for plant or crop. The system checks the temperature and humidity of soil to retain the nutrient composition of the soil managed for growth of plant.

In [11] Design of water quality monitoring system for aquaculture ponds based on NB-IoT by Juan Huan, Hui Li. In order to promote the development of aquaculture informatization and monitor aquaculture ponds more accurately and conveniently, this article has developed a water quality monitoring system for aquaculture ponds based on the narrow band internet of things (NB-IoT) technology. This system realizes remote collection and data storage of multi-sensor processor information (temperature, pH, dissolved oxygen (DO) and other environmental parameters), as well as intelligent control and centralized management of breeding ponds. The system uses STM32L151C8 microcontroller and sensor terminal real-time acquisition, such as temperature, pH value, dissolved oxygen. It realizes data aggregation and transmission over a long distance to the Internet of things (IoT) telecom cloud platform through the technology of NB-IoT. These software called Keil implement the data format design of wireless communication module and data transmission. Java is used to develop background monitoring applications for accessing cloud platform, controlling underlying devices and local data processing.

In [12] Design and implementation of IoT sensor-based drinking water quality measurement system (2021) by Nitin Kothari, Jitendra Shreemali Water is essential for the living being. Water plays major role in all metabolic activity. After being filtered at the treatment plant, water is used for drinking. Mostly the water supplies to the houses and industry is through underground pipe line network system. If there is any damage/leakage in the pipe line system, water gets mixed with impurity and is polluted. High DO value speeds up corrosion in water pipes. This paper presents the drinking water quality measurement system with the help of various sensors such as temperature, TDS, pH and DO sensors. Drinking water, cold or hot, keeps human body hydrated and healthy so it is very essential to monitor the drinking water temperature. Thus, required added temperature sensor in the developed module; TDS sensor gives the measurement of solid object dissolved in the water; pH sensor was installed to monitor the content of acidic substances in water and the DO sensor used to monitor the dissolved oxygen, it added better taste of drinking water. Developed system was successively tested on tube well, tap, rain and RO water. The data collection method uses an Arduino mega2560 microcontroller and GSM SIM 900 module. The data from sensors is transmitted using a wireless connection with the help of GSM SIM 900 module to the database server at Thinger.io. The data sent can be viewed using an Android IoT application connected to the server. The data displayed on the applications in real-time successfully, so the users able to check the sensors value on android mobile screen.

In [13] Water Quality Monitoring System Based on IOT by Vaishnavi V. Daigavane and Dr. M.A Gaikwad. Water pollution is one of the biggest fears for the green globalization. In order to ensure the safe supply of the drinking water the quality needs to be monitor in real time. In this paper we present a design and development of a low cost system for real time monitoring of the water quality in IOT(internet of things).The system consist of several sensors is used to measuring physical and chemical parameters of the water. The parameters such as temperature, PH, turbidity, flow sensor of the water can be measured. The measured values from the sensors can be processed by the core controller. The Arduino model can be used as a core controller. Finally, the sensor data can be viewed on internet using WI-FI system.

In [14] Smart Irrigation System using Iot by Vinay Kumar , Abhishek Nayaka, Akshay G Aramot, V Jaya Krishna. In India most of people are doing work connected directly or indirectly to agriculture. Economy of India is mostly affected by activities related to agriculture. There's challenge in front of every major country to reduce the water consumption used for farming and provide fresh and healthy food. In this project, we made a smart irrigation system that will inform farmers on their registered mobile devices and email addresses. These days the industries are using automatically controlled machines which are high in cost and not advisable for garden field. So in this project we designed a irrigation technology based on IoT using Raspberry pi which is smart. This system can be used to control the water pump automatically and also monitor the growth of crops or plants by using webcam that is connected using a wireless module through mobile phone using a software application by using a Wi-Fi network or module. If the moisture level of the soil is less than the given input value and it need to be watered using the moisture sensor the motor will be switched on that is attached with main controller. For fire detection we can use flame detection sensor and when there is any fire accident in farm, the system will notify the farmer through email or mobile application.

In [15] Water Purifier Quality Monitoring Using IOT by Trupti Deshmukh, H.N Lokhande, Mayuri Raj , Rutuja Sadegaonkar. Water is vital resource for life. Drinking safe water is important aspect for a healthy life. In modern world water pollution is one of the major cause for various types of water-borne diseases, 40% of the deaths worldwide are caused by water pollution. The clean and safe drinking water is getting depleted every second hence water purification is todays need. World bank estimates that 21% of communicable diseases in India are related to unsafe water, contamination has been a long standing problem in our country. The older methods are unable to monitor the water quality in real time and notify the user about the contamination. So, it is necessary to develop a real time water quality monitoring and notification system. Smart solutions for water quality monitoring are gaining importance with advancement in communication technology. Water quality depends on pH, turbidity, temperature along with some other factors are significant, and will be monitored by the system using sensors, through wifi system the sensor output data is sent to concern authority for further steps to improve water quality. The proposed system is portable, automatic water quality monitoring and notification system saves time and human resources. The notification will be sent to authorized person when sensors will detect bad water quality. It is low cost system for real time water quality monitoring.

Chapter 3

ANALYSIS

3.1 Problem Identification

Clean water is a global resource that is a natural and valuable gift farming, production, and human health in the world. Currently, water facilities face new real-world problems. Due to the limited water resources, intensive money requirements, growing population, urban change in rural areas, and the excessive use of sea resources for salt extraction has significantly worsened the water quality available to people. The high use of chemicals in manufacturing, construction and other industries, fertilizers in farms and also directly leaving the polluted water from industries into nearby water bodies have made a huge contribution to the global water quality reduction, which has become an important problem. Even due to containment water various water born are increasing day by day, due to which many human beings are losing their lives.

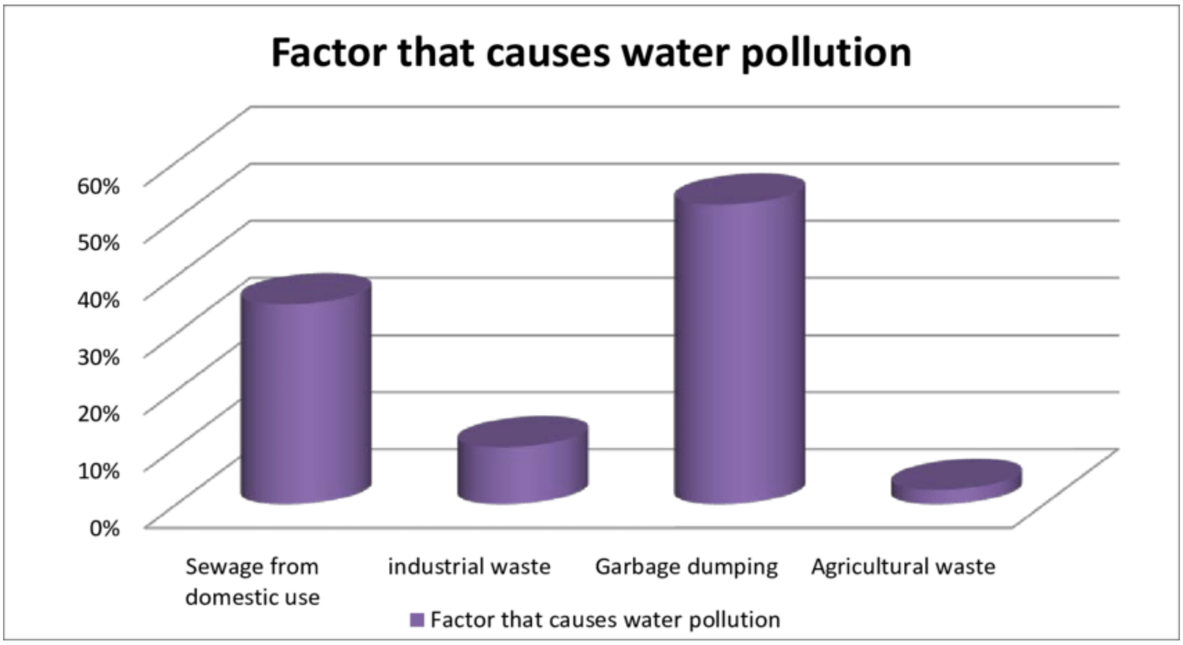

Fig 3.1 Factor that causes water pollution

The consequences of water pollution or poor water quality are:

- Destruction of biodiversity: Pollution of water reduces aquatic ecosystems and initiates unrestrained increase of phytoplankton in water resources. Food chain contamination: Fishing carried out in polluted water resources and utilization of waste water for agriculture and livestock husbandry may lead to addition of toxins or contaminants into foods that are injurious to the health after consumption.

- Scarcity of drinkable water: If pollution of water increases or quality of drinking water is not maintained, then there will be no clean water for drinking or public health or sanitization, in rural as well as urban areas.
- Disease: According to WHO (World Health Organization) information, roughly 2 billion people across the world do not have any option for pure water resources, but they have to drink water polluted by excrement, which exposes them to many ailments.
- Infant mortality: As per WHO, diarrheal diseases associated with lacking of hygiene results in death of nearly 1000 children per day across the world.

Traditionally, detection of water quality was manually performed where water samples were obtained and sent for examination to the laboratories which is time taking process, cost and human resources. Such techniques do not provide data in real-time.

In this paper, we proposed smart water quality monitoring system is consisting of a microcontroller and basic sensors, is compact and is very useful for pH, turbidity, water level detection, temperature and humidity of the atmosphere, water leakage etc., continuously and real-time data sending via wireless technology to the monitoring station.

3.2 Objective

The main objectives of this project are:

- To measure perilous quality metrics.
- With the help of sensors like ph sensor, turbidity sensor, DHT-11 sensor, soil moisture sensor, water leakage sensor, water level sensor., we measure the value.
- To find the derivatives in measured metrics and give timely warning in recognition threats or hazards.
- Monitoring and assessment of the environmental state of surface water.
- To provide real-time analysis of the sensor data and recommend appropriate corrective measures.
- The system objective is to provide the facility through a Blynk cloud.
- To provide cloud storage which helps users to access the data anywhere from globe and can be scaled up or down depending on the user requirement.
- This project is developed to make everyday life of users easy over the internet.

- The system aims to provide easy integration of the software application in any mobile like Android. Thus provides flexibility in usability for users.

3.3 Methodology

Methodology is the systematic, theoretical analysis of the methods applied to a field of study. It comprises the theoretical analysis of the body of methods and principles associated with a branch of knowledge. Typically, it encompasses concepts such as paradigm, theoretical model, phases and quantitative or qualitative techniques. A methodology does not set out to provide solutions—it is therefore, not the same as a method. Instead, a methodology offers the theoretical underpinning for understanding which method, set of methods, or best practices can be applied to a specific case, for example, to calculate a specific result.

The methodology is the general research strategy that outlines the way in which research is to be undertaken and, among other things, identifies the methods to be used in it. These methods, described in the methodology, define the means or modes of data collection or, sometimes, how a specific result is to be calculated. Methodology does not define specific methods, even though much attention is given to the nature and kinds of processes to be followed in a particular procedure or to attain an objective.

The methodology needed to be followed are:

- Connection of the input sensors and relays along with required appliances to the NodeMCU board.
- Uploading the necessary codes to NodeMCU via Arduino IDE.
- Connecting Hardware model to Blynk cloud using auth code.

The following components are required for proposing the methodology,

3.3.1 Node MCU

The project requires continuous values from the environment to provide a detailed information to the users. It must be well integrated with other software to provide easy development and implementation of all the features to deliver a smart and secure system.

Fig 3.2 Node MCU

The ESP8266 is the name of a micro controller designed by Espress if Systems. The ESP8266 itself is a self-contained WiFi networking solution offering as a bridge from existing microcontroller to WiFi and is also capable of running self-contained applications. This module comes with a built in USB connector and a rich assortment of pin-outs. With a micro USB cable, you can connect a NodeMCU devkit to your laptop and flash it without any trouble, just like Arduino. It is also immediately breadboard friendly.

Specification:

• Voltage: 3.3V.

• Wi-Fi Direct (P2P), soft-AP.

• Current consumption: 10uA~170mA.

• Flash memory attachable: 16MB max (512K normal).

• Integrated TCP/IP protocol stack.

• Processor: Tensilica L106 32-bit.

• Processor speed: 80~160MHz.

• RAM: 32K + 80K.

• GPIOs: 17 (multiplexed with other functions).

• Analog to Digital: 1 input with 1024 step resolution.

• +19.5dBm output power in 802.11b mode

• 802.11 support: b/g/n

• Maximum concurrent TCP connections: 5

3.3.2 Sensors

pH sensor: The pH of a solution is the measure of the acidity or alkalinity of that solution. The pH scale is a logarithmic scale whose range is from 0-14 with a neutral point being 7. Values above 7 indicate a basic or alkaline solution and values below 7 would indicate an acidic solution. It operates on 5V power supply and it is easy to interface with arduino. The normal range of pH is 6 to 8.5.

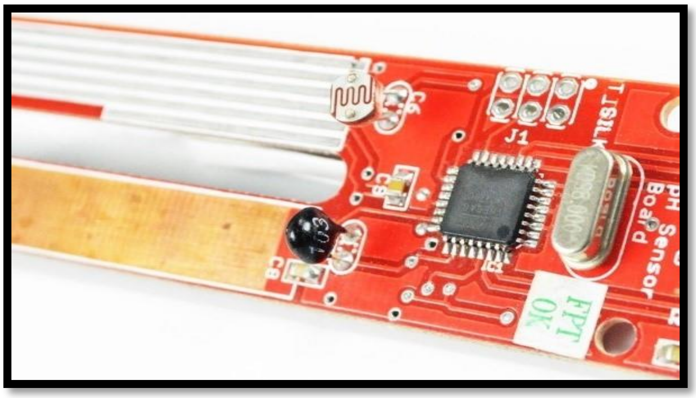

Fig 3.3: ph Sensor

DHT-11 Sensor: The DHT11 is used to measure temperature and humidity of surrounding atmosphere. It consist dedicated NTC and 8 bit microprocessor to transmit values. DHT-11 require 3.5 to 5.5 voltage and produce serial data. It measure temperature from 0°C to 50°C and 20 to 90 humidity.

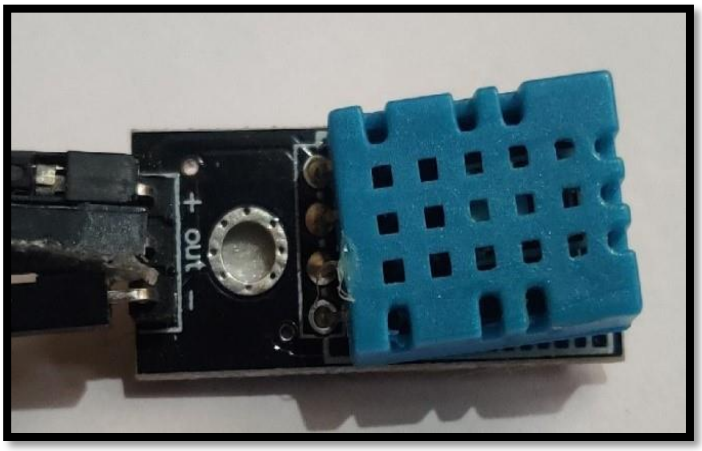

Fig 3.4: DHT-11 Sensor

Turbidity Sensor: The Turbidity sensor measures the cloudiness or haziness of water caused by particles that aren’t visible. The sensor detects suspended particles in water by calibrating the light transmittance and scattering rate, which varies depending on the water’s total suspended solids quality.

Fig 3.5: Turbidity Sensor

Soil Moisture Sensor: In the irrigation field as well as in plant gardens, soil moisture is critical. Plants require nutrients to thrive, which are provided by soil nutrients. In order to adjust the temperature of the plants, they must be given water. Water can be used to adjust the temperature of a plant through a process called as transpiration. When plants grow in damp soil, their root systems develop more quickly. Extreme soil moisture levels can lead to anaerobic conditions, which can promote plant growth and the spread of soil diseases.

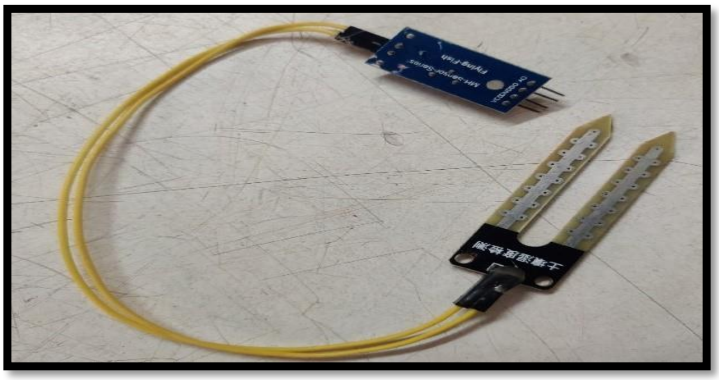

Fig 3.6: Soil Moisture sensor

Water Level : The water level sensor is used to check whether water is present in tank or not. It has 2 values High or Low.

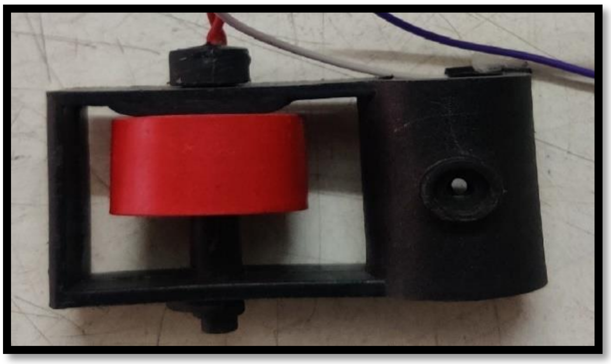

Fig 3.7: Water Level

Water Leakage Sensor: The water leakage sensor is used to check leakages in pipes. It is easy to use low cost sensor.

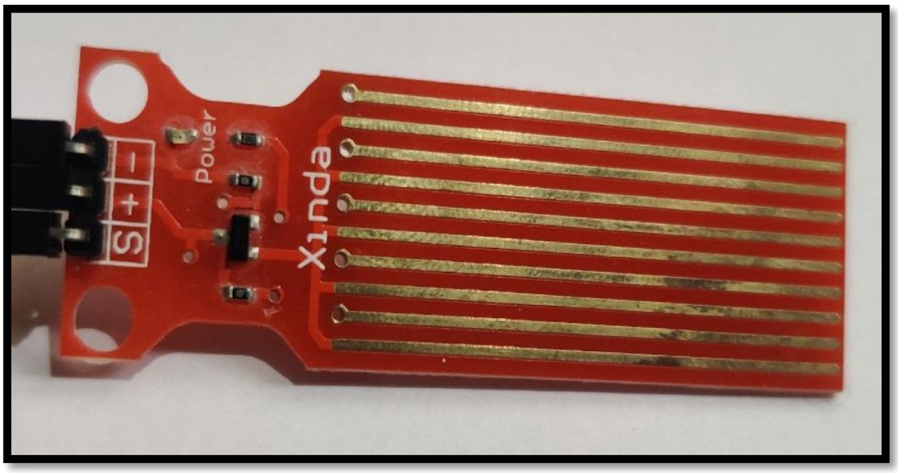

Fig 3.8: Water Leakage Sensor

3.3.3 ARDUINO IDE

Arduino first and foremost is an open-source computer hardware and software company. The Arduino Community refers to the project and user community that designs and utilizes microcontroller-based development boards. These development boards are known as Arduino Modules, which are open-source prototyping platforms. The simplified microcontroller board comes in a variety of development board packages.software specification

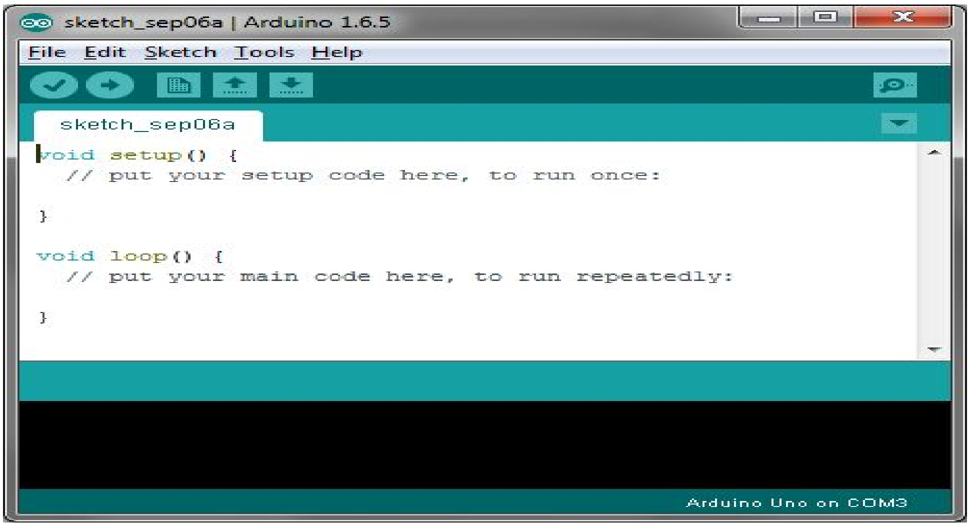

Fig. 3.9: Arduino IDE window

The most common programming approach is to use the Arduino IDE, which utilizes the C programming language. This gives you access to an enormous Arduino Library that is constantly growing thanks to open-source community.

3.3.4 Blynk cloud

Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data, vizualize it and do many other cool things. There are three major components in the platform:

- Blynk App - allows to you create amazing interfaces for your projects using various widgets we provide.

- Blynk Server - responsible for all the communications between the smartphone and hardware. You can use our Blynk Cloud or run your private Blynk server locally. It's open-source, could easily handle thousands of devices and can even be launched on a Raspberry Pi.

- Blynk Libraries - for all the popular hardware platforms - enable communication with the server and process all the incoming and outcoming commands.

Now imagine: every time one presses a Button in the Blynk app, the message travels to the Blynk Cloud, where it magically finds its way to your hardware. It works the same in the opposite direction and everything happens in a blynk of an eye.

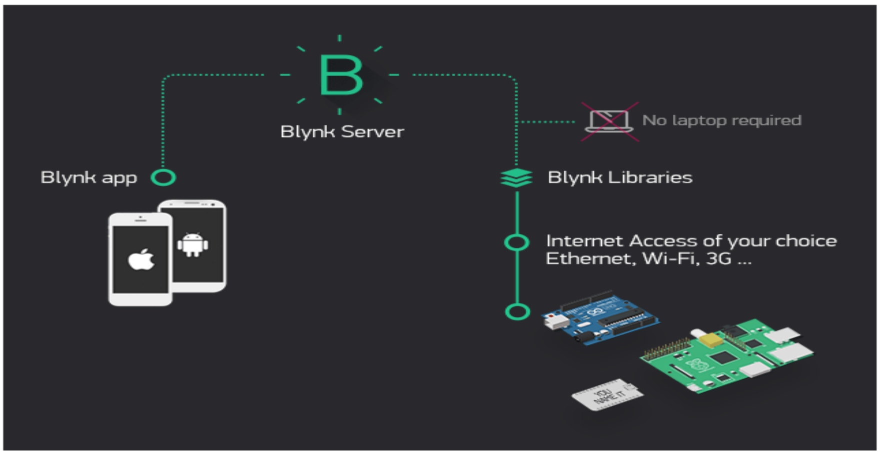

Fig 3.10: Blynk Cloud

Features

- Similar API & UI for all supported hardware & devices
- Connection to the cloud using:

- WiFi
- Bluetooth and BLE
- Ethernet
- USB (Serial)

- Set of easy-to-use Widgets
- Direct pin manipulation with no code writing
- Easy to integrate and add new functionality using virtual pins
- Device-to-Device communication using Bridge Widget
- Sending emails, sms, push notifications, etc.

3.4 System Requirement Specification

A System Requirements Specification (SRS) is a description of a software system to be developed. It lays out functional and non-functional requirements and may include a set of use cases that describe user interactions that the software must provide.

Software requirements specification establishes the basis for an agreement between customers and contractors or suppliers on how the software product should function. Software requirements specification is a rigorous assessment of requirements before the more specific system design stages, and its goal is to reduce later redesign. It should also provide a realistic basis for estimating product costs, risks, and schedules. Used appropriately, software requirements specifications can help prevent software project failure.

3.4.1 Software Requirement Specification

1. OS :Windows 10
2. Embedded C++.
3. Arduino IDE.

3.4.2 Hardware Requirement Specification

1. pH sensor.
2. Turbidity sensor.
3. Temperature and Humidity Sensor.
4. Water level sensor.
5. Water leakage sensor.
6. Soil moisture sensor.
7. Motor.

8. Relay.
9. NodeMCU.

3.5 Functional Requirements

A Functional Requirement defines a function of a system or its component, where a function is described as a specification of behavior between outputs and inputs.

1. IoT Platforms Leverage Applications: IoT software applications are emerging for businesses in virtually every industry as well as for home users. System should be compatible.

2. Remote configuration: Through this requirement it is possible to configure some parameters of the stations remotely, namely the frequency sampling of each sensor.

3. Event Notification: This feature is considered a very important requirement, because it allows notification in real-time if disruptive events occur in one station, e.g. if the water level of one tank gets down the set-point, the system sends an alert to the person in charge of the maintenance.

4 Update Information: The system must allow inquiry into stations in order to attain current data. This will allow information of the status of any station and its sensors in real-time.

5 Monitoring stations status: One efficient strategy to reduce the risk of problems in water supply is by better controlling aspects such as the level and quality of the water. Monitoring the stations brings two major benefits, namely real-time analysis of these parameters and using the data to produce statistical reports.

6 Manage a Range of Devices: The number of devices connected to IoT will soon reach anywhere from 28 billion to 50 billion, depending on who you ask. IoT sensors gather information about conditions in their vicinity, such as temperature or moisture level. IoT actuators perform specific tasks, such as turning things on or off and recording information about its triggers and subsequent reactions. Thus, to manage a heterogeneous set of devices.

7 Generate Massive Amounts of Data: System must be must be able to support storing massive amounts of data.

8 Require Powerful Analytics: The vast volumes of data discussed above have the potential to provide unprecedented insights into consumer behavior and preferences. Unlocking those insights, however, requires powerful analytics tools. A key IoT platform functionality, therefore, is that it is capable of either incorporating — or offering compatibility with —analytics solutions that will translate significant amounts of data into useful and actionable insights.

3.6 Non-Functional Requirements

Security: Even with the recent attention given to security for IoT devices, it can be easy to overlook the need for end-to-end security for an IoT platform. Every part of a platform should be analysed for security prospects. From internet connections to the applications and devices to the transmitted and stored data, there is a potential for an attack vector. Without question, the single most important non-functional requirement of an IoT platform is that it offers robust security.

Scalability: In light of the billions of devices and zettabytes of data discussed earlier, scalability is clearly a requirement in an IoT platform. The best practice for both businesses and consumers is to start small with IoT. However, many IoT solutions achieve their true potential only at scale. The ideal IoT platform is fully able to support a small, initial implementation, but also should be able to scale out as your business needs grow.

Availability: Highly robust public cloud platforms have conditioned us to expect 4 or 5 nines when we think about internet availability. Those same expectations should extend to IoT platforms. In fact, there is a good reason to anticipate even higher levels of availability from IoT platforms. That is because IoT platforms can interact with and control devices that have real-world impact. IoT platforms must, therefore, offer exceptionally high availability.

Performance: The system response time depends on how sophisticated the sensors are. If the sensors are rough (level sensors), the system will be cheaper but not so accurate when using sophisticated sensors (ultra-sonic).

Flexibility: The system must be flexible in order to allow the user to insert, remove or edit elements, such as new stations, more sensors or adding mobile phone numbers to deliver alerts.

Usability: A friendly interface, flexible, with strong graphical capabilities and succinct and clear messages can raise the system efficiency.

Power supply: In order to solve the problem of remote stations located in isolated places, with difficult access, and without power supply, all these stations need to be equipped with a solar panel and a battery.

Chapter 4

SYSTEM DESIGN

4.1 System Architecture

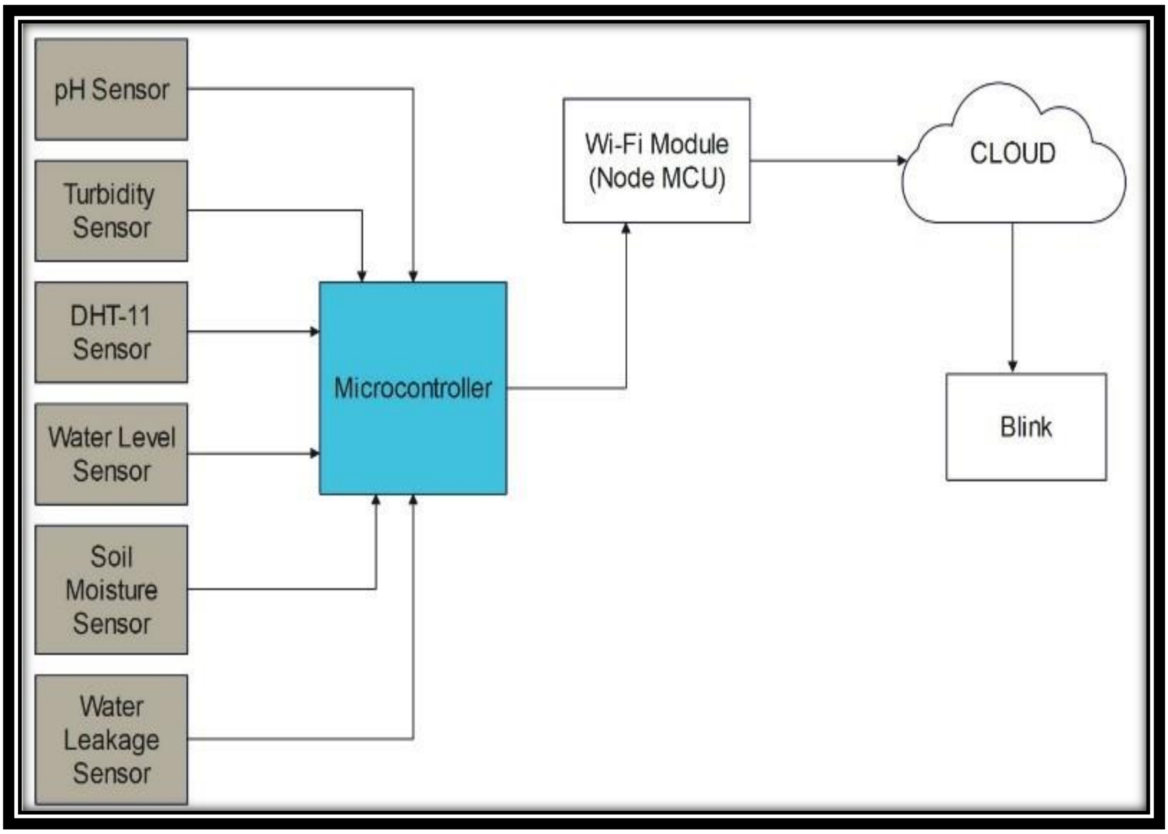

Fig 4.1: Block diagram of water quality monitoring system

In this, we present the theory on real time monitoring of water quality in IoT environment. The overall block diagram of the proposed method is explained. In general water quality monitoring system consists of various sensors such a pH sensor, turbidity sensors, temperature sensors, humidity sensors and many other sensors. Fig. 4.1 shows the general block diagram of smart water quality monitoring system. As shown in the figure, Microcontroller forms the heart of the system. All the sensors are connected a microcontroller and this controller controls the operation, gets data from sensors, and compares it with that of the standard values and sends the values to the concerned end user or authorities through wireless modules.

The microcontroller is integrated with various sensors such as pH sensor, temperature sensor, turbidity sensor and many sensors. The sensor leads are placed in the water to be tested. The sensor values will be processed by ADC and the microcontroller reads the value and it will be uploaded on the cloud. The values will be monitored continuously by checking whether the sensor value is greater than threshold or not. If the sensor value is greater than threshold, then it will be communicated to the concerned end user for further action. If sensor value is lesser than threshold, then the parameters are again checked for different water source.

4.2 High level Design

Wifi module: The ESP8266 WiFi Module is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware. The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community.

Fig 4.2: Wi-Fi module

4.3 Data Flow Diagram

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It can be manual, automated, or a combination of both.

The data received from sensors are updated frequently in the Blynk cloud. The cloud has various interfaces that provide easy access to received data and analyze them. The cloud is also accessible by users.

Figure 4.3 shows the data flow in the system. The data which are collected from sensors are then compared with the standard threshold, if it exceeds the standard value the alert message will be sent to the users.

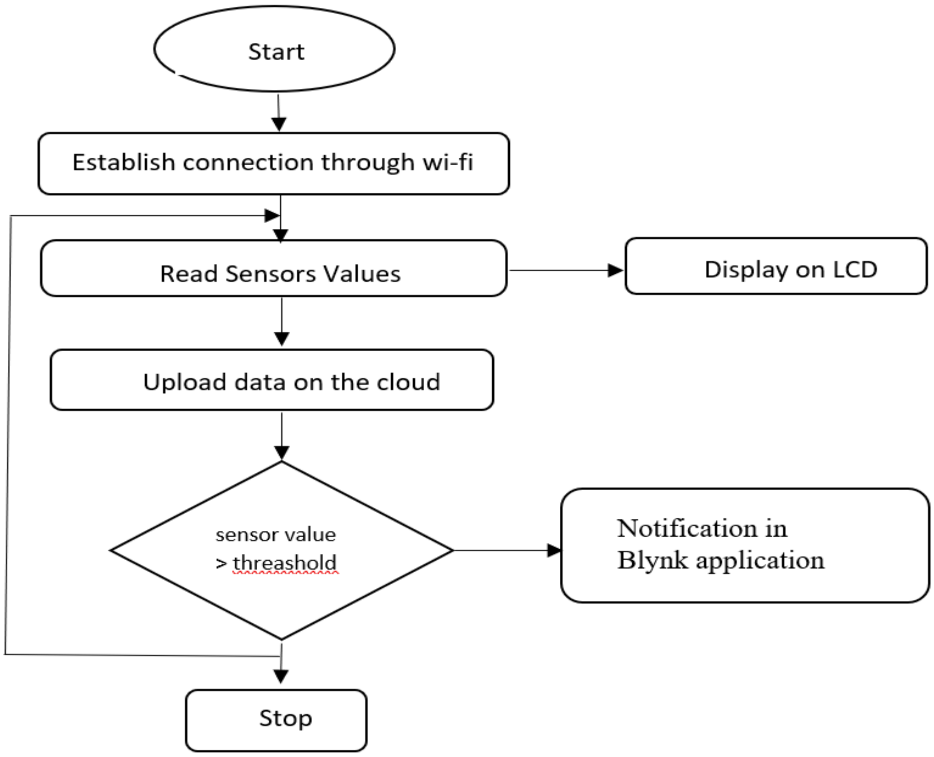

Fig 4.3: Data Flow Diagram

4.4 Use Case Diagram

Use-case diagrams describe the high-level functions and scope of a system. These diagrams also identify the interactions between the system and its actors. The use cases and actors in use-case diagrams describe what the system does and how the actors use it, but not how the system operates internally.

Use-case diagrams illustrate and define the context and requirements of either an entire system or the important parts of the system. You can model a complex system with a single use-case diagram, or create many use-case diagrams to model the components of the system. You would typically develop use-case diagrams in the early phases of a project and refer to them throughout the development process.

Figure 4.4 is a use case diagram of smart water quality monitoring system. In this figure, developer is considered as an actor who sets the monitoring mode, deploy sensor, define threshold, sets environment property for monitoring.

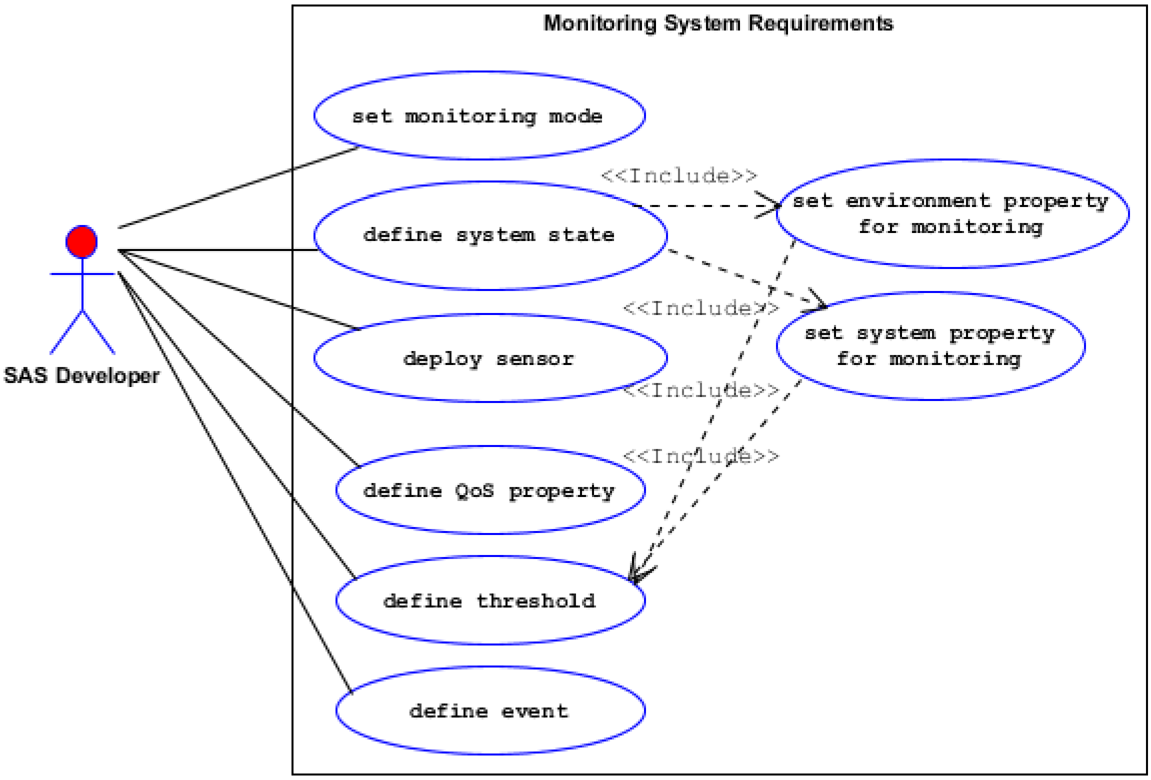

Fig 4. 4: Use Case Diagram

4.5 Sequence Diagram

A sequence diagram is a Unified Modeling Language (UML) diagram that illustrates the sequence of messages between objects in an interaction. A sequence diagram consists of a group of objects that are represented by lifelines, and the messages that they exchange over time during the interaction.

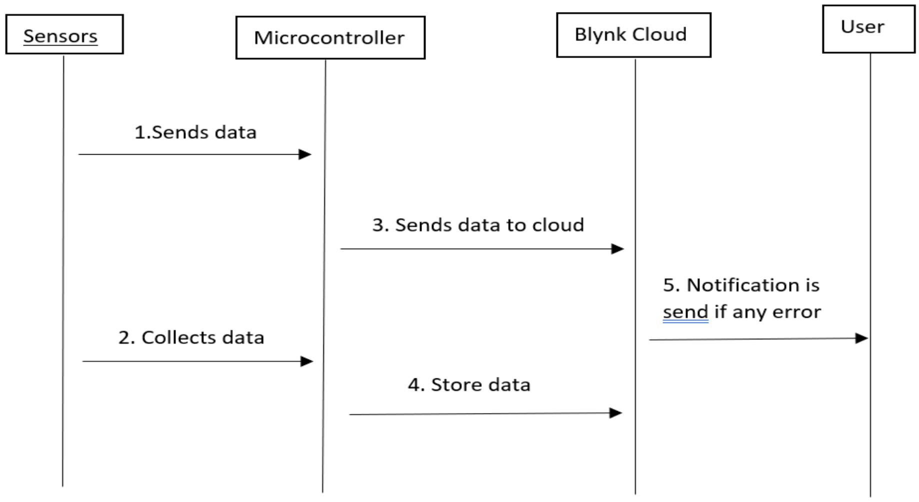

Fig 4.5: Sequence Diagram

Figure 4.5 is a sequence diagram of smart water quality monitoring system. In this system, all the data are collected from sensors and given to microcontroller. From microcontroller to the Blynk cloud. In cloud data get stored and in case any error, notification is send to the user.

4.6 Class Diagram

Class diagram is a static diagram. It represents the static view of an application. Class diagram is not only used for visualizing, describing, and documenting different aspects of a system but also for constructing executable code of the software application.

Class diagram describes the attributes and operations of a class and also the constraints imposed on the system. The class diagrams are widely used in the modeling of objectoriented systems because they are the only UML diagrams, which can be mapped directly with object-oriented languages.

Class diagram shows a collection of classes, interfaces, associations, collaborations, and constraints. It is also known as a structural diagram.

Chapter 5

IMPLEMENTATION

5.1 Overview of System implementation

Smart Water quality management sensor is used to monitor the quality of water. Turbidity sensor, DHT11 sensor, pH sensor, soil moisture sensor, water leakage sensor, and water level were employed in our created system to determine the water quality. The temperature and humidity in the environment were determined using the DHT-11 sensor, while the acidic and basic material levels in water were determined using the pH sensor. The turbidity sensor determines whether the water is clear or cloudy. To determine the quantity of moisture in the soil, a soil moisture sensor is employed. The water levels determines whether the water is low or high; and the water leakage sensor detects whether water is seeping from the pipe. NodeMCU collects data from the sensor and displays it on the LCD (Liquid crystal display).

Additionally, this data is sent to the Blynk program via the Wi-Fi module. Water monitoring is carried out in this application. If any data changes, a notification is delivered to both the client and the server. This paper introduces a smart and secure automated system where physical security is provided. The system objective is to provide the facility through a cloud based approach which helps user to access the data anywhere from globe and can be scaled up or down depending on the user requirement. The user can control the system using a user interface built in android.

5.2 Algorithm of proposed system

The proposed system's entire algorithm is shown. Initially, the serial monitor is initialized with 9600 baud rate. Later the ESP Wi-Fi module and the Blynk Server is also initialized. The six sensors are being connected and the values are read into the sensors. The algorithm flow of turbidity sensor, water level, water leakage, soil moisture and DHT 11 sensor flow is explained. The turbidity sensor checks the water clearness. The water level reads the digital value of level of water. The water leakage sensor checks that the water is leaked or not with the help of 0 and 1. The soil moisture reads the analog value of soil. The DHT 11 Sensor reads the analog values of temperature and humidity. Later the same values are sent into the Blynk server and the same values are updated in the monitor.

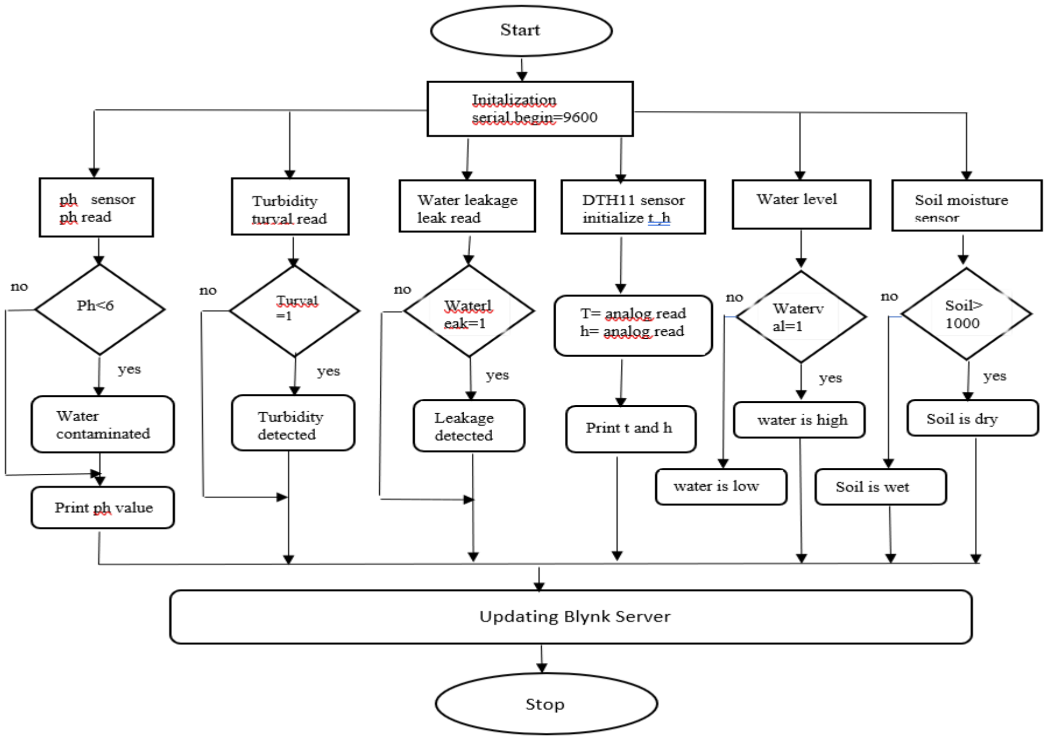

Fig 5.1: Algorithm

5.3 Pseudocode

In computer science, pseudocode is a plain language description of the steps in an algorithm or another system. Pseudocode often uses structural conventions of a normal programming language, but is intended for human reading rather than machine reading. It typically omits details that are essential for machine understanding of the algorithm, such as variable declarations and language-specific code. The programming language is augmented with natural language description details, where convenient, or with compact mathematical notation. The purpose of using pseudocode is that it is easier for people to understand than conventional programming language code, and that it is an efficient and environment-independent description of the key principles of an algorithm. It is commonly used in textbooks and scientific publications to document algorithms and in planning of software and other algorithms.

This project collects the data from sensor and pass that data to a Blynk cloud. Notification is seen in Blynk cloud when data is above the threshold values.

5.3.1 Setting up

```
FUNCTION Setup()
BEGIN
```

```
        Begin serial with baud rate 9600
        Begin DHT-11 sensor
        pinMode(relay, OUTPUT);
        pinMode(water_leak, INPUT);
        pinMode(waterlevel,INPUT);
        pinMode(turb ,INPUT);
        pinMode(soil,INPUT);
        Write relay is high
        lcd.init();
        lcd.backlight();
        lcd.setCursor(0,0);
        Print "Connecting To" in LCD
        Set LCD Cursor(0,1);
        Print ssid
        Begin Blynk app with authentication, user id and password
        Print "Connected :-)" on LCD
        timer.setInterval(1000, sensor);
END

FUNCTION loop()
BEGIN
        Blynk.run();
        timer.run();
END
```

5.3.2 Temperature and humidity detection

```
H ⟵ Read humidity value from sensor
T ⟵ Read humidity value from sensor
IF H and T value is null Then
        Print "Failed to read from DHT sensor!"
        Return;
Print H value and T value on LCD
Send data to the server
Print Temperature value on V1 in Blynk app
```

Print Humidity value on V2 in Blynk app

5.3.3 Water level Detection

IF water level is low

Print " WATER IS LOW" on LCD

Write "WATER IS LOW" on V3 in Blynk app

Sends Notification in Blynk app

ELSE

Print "WATER IS HIGH" on V3 in Blynk app

Sends Notification in Blynk app

5.3.4 Soil Moisture

IF soil moisture >=1000 and water level ==0

Write Relay is low in digital form

Print "SOIL IS DRY"

Sends Notification in Blynk app

ELSE

Print " SOIL IS WET" on LCD

Writes "SOIL IS WET" on V3 in Blynk app

5.3.5 PH value

IF ph value is inbetween 0 and 6

Print "WATER CONTAMINATED" in LCD

Write "WATER CONTAMINATED" on V5 in Blynk app

Sends Notification in Blynk app

Write Relay is high in digital form

ELSE

Print "NO WATER CONTAMINATED" on V5 in Blynk app

5.3.6 Water Leakage Detection

IF water leakage is detected

Print " WATER LEAK DETECTED" on LCD

Write "WATER LEAK DETECTED" on V6 in Blynk app

Sends Notification in Blynk app

ELSE

Print "NO WATER CONTAMINATED" on V6 in Blynk app

5.3.7 Water Turbidity Detection

IF water turbidity is detected

Print " WATER TURBIDITY DETECTED" on LCD

Write "WATER TURBIDITY DETECTED" on V7 in Blynk app

Sends Notification in Blynk app

ELSE

Print "NO WATER TURBIDITY DETECTED" on V7 in Blynk app.

5.4 Implementation support

Embedded C: This language apply to programming embedded controllers. The language in which Arduino is programmed is a subset of C and it includes only those features of standard C that are supported by the Arduino IDE.

This does not mean that Arduino C lags anywhere because it is a subset of C. Most of the missing features of standard C can be easily worked around. Rather, Arduino C is a hybrid of C and C++, meaning it is functional and object-oriented.

The structure of sketches

Essentially, a blank Arduino sketch has two functions: Setup() and loop(). As the Arduino sketch starts executing, the setup() function is called first. It's executed only once and must be used to initialize variables, set pinModes, make settings for hardware components, use libraries, etc.

The loop() function is next to the setup() function and it is iterated infinitely. Any other user-defined functions must be called inside the loop function. This is how microcontrollers execute their firmware code by repeating their code for an infinite number of times while they remain powered on.

If users have programmed other microcontrollers (such as 8051, AVR, PIC, or RX), it's possible to compare the code inside the setup() function with the one outside of the main() loop of an embedded C program — which may have been written to initialize variables and make hardware settings. The setup() and loop() functions have void return types.

A program for a microcontroller must be structured in the same manner as it functions. A microcontroller must be "aware" of its hardware environment and know how to interact with it.

A microcontroller can interact with other hardware components or devices only through these five ways:

1. **Digital Input.** This may be received in digital LOW or HIGH from other devices. These will be TTL logic levels or voltages converted to TTL logic levels before being applied to the GPIO.
2. **Digital Output.** This may be output that's digital LOW or HIGH compared to other devices. Again, the output will be TTL logic levels.
3. **Analog Input.** It may "sense" analog voltage from other devices. The sensed voltage is converted to a digital value using a built-in, analog-to-digital converter.
4. **Analog Output.** It may output analog voltage to other devices. This analog output is not analog voltage but a PWM signal that approximates analog voltage levels.
5. **Serial Communication.** It may transmit, receive, or transceive data with other devices in serial, according to a standard serial data protocol such as UART, USART, I2C, SPI, microwire, 1-wire, and CAN, etc. The serial communication with other devices can be peer-to-peer (UART/USART), half-duplex (I2C), or full-duplex (SPI).

Users that know how to perform these five types of microcontroller interactions can interface any hardware with it.

An Arduino program or any microcontroller program must first have code for initialization. This may include:

- Defining variables and constants
- Setting up pin Modes
- Setting up ADC/PWM channels
- Initializing settings for serial communications

A microcontroller simply intercepts incoming data, processes it according to programmed instructions, and outputs data through its I/O peripherals. This means the program must be organized in specific sections that can handle input data, process data, and control output. Unlike desktop applications, µc programs are not designed to terminate. These programs keep iterating for an infinite number of times until the system is shut down or it meets failure. After a power shutdown, Arduino or any microcontroller resets on the "power resume" and begins execution of its program from the beginning.

The program includes code to handle failures when possible. So, any Arduino program can be visualized as a four-step program as follows:

1. **Initialization**

2. **Input** – this should include code for data validation and to handle incorrect or unexpected incoming data.
3. **Processing** – this should include code for unexpected failures or exceptions raised while data processing.
4. **Output** – this may include code for verification of expected results if the interfaced device can also communicate back to the microcontroller.

Chapter 6

Testing

Software testing is conducted to provide stakeholders with information about the quality of the software product or service under test. Software testing can also provide an objective, independent view of the software to allow the business to appreciate and understand the risks of software implementation. It involves the execution of a software component or system component to evaluate one or more properties of interest (a program or application), with the intent of finding software bugs (errors or other defects), and verifying that the software product is fit for use.

6.1 Unit Testing

Unit testing is a software testing method by which individual units of source code, sets of one or more computer program modules together with associated control data, usage procedures, and operating procedures, are tested to determine whether they are fit for use.

Table 6.1: Test cases for connecting hardware to cloud

Case id	Description	Input Data	Expected Output	Actual Output	Output Status
1	Connecting hardware to the Cloud via Wi-Fi	Specific Wi-Fi name and password	LCD will display "Connected to Water".	Displayed	Pass
2	Connecting hardware to the Cloud via Wi-Fi	Invalid Wi-Fi name and password	LCD will display "Water monitoring system".	Displayed	Pass

Table 6.2: Test cases for DHT-11 sensor

Case id	Description	Input Data	Expected Output	Actual Output	Output Status
1	Read from DHT11 sensor	h, t is non-zero values	LCD will display temperature and humidity values.	Displayed	Pass
2	Read from DHT11 sensor	h, t is zero values	LCD will display "Failed to read from DHT11 sensor!".	Displayed	Pass

Table 6.3: Test cases for Turbidity sensor

Case id	**Description**	**Input Data**	**Expected Output**	**Actual Output**	**Output Status**
1	If turbidity detected	turval= 1	LCD will display "Turbidity detected", notification messages will be received.	Received	Pass
2	If turbidity not detected	turval = 0	"No Turbidity detected", messages is displayed on blynk app.	Displayed	Pass

Table 6.4: Test cases for Water leakage

Case id	**Description**	**Input Data**	**Expected Output**	**Actual Output**	**Output Status**
1	If water leakage detected	Waterleak =1	LCD will display "Water leakage detected", notification messages will be received.	Received	Pass
2	If water leakage not detected	Waterleak =0	"No water leakage detected", messages is displayed on blynk app.	Displayed	Pass

Table 6.5: Test cases for water level

Case id	**Description**	**Input Data**	**Expected Output**	**Actual Output**	**Output Status**
1	If water level is low	waterval=0	LCD will display "Water level is low" notification messages will be received.	Received	Pass
2	If water level is high	waterval=1	"Water level is high", messages is displayed on blynk app.	Displayed	Pass

Table 6.6: Test cases for soil moisture

Case id	Description	Input Data	Expected Output	Actual Output	Output Status
1	If soil moisture is dry	soil=0	"Soil moisture is dry" notification messages will be received.	Received	Pass
2	If soil moisture is wet	soil=0 && soil =1023	"Soil moisture is wet", messages is displayed on blynk app.	Displayed	Pass

Table 6.7: Test cases for ph sensor

Case id	Description	Input Data	Expected Output	Actual Output	Output Status
1	If ph value is acidic	ph=0 to ph=6	"Water contamination is found" notification messages will be received and ph value is displayed in Blynk app.	Notification is Received and ph value is displayed	Pass
2	If ph value is neutral	ph=7 to ph=14	"No Water contamination" and ph value is displayed in Blynk app.	Displayed	Pass
3	If ph value is basic	ph=7 to ph=14	"No Water contamination" notification messages will be received and ph value is displayed in Blynk app.	Displayed	Pass

6.2 Integration Testing

Integration testing is the phase in software testing in which individual software modules are combined and tested as a group. It occurs after unit testing and before validation testing.

Table 6.8: Integrated testing

Case id	Description	Input Data	Expected Output	Actual Output	Output Status
1	If soil moisture is dry and water level is high	soil=0 && waterval=1	"Soil is dry" notification messages will be received and relay gets on	Received and motor is on	Pass
2	If soil moisture is wet and water level is high	soil=1023 && Waterval=1	"Soil is wet", messages is displayed on Blynk app and relay does not on	Displayed and motor is off	Pass
3	If soil moisture is wet and water level is low	Soil=1023 && Waterval=0	"Soil is wet", messages is displayed on Blynk app and relay does not on	Displayed and motor is off	Pass
4	If soil moisture is dry and water level is low	Soil=0 && Waterval=0	"Soil is dry", messages is displayed on Blynk app and relay does not on	Displayed and motor is off	Pass

6.3 System Testing

System testing is testing conducted on a complete integrated system to evaluate the system's compliance with its specified requirements. System Testing is a level of software testing where a complete and integrated software is tested. The purpose of this test is to evaluate the system's compliance with the specified requirements. The application is run to check if all the modules (functions) can be executed concurrently, if each return correct results of the operations performed by them, and if the data and index files are left in consistent states by each module.

System Design for tech interviews is something that can't be ignored! Almost every IT giant whether it be Facebook, Amazon, Google, or any other ask various question based on System Design concepts such as scalability, load-balancing, caching, etc. in the interview.

Table 6.9: System testing

Case id	Description	Input Data	Expected Output	Actual Output	Output Status
1	If soil moisture is dry, water level is high, No contamination, no turbidity, non-zero temperature and humidity, no leakage	soil=0 && waterval=1, ph>6.5, turbval=0, d,t=non-zero, waterleak=0	"Soil is dry" notification messages will be received. relay gets on. ph, temperature, humidity value is displayed on LCD and Blynk app.	Displayed the values, received notification and motor is on	Pass
2	If soil moisture is wet, water level is high, No contamination, no turbidity, non-zero temperature and humidity, no leakage	soil=1023 && Waterval=1, ph>6.5, turbval=0, d,t=non-zero, waterleak=0	"Soil is wet", messages is displayed on blynk app and relay does not on. ph, temperature, humidity value is displayed on LCD and Blynk app.	Displayed the values, received notification and motor is off	Pass
3	If soil moisture is dry, water level is high, water contamination, no turbidity, non-zero temperature and humidity, no leakage	Soil=0, Waterval=1, Ph<6.5, turbval=0, d,t=non-zero, waterleak=0	"Soil is dry", messages is displayed and "Water Contaminated" notification is received on blynk app and relay off	Displayed the values, received notification and motor is off	Pass
4	If soil moisture is dry, water level is high, No water contamination, turbidity detected, non-zero temperature and humidity, no leakage	Soil=0, Waterval=1, ph>6.5, turbval=1, d,t=non-zero, waterleak=0	"Soil is dry", messages is displayed and "Turbidity detected", notification is received on blynk app and relay off	Displayed the values, received notification and motor is off	Pass
5	If soil moisture is dry, water level is high, No water contamination,	Soil=0, Waterval=1, ph>6.5, turbval=1, d,t=zero,	"Failed to read from DHT 11 sensor" is displayed on LCD	Displayed	Pass

	turbidity, zero temperature and humidity, no leakage	waterleak=0			
6	If soil moisture is dry, water level is high, No water contamination, turbidity, non-zero temperature and humidity, leakage detected	Soil=0, Waterval=1, ph>6.5, turbval=1, d,t=non-zero, waterleak=1	“Soil is dry”, messages, relay on, “Leakage detected”, notification is received on blynk app	Motor is on and received notification	Pass
7	If soil moisture is wet, water level is high, No contamination, no turbidity, non-zero temperature and humidity, no leakage	Soil>1000 , waterval=1, ph>6.5, turbval=0, d,t=non-zero, waterleak=0	“Soil is wet” notification messages is received. Relay off ph, temperature, humidity value is displayed on LCD and Blynk app.	Displayed the values, received notification and motor off	Pass
8	If soil moisture is wet, water level is low, No contamination, no turbidity, non-zero temperature and humidity, no leakage	Soil>1000, Waterval=0, ph>6.5, turbval=0, d,t=non-zero, waterleak=0	“Soil is wet” and “water is low” messages is displayed relay off. ph, temperature, humidity value is displayed on LCD and Blynk app.	Displayed the values, received notification and motor is off	Pass
9	If soil moisture is wet, water level is high, water contamination, no turbidity, non-zero temperature and humidity, no leakage	Soil>1000, Waterval=1, Ph<6.5, turbval=0, d,t=non-zero, waterleak=0	“Soil is wet”, messages is displayed and “Water Contaminated” notification is received on Blynk app and relay off	Displayed the values, received notification and motor is off	Pass
10	If soil moisture is wet, water level is high, No water contamination, turbidity detected, non-zero temperature and	Soil>1000, Waterval=1, ph>6.5, turbval=1, d,t=non-zero, waterleak=0	“Soil is wet”, messages is displayed and “Turbidity detected”, notification is received on Blynk app and relay off	Displayed the values, received notification and motor is off	Pass

	humidity, no leakage				
11	If soil moisture is wet, water level is high, No water contamination, turbidity, zero temperature and humidity, no leakage	Soil>1000, Waterval=1, ph>6.5, turbval=1, d,t=zero, waterleak=0	“Failed to read from DHT 11 sensor” is displayed on LCD	Displayed	Pass
12	If soil moisture is wet, water level is low, No water contamination, turbidity, non-zero temperature and humidity, no leakage	Soil>0, Waterval=1, ph>6.5, turbval=1, d,t=non-zero, waterleak=0	“Soil is wet”, messages, relay on, “water is low”, notification is received on Blynk app and others values are displayed	Motor off and received notification	Pass

6.4 Validation Testing

Validation Testing ensures that the product actually meets the client's needs. It can also be defined as to demonstrate that the product fulfills its intended use when deployed in an appropriate environment. The process helps to ensure that the software fulfills the desired use in an appropriate environment. The validation process involves activities like unit testing, integration testing, system testing and user acceptance testing. Validation testing is confirmation that a product meets its intended use and the needs of its users.

6.5 User Acceptance Testing

User acceptance testing, a testing methodology where the clients/end users involved in testing the product to validate the product against their requirements. It is performed at client location at developer's site. For industry such as medicine or aviation industry, contract and regulatory compliance testing and operational acceptance testing is also carried out as part of user acceptance testing. UAT is context dependent and the UAT plans are prepared based on the requirements and NOT mandatory to execute all kinds of user acceptance tests and even coordinated and contributed by testing team.

Chapter 7

RESULTS

- It can show Temperature and humidity of surrounding atmosphere.
- It provide notification when ever turbidity detected, water level is low and leakages in pipes.
- When ever water is contaminated it will turn off the motor.
- When ever the soil is dry it will turn on motor.
- It will also measure the pH value of water.

Fig 7.1: Result

In figure 7.1, temperature value, humidity value, pH value, water level status, water turbidity status, water leakage status and soil status are shown. The notification message is received if any change in the status of water quality monitoring system.

This is the graph of temperature and humidity, the blynk application can show up to 3 months of data. In figure 7.2, the change in humidity for the period of 3 months can be seen in graph format.

Fig 7.2: Humidity Graph

In figure 7.3, the change in temperature for a week can be seen in graph format.

Fig 7.3 : Temperature Graph

Chapter 8

CONCLUSION AND FUTURE ENHANCEMENT

CONCLUSION

- The proposed system using IOT is a solution for real-time water quality monitoring system that is low-cost and high- efficiency.
- This system is being developed with the help of a Micro Controller and NodeMCU target boards, which are connected to a variety of sensors.
- An efficient system will be constructed to track water quality. After that, all the sensors value will be measured.
- Android application Blynk is utilized to monitor data such as pH, turbidity of the water, level of water in the tank, moisture in the soil, pipe leaks, temperature and humidity of the surrounding atmosphere.

FUTURE ENHANCEMENT

- We can set specific amount of water level for different kinds of crops.
- NPK sensor can be installed, it will provide values of nitrogen, phosphorus, potassium in soil.
- It can be further used for other farming like cattle farming, Fish farming etc.
- Detecting the more parameters for most secure purpose.
- Develop a mobile application and SMS to the users
- Increase the parameters by addition of multiple sensors.

REFERENCES

[1] Vennam Madhavireddy, B. Koteswarrao, "Smart Water Quality Monitoring System Using Iot Technology", International Journal of Engineering & Technology, Volume-7, (2018), pp. 636-639.

[2] A.N. Prasad, K. A. Mamun, F. R. Islam, H. Haqva, "Smart Water Quality Monitoring System", 2nd IEEE Asia Pacific World Congress on Computer Science and Engineering, (2018).

[3] K. Rajalashmi, N. Yugathian, "IoT based smart water quality monitoring system", Engineering Materials Today: Proceedings, 2021 Environmental Science, Published 22 April.

[4] G.Manoj Kumar, S.E. Gouthem , A. Srithar , V. Surya Prakash, "IOT based water quality control and filteration system", Materials Today: proceedings, Volume-46, Part-9, (2021), pp. 3557-3560.

[5] Sathish Pasika, Sai Teja Gandla, "Smart water quality monitoring system with cost-effective using IoT", Research article, Volume 6, issue 7, E04096, July 01, 2020.

[6] Mohammad Salah Uddin Chowdurya, Talha Bin Emranb, Subhasish Ghosha, Abhijit Pathaka, Mohd. Manjur Alama, Nurul Absara, Karl Anderssonc and Mohammad Shahadat Hossaind, "IoT Based Real-time River Water Quality Monitoring System", the 16th International Conference on Mobile Systems and Pervasive Computing (MobiSPC), Procedia Computer Science, Vol-155 ,(2019), pp. 161–168.

[7] Saif Allah H. AlMetwally, Mohamed K. Hassan , Mohamed H. Mourad, "Real Time Internet of Things (IoT) Based Water Quality Management System", Procedia CIRP 91, (2020), pp. 478–485.

[8] S. Monisha, N. Jeevitha, K. Rajalashmi, N. Yugathian, "IoT based water quality management system", Engineering Materials Today: Proceedings, 2019, Environmental Science, Published 22 April.

[9] Samuel C. Olisa, Christopher N. Asiegbu b, Juliet E. Olisa, "Smart two-tank water quality and level detection system via IoT", Heliyon, Volume 7, Issue 8, August 2021, e07651.

[10] Vaishali S, Suraj S, "Mobile Integrated Smart Irrigation Management and Monitoring System Using IOT", International Conference on Communication and Signal Processing, Volume-7, April 6-8, 2017 pp. 2164-2168.

[11] Juan Huan, Hui Li, Fan Wu, Weijian Cao, "Design of water quality monitoring system

for aquaculture ponds based on NB-IoT", J. Ind. Inf. Integration, Volume. 6, pp. 1–10, 2017.

[12] Nitin Kothari, Jitendra Shreemali, Prasun Chakrabarti, Sandeep Poddar, "Design and implementation of IoT sensor based drinking water quality measurement", Materials Today: proceedings, 2021.

[13] Vaishnavi V. Daigavane and Dr. M.A Gaikwad, "Water Quality Monitoring System Based on IOT", Advances in Wireless and Mobile Communications, ISSN 0973-6972 Volume 10, Number 5 (2017), pp. 1107-1116.

[14] Vinay Kumar , Abhishek Nayaka, Akshay G Aramot, V Jaya Krishna, "Smart Irrigation System using Iot", International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395-0056, Volume: 08 Issue: 06, June 2021, pp. 882-887.

[15] Trupti Deshmukh, H.N Lokhande, Mayuri Raj , Rutuja Sadegaonkar, "Water Purifier Quality Monitoring Using IOT", International Journal Of Innovative Research In Technology (IJIRT), July 2020, Volume 7 Issue 2, ISSN: 2349-6002.

[16] https://stackoverflow.com/questions/29339565/how-do-i-call-rest-api-from-an-android-app

[17] https://docs.blynk.io/en/getting-started/what-do-i-need-to-blynk/quickstart-device-code-overview