SMART WATER METERING AND QUALITY MONITORING

An Undergraduate CAPSTONE Project
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Faculty of Engineering
American International University - Bangladesh

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A CAPSTONE Project submitted to the Faculty of Engineering, American International University - Bangladesh (AIUB) in partial fulfillment of the requirements for the degree of Bachelor of Science in their mentioned respective programs.

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DECLARATION

This is to certify that this project is our original work. No part of this work has been submitted elsewhere partially or fully for the award of any other degree or diploma. Any material reproduced in this project has been properly acknowledged.

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APPROVAL

The CAPSTONE Project titled **Smart Water Metering And Quality Monitoring** has been submitted to the following respected members of the Board of Examiners of the Faculty of Engineering in partial fulfillment of the requirements for the degree of Bachelor of Science in the respective programs mentioned below on **January 2023** by the following students and has been accepted as satisfactory.

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ABSTRACT

Water quality and water metering system is basically a manual system which has been monitored and maintain by individuals or any worker who have assign for this work. This project was carried out a solution of water quality monitoring and water metering system by implementing a wireless solution. A furnished model was developed where for quality monitoring of water different type of sensor has been used like pH sensor TDS sensor and Turbidity sensor has been used. For getting the sensor output from the sensor's a microprocessor unit has been used. On the other hand, to get the water flow reading or water metering system water a flow sensor used and that water flow sensor data has been sent to the microprocessor unit for storing the data. To make it wireless, a wireless module based on Wi-Fi which has been connected to the system and this module send all sensors output to a web-based channel. Through the Wi-Fi connection and the link of that channel anyone from anywhere in the world can access the reading and observe the water quality through that channel. After constricting the desired model the output of that model which has been collected by the tasting of the module is quite satisfied. This system has been identified the water quality and water meter reading quite accurately and the sensor reading has been transferred to the web-based channel correctly. The web-based channel showed the actual result of the sensors which has been send be the microprocessor unit to the channel.

Chapter 1

INTRODUCTION

1.1. Overture

No one wants to drink contaminated water. However, keeping drinking water uncontaminated can be difficult. In most cases, the presence of small amounts of foreign substances does not pose a health hazard, but we still need to be careful about the content of our local drinking water. Another thing is the permissible level of arsenic in drinking water is 0.01 mg per liter as determined by the WHO. Drinking this amount of water for a long time causes various skin disorders including stomach pain, vomiting, loss of appetite, red eyes, swollen feet, tingling hands and feet and paralysis. It can even lead to liver, kidney, bladder and lung cancer.

Due to shortage of water we have to depend on WASA. The water supplied by WASA cannot be called completely clean water. The main reason for this is that the areas that WASA uses as a source of water are so polluted that they do not return to normal even after purification. Another problem is with the chemicals used to deodorize the water. Water has a chemical smell if used in excess. And if the amount is less, the water will smell bad. All in all, WASA has to think more modernly about the issue of water supply.

We have developed a device that inform us about the quality of water. By using this device we know about water pH value, water TDS value and water turbidity value. Firstly, the meter should be set on the water line, if there is any fault in the water, the meter will detect it immediately and the information will be sent to the server. Finally, all the sensors are connected to observe the water quality

1.2. Engineering Problem Statement

Smart water metering offers utilities the chance to simplify their water distribution procedures through data-driven decisions as demand to save finite water resources grows. The utilities can automatically collect data on use, do away with manual meter reading, increase efficiency, and save costs thanks to smart water metering. In addition, it offers a chance to more effectively detect leaks and unusual consumption than manual techniques. A typical smart system uses bidirectional communication networks and electronic sensors to read, store, and transport data remotely for analysis and feedback. The processing server receives the consumption data from the transmitter attached to the water meter for analysis, billing, and other purposes. A typical automated meter reading and transmission frequency ranges from daily to hourly to real-time. Benefits of a smart water metering system include improved leak detection, reduced maintenance costs for the water provider, and transparent consumption and invoicing for the consumer. Utility firms must, however, overcome a number of technological and financial obstacles before they can fully benefit from digital systems. To automate the gathering and processing of meter data, a smart water metering system uses a number of technologies. The components of a typical system are a water meter with a data logger to record the data, a communications device to communicate the data, and a server to process the data. Smart water metering wireless solutions offer greater flexibility and can connect more devices with less work and expense. Cellular, Wi-Fi, Bluetooth, LoRa, satellite, and others are a few of the widely used wireless technologies for smart meters.

1.3. Related Research Works

The use of SWM in water distribution is still a relatively new practice, despite the market having a number of smart water metering options.

Since there are no widely used communication standards, SWM businesses often offer their own solutions. Remote communication was done in the initial generation of SWM utilizing low-power, short-range wireless technologies as wireless M-Bus (WM-Bus) [20] or ZigBee [6], which operated on unlicensed frequencies.

Each network node (smart meter) in these wireless sensor networks transmits data to a particular node, the gateway, which may be stationary or mobile and is in charge of retransmitting the gathered data to the management center. With a mobile gateway, users who have mobile receivers gather data around the SWM, typically in drive-by mode. This technology does away with the requirement for physical access to the water meter or visual inspection, but it does not support automatic or real-time monitoring of water usage.

Data collection is totally automated with a fixed gateway since the primary nodes periodically communicate information about water usage to the gateway units, which then collect data from nearby meters and retransmit it to the relevant utility in the management center. The water management firms must now offer gateways in addition to the smart meters, which frequently necessitate careful location to enhance their efficacy and range. This is now a real AMR solution, but it still has severe limitations. In certain circumstances, the need for suitable cabinets or cases for protection and external power to operate results in increased expenditures.

1.3.1. Earlier Research

Cape Town's water management was emphasized. International recognition for Cape Town's work in water management. In the past 15 years, the city has been able to reduce water use by 30% even though population increase during that time was over 30%. By promoting two key ideas, the city was able to enhance its water management procedure.

I) Persuading individuals to use less water. ii) Making good use of information and communication technologies when using water.

To develop the infrastructure for the water distribution network, water companies create daily demand profiles and peaking factors [27]. A few of the actions taken to enhance water management included adjusting water pressure, installing new pipes, and locating and correcting leaks. More than 20,000 defective water meters were replaced by the city in 2011, and more than 60 schools received extensive training in water conservation. The North American region has been given attention in terms of smart water management. In North America, it is anticipated that smart water management will increase from $1.77 billion in 2013 to $3.64 billion in 2018[18]. The use of ICT in water management solutions improves the management of public assets and lowers the cost of maintaining the distribution system. In accordance with environmental standards, the North American government has created strict rules and regulations for water management. The majority of the ongoing smart city projects in the North American region revolve around smart water management [21]. To address the growing demand for water resources, the US and Canada have already undertaken large-scale projects on water management and distribution systems. The wireless sensor network was taken into consideration by the authors as a viable alternative to the traditional water monitoring method. Wireless sensor networks are reasonably priced and enable measurements to be performed remotely, in real-time, and with little assistance from humans. Traditional water monitoring techniques were time-consuming, labor-intensive, and lacked real-time results to encourage proactive response to water contamination. The idea of a wireless sensor network to reduce water usage in England has been discussed. By identifying leaks or analyzing the distribution of water in the network, the usage of WSN helps to optimize the water facility and enables users to make well-informed decisions about how water is managed effectively. For instance, the WSN's sensors can detect leakage in water pipes and immediately alert engineers or the appropriate authorities to take the appropriate measures. Given that 3.3 billion liters of water are lost every day in England and Wales owing to inadequate infrastructure, this information is extremely valuable. IoT is characterized as a system in which physical items can participate actively and where resources can be accessible online via the cloud to interact with these devices [28][29]. Through the use of the internet, it enables networks and devices to communicate, share, and store data on the cloud platform with or without human intervention. It is necessary to add a new device to the cloud and obtain the device credentials—the username and device ID—before a device can transfer data there. In order to send data to the cloud, a link between Wi-Fi and the latter must be established using these credentials. It can receive the data broadcast by the Wi-Fi after locating the Wi-Fi in the cloud. Water consumption difficulties can be resolved with the help of smart meters, which track each household's or building's water use to regulate consumption levels.

When installing this smart water meter, random consumption issues should be prevented [30][31], and the amount of water used may be checked online. If no one is home and water use declines either directly or indirectly, the water supply may be cut off [32].

1.3.2. Recent Research

The major goal of a smart water management system is to establish a trustworthy relationship between the consumer and the utilities sector, according to the 2014 Review of Smart Metering and Intelligent Water Networks in Australia and New Zealand. This is how smart metering is characterized.[7] The client and service provider can benefit from a well-executed and visual application to find any defects in the service provided or the full integrated smart water management system. Within a 100m radius, the designed technology permits mesh networking between meter interface nodes. The data sent by the meter interface node is gathered by the gateway and forwarded straight to the server. A web-based visual tool for analysis is being created, and Pandora Flexible Monitoring Software (FMS) [2] is used as an extension to this system as a monitoring program. The collected data can also be given a more graphical interpretation using a web-based application, which can also be expanded to create a billing system and other services. The monitoring application and the meter interface node, however, are the main topics of this article. The Dizic module, which provides short-range communication, should be replaced by a module that supports medium-range communication (2 to 3 km), such as the AX8052F143 RF-microcontroller, in future work.[1] On the other hand, more FMS agents will be developed to monitor more elements of the system, such as well as the functioning status of the interface node and the battery charging status. The implementation of a smart leakage detection and localization algorithm will be the last step. It will detect irregular water usage, such as that caused by a pipe leak, and notify users of it. The detection of a water leak will take less time thanks to this technique. Security is becoming more crucial in everyday sensing applications, thus in the future we'll investigate how the system could safeguard user information.

Based on more research, a design for a smart water metering system was created, utilizing image recognition and the Narrowband Internet of Things (NB-IoT) (MCU).[8] Smart water meters have been developed in the past [9, 10] for the same purpose, but all processing is done in the data acquisition unit without the use of cloud computing, making the system vulnerable to single point of failure. If the data acquisition unit fails, no more data is recorded, and the user is unaware of the failure until the unit is physically checked, making it difficult to maintain in large-scale implementations. An idea for an android-based smartphone application to show the water consumption for water pipes is presented in another study [11], where the data from the acquisition units is sent directly to the cellphones. Other recent research [12, 13] employed the cloud platform, however their data gathering module was made with an Arduino UNO or Raspberry Pi instead of our NodeMCU, making their system far more expensive than ours. Our architecture, however, makes use of cloud computing, which has a number of additional advantages, including the ability to guarantee server-less architecture, ease of scalability, the visualization of numerous users simultaneously through mobile computing devices, the implementation of machine learning techniques, and effective centralized data storage, among others. A sensor node is made up of a sensing component, a signal amplification and filtering system, and special data manipulation software. A unique wireless transmission component is present in wireless sensors. Wireless sensors are frequently used to monitor water quality parameters as pH, chlorine, temperature, flow, and turbidity. One of the key components of a water quality monitoring sensor is the primary sensing component, which has physical, chemical, and biological properties of various materials [6]. In the literature, a number of techniques have been put out to reduce node energy consumption in wireless sensor networks, which effectively affect the sensor lifetime [12]. These techniques include duty cycle scheduling, energy-efficient medium access control, and energy-efficient routing. Another method involves recharging sensor nodes by capturing environmental energy (light, temperature gradients, vibrations, water/wind flow, etc.) and converting it to electric energy to power the electronics [13]. By extending battery lifetime or lowering required battery capacity, the integration of energy harvesting technologies holds significant promise for environmental and commercial benefits. To our knowledge, no commercial water meter incorporates or even considers energy harvesting methods. It is noteworthy that the current generation of smart commercial water meters still completely rely on internal batteries. Motivating research has recently been conducted in this area, primarily focused on the investigation of tiny micro-turbines made to capture energy from a water stream [14–17]. Interesting findings from these investigations demonstrate that a modest water turbine may generate a sizable quantity of power, which could lead to a self-powered system. It's important to keep in mind that the majority of this study still faces significant obstacles in terms of integrating the suggested solution into AMR units, and that before widespread deployment, the proof-of-concept prototypes must solve a number of technical and scientific issues. The use of SWM in water distribution is still a relatively new practice, despite the market having a number of smart water metering options. There are no established communication standards, and SWM providers frequently offer exclusive solutions [20]. Remote communication was done in the initial generation of SWM utilizing low-power, short-range wireless technologies as wireless M-Bus (WM-Bus) [20] or ZigBee [6], which operated on unlicensed frequencies. Each network node (smart meter) in these wireless sensor networks transmits data to a particular node, the gateway, which may be stationary or mobile and is in charge of retransmitting the gathered data to the management center. With a mobile gateway, users who have mobile receivers gather data around the SWM, typically in drive-by mode. This technology does away with the requirement for physical access to the water meter or visual inspection, but it does not support automatic or real-time monitoring of water usage. Data collection is totally automated with a fixed gateway since the primary nodes periodically communicate information about water usage to the gateway units, which then collect data from nearby meters and retransmit it to the relevant utility in the management center. The water management firms must now offer gateways in addition to the smart meters, which frequently necessitate careful location to enhance their efficacy and range. This is now a real AMR solution, but it still has severe limitations. In certain circumstances, the need for suitable cabinets or cases for protection and external power to operate results in increased expenditures. Later, certain AMR solutions became long-range (GSM, GPRS) capable, eliminating the need for an external gateway. Due to the high energy consumption needed to operate, such a communication system is not appropriate for the SWM market and calls for either huge batteries or frequent battery replacement.

1.4. Critical Engineering Specialist Knowledge

Before beginning work on this project, we look for other papers that are related to it in order to learn more about their working methods, processes, and issues they encountered.

We also read several blogs and journals written by others working on projects related to ours.

After reading every valuable paper, we came up with a lot of solutions to our problems. A typical smart system uses bidirectional communication networks and electronic sensors to read, store, and transport data remotely for analysis and feedback. The processing server receives the consumption data from the transmitter attached to the water meter for analysis, billing, and other purposes. A typical automated meter reading and transmission frequency ranges from daily to hourly to real-time. To automate the gathering and processing of meter data, smart water metering systems rely on a number of technologies. The components of a typical system are a water meter with a data logger to record the data, a communications device to communicate the data, and a server to process the data. In reality, the utilities frequently employ a range of communication techniques to meet the varied transmission objectives.

An appealing, dependable, and high bandwidth connection is provided via a direct wire connection. Due to the high installation and maintenance expenses associated with wiring millions of meters, this is, however, expensive and occasionally unfeasible. Wireless networks, on the other hand, offer greater flexibility and can connect more devices with less expense and labour. Cellular, Wi-Fi, Bluetooth, LoRa, satellite, and others are a few of the widely used wireless technologies for smart meters.

The maximum range, transmission rate, capacity, resistance to inference, and other characteristics of communication networks vary. In order to increase coverage and quality, utilities may therefore combine several wired and wireless technologies. They purchase every sensor except the temperature sensor and make it for pipe usage in the paper titled "A low cost system for real time monitoring and assessment of potable water quality at consumer sites."

1.5. Stakeholders

Although there is water available everywhere, it is not always safe. We must consider safe water because we can go without it for a day. No life form, including humans, can survive without water.

Water-related research is ongoing worldwide, and everyone is looking for more effective ways to address the issue that are also affordable. Millions of dollars have been spent on water safety by wealthy nations. The government provides them with access to clean water for their home.

They don't have to be concerned about it. The issue of safety arises in developing, densely populated nations like Bangladesh.

Safety suffers because the government cannot handle a large number of people. We must consider our own security and use modern technology to simplify our lives. All people benefit from this device's provision of safe drinking water. Smart Meters assist utilities in obtaining automatic, trustworthy, and accurate data on water consumption for billing purposes. Interruptions, hidden frauds, or human errors won't have an impact on the utility's revenue, and customers will be correctly paid. The water supplied by WASA in our nation. Water from WASA cannot be considered entirely pure. The main reason for this is that the areas that WASA uses as a source of water are so polluted that they do not return to normal even after purification. Another problem is with the chemicals used to deodorize the water. In excess, water has a chemical odor. Additionally, the water will smell terrible if the amount is lower. Overall, WASA has to approach the problem of water supply with more contemporary thinking.

1.6. Objectives

The system that will be the major focus of this project will be able to both monitor liquid or water quality and flow.

1.6.1. Primary Objectives

- For billing reasons, a water meter's function is to measure the volume of water given to a customer over a predetermined time period (often in liters, mega liters)

- It ensures reasonable water usage charges and enhanced demand management. A tool used to monitor water usage is a water meter. Not only does it aid in consumption monitoring, but it also helps to reduce energy consumption at sewage treatment facilities and costs associated with electricity required to pump water.

- The volume of water that flows through a pipe or other outlet is measured by a water meter. In most cases, meters measure volume in standard units like cubic feet or gallons.

- Smart meters are made to measure consumption accurately and not excessively. While readings are taken every hour, the overall consumption is only uploaded every 24 hours. The sensors are easily tampered with because they hang on the meter outside the house unattended. They may be the target of active or passive cyberattacks, depending on whether commands are given to them or data is taken. People could hack the sensors if they wanted to lower their water costs.

- When exposed to utility-side electrical surge events and outside weather conditions, electronic meters' delicate tiny electronic circuit boards are vulnerable to burning and exploding.

1.6.2. Secondary Objectives

- The properties of liquids or water, including their flow rate, volume, pH balance, quality, and electrical conductivity. The proper amount of liquid to add to a product or process is measured using a variety of meters, some of which are used to compute monthly water bills.
- The digital water meter wirelessly transmits data to South East Water about the amount of water entering your house in real-time. Then, we can spot unusual water usage trends that might be brought on by a water leak on the property.

1.7. Organization of Book Chapters

Briefly discussed how the contents of the book has been arranged chapter wise. Provide details how the contents are continued and interconnection between the chapters.

Chapter-2: Project Management

Chapter-3: Methodology and Modeling

Chapter-4: Implementation of Project

Chapter-5: Results Analysis & Critical Design Review

Chapter-6: Conclusion

Chapter 2

PROJECT MANAGEMENT

2.1. Introduction

As this project is primarily concerned with water quality assurance for consumers as well as water suppliers who wish to provide good quality water to their customers. To ensure this, we planned a model that will continuously monitor the water quality using sensors and send the sensor data to a private or public server that can monitor both the consumer and the water supplier. Based on this concept, this project has been enrolled, and some of the sensors such as the pH sensor, which will monitor the water pH level, the TDS sensor, and the turbidity, which will both observe the turbidity as well as the TDS of water, which means total dissolves solids in the water, will ensure the water quality Another thing appears as a result of this, and that is the water meter reading. In today's environment, this reading is manually collected from consumer door to door. A meter reader reads all of the data from the meter, then the readings are compiled on a server or data sheet, and the bill is generated based on those readings. To resolve this manual meter reading methodology. This project is linked to a water flow sensor, which takes readings automatically and sends them to the server. Overall, this is the primary goal of the project.

2.2. S.W.O.T. Analysis

Our project's SWOT analysis has been provided here. SWOT analysis is a strategic planning exercise that identifies a company's internal strengths and weaknesses as well as external opportunities and threats. The internal analytical specs make use of an efficient method to look into economic, management, infrastructure, production, distribution, reputational components, and revolution. They also consider assets, abilities, necessary competences, and competitive advantages. In order to identify the source of competitive advantage, the internal study is essential. By examining the competitors' ambiance, the industry's ambience, and the overall ambience, the outside review identifies market possibilities and dangers. This analysis is an internal project research that can be based on surveys, but we choose to base it on information we could find online. An important step in the project planning process is the SWOT analysis.

2.2.1. Strength

The following strengths of this project are given below:

- Very Useful for monitoring water flow and quality of the water.
- Easy to make with a use of a microcontroller.
- Cost efficient as sensors used in the project are of very minimum cost.
- Effective applications in daily uses on installation.

2.2.2. Weakness

- Might malfunction at times due to errors of the sensors.
- Short circuit might occur which might damage the microcontroller.
- New technology need time to adjust within the consumers.

2.2.3. Opportunities

- Optimize circuit building for responsiveness and built-in feedback.
- Attract a larger, wider target audience.

2.2.4. Threats

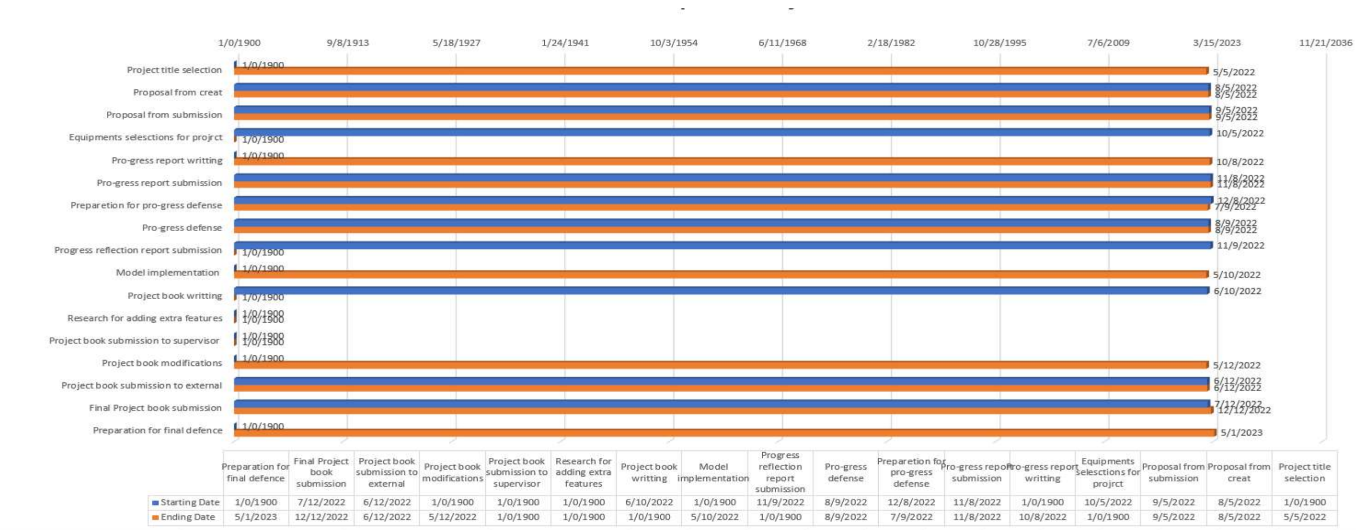
- Can operate at a loss to drive away competition
- With time the device may get damage and might need to be replaced.

There is no such practice of using such devices in the country which will need ample amount of time to make it habitable for everyone.

2.3. Schedule Management

Table 2.1 shows the project management chart. Where firstly the prototype of the project is made, then the problem has been found by using that prototype. To use the sensors to the prototype there some calibrations has been done for get the exact result from the final device. After checking all the sensor and the calibration of the sensor then the implementation part comes. In this implementation part all the sensors which has been checked all are connected to the microcontroller and check the result of the sensor all together. Then comes the output result taking. From various section of the Dhaka reading has been taken on different time and date. After that the assemble of the component and final product completed.

Table 1: Gantt Chart



2.4. Cost Analysis

Table 2.2. Total Project Cost with Individual Component Cost and Deviation of Cost

Product Name	Actual Cost of Product (BDT)	Predicted Cost of Products (BDT)	Deviation(%) [{(Actual cost – Predicted cost)/ Actual Cost}/100]
Arduino Uno	1000	500	50.00%
NodeMCU	250	150	40.00%
pH Sensor	2500	1500	40.00%
TDS Sensor (Total Dissolve Solid)	1800	1000	44.40%
Turbidity Sensor	650	500	23.07%
Bread Bord	100	80	20.00%
Connecting Wares (male to male, male to female)	300	200	33.33%
Total	6600	3930	40.45%

2.5. P.E.S.T. Analysis

This lesson is a frame that our presented project categorizes macro-environmental influences in strategic planning which is used by formations to detect, evaluate, arrange and track macro-economic elements which can be effective on its business now and in the upcoming future. This framework shows the opportunities and threats due to Political, Economic, Social and Technological units. PEST analysis helps to assess the technique which fits into the broader circumstances and stimulates artistic thinking and also gives an overall essential external and internal impacts that can affect our project. This PEST analysis will be useful for any institutions that need to measure the current and future markets of our project.

2.5.1. Political Analysis

This project will have no impact on factors such as government policy, political stability or instability, bureaucracy, corruption, competition regulation, foreign trade policy, tax policy, trade restrictions, labor/environmental/copyright/consumer protection laws, funding grants and initiatives, and so on.

2.5.2. Economic Analysis

Global economic dynamics that may have an impact on project success. Economic trends, growth rates, industry growth, seasonal factors, international exchange rates, international trade, labor costs, consumer disposable income, unemployment rates, taxation, inflation, interest rates, credit availability, monetary policies, raw material costs, and so on are all factors to consider.

2.5.3. Social Analysis

Social attitudes, practices, and trends that have an impact on project management and the target market. Money, customer service, imports, religion, cultural taboos, health, employment, leisure, the environment; population growth and demographics, immigration/emigration, family size/structure, lifestyle trends, and so on are all examples of common ideas.

2.5.4. Technological Analysis

Technology that can influence how we manufacture, distribute, and sell your products and services. Infrastructure for technology and communications, technology legislation, consumer access to technology, competitor technology and development, new technologies, automation, research and innovation, intellectual property protection, technological incentives, and so on.

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2.6. Professional Responsibilities

Ensuring that a system, method, or product is risk-free and effective in its intended usage is the responsibility of an engineer. For their projects to succeed, engineers need to be able to effectively collaborate with one another and work in teams. All parties involved in engineering, including customers and businesses, must effectively communicate. Along with these duties, engineers are also accountable for the following:

Creating plans with the use of detailed drawings. Creating forecasts and budgets for varied tasks defining the project's scope's boundaries, the process of creating experiments for the engineering field preparing regulatory paperwork that is pertinent to safety initiatives, producing technical papers that are targeted at the clients, and executing projects on time and within budget. Sharing analysis's final findings and conclusions with coworkers and clients.

2.6.1. Norms of Engineering Practice

In general, engineers labor to enhance society, countries, and the world by solving technical problems. This is a skill that has been established in the country. Initially, an engineer attempts to identify social or other types of problems in society or the globe. Then they strive to find any feasible solution to the problem or to make the problem easier to solve. To produce or fix those things, an engineer thinks in many different ways, both conceptually and practically. For this and your initial point regarding that practical problem that can be solved effectively. As a result, they identify practical problems in society and attempt to fix them using engineering knowledge. If they are unable to solve the problem using their practical expertise, they will conduct some theoretical work, such as conducting research on the subject and solving mathematical equations, so that the problem becomes much easier to solve and a solution can be obtained. Then follows the technical technology part's usage. Where engineers work, they start with the basics so that technology may solve the problems. As an example, we worked alone with those items. To begin, we notice a problem with clean water. Most people in a new nation do not get drinkable water from the distributor who delivers water from house to house. By monitoring this situation and conducting water-related research. Following that, we develop a model for the solution, and ultimately, we develop a solution that will assist distributors in continuously monitoring a sea water quality monitoring system for consumers to utilize water from anywhere in the world at any time. We also follow the code of ethics for development and problem solving.

2.6.2. Individual Responsibilities and Function as Effective Team Member

Group is a four-member group so we divide our work in four different ways. Each different member does some specific different work for solve that problem. Overall, all the members have do their individual research for solving the problem. Based on that research the related model easily designs by one member. Then based on the design one member will do the basic equational work or theoretical work for solving the problem and get a software base prototype model. Then I third member will implement the model by hardware and by coding. Finally, the last member will make a report or and project book for updated result and solution. Based on those all the members have do their own research based on the problem we have find out. After that first member design a model diagram for the solution of the problem.

After that this next member do some research on those models and did some theoretical work as well as mathematical work on those things. After those things third member has come up with a prototype solution of the problem which have developed by software and some coding.

Finally last member has implemented the model word based on the prototype model which has been simulated in the software and Juice some data taking and testing by the implemented work. After all this both all the members write their own part of their book for, they are basis of work.

2.7. Management Principles and Economic Models

The management of our project is primarily concerned with water management. In our daily lives, water is the most vital element of our environment as well as the planet. We humans require at least 1.5 litters of pure water per day. They also require a lot of water in their daily lives. For drinking water, the water must be pure so that it can be consumed without having an impact on the human body or society. Clean water or water must always be monetized through this type of system. In light of this, we created a project in which water is monitored by a sensor at all times while water is flowing through the pipe for users. All of them are the essential principles for the system that our built system must control.

2.8. Summary

Every engineering problem solving system is managed in a methodical manner throughout the project. We first identify the problem before attempting to remedy it. When an issue is discovered, we attempt to obtain all viable solutions for the problem by investigating journals and other potential solutions. In this scenario, it's strange to try to get assistance from a study report. After we have arrived at a solution to the problem through various research and related effort, we have initiated our project system and effective method of solving this problem. We have developed a few solutions for this challenge and are attempting to implement those solutions through simulation and simulated data collection. Following that, we assessed the practicality of this project, determining whether it is feasible for society and forward, and, most importantly, whether it is user friendly or not. We are moving forward with the project implementation after establishing its feasibility. Finally, after deployment, we collect data from various locations and distribute it to some consumers who utilize it and provide comments. We finally finished our project after gathering all of the data and feedback, and the book was created as a result.

Chapter 3

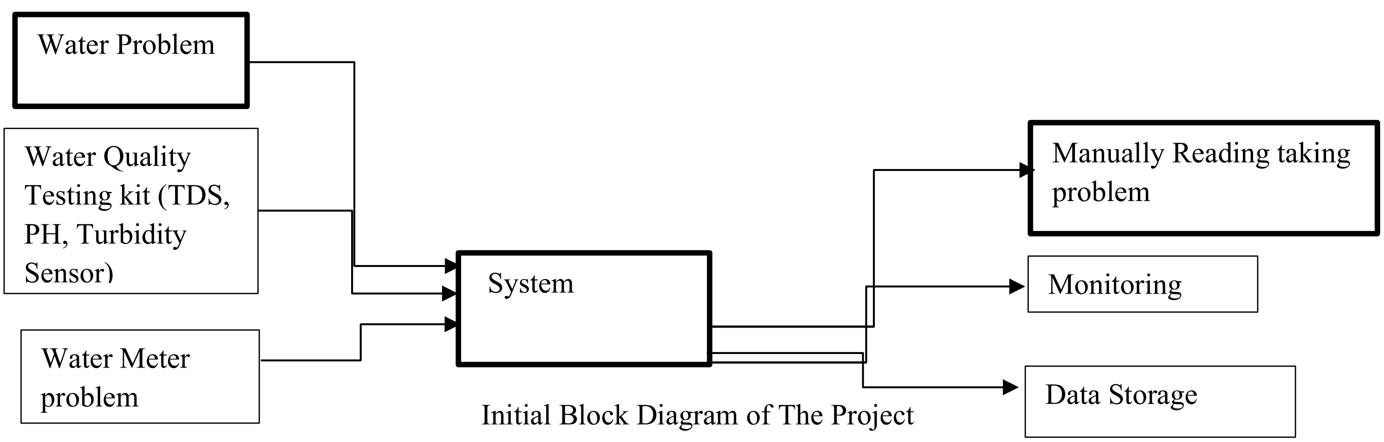
METHODOLOGY AND MODELING

3.1. Introduction

Method engineering is a solution to the problem of determining the "best appropriate" approach for an organization and/or its projects. That existing techniques are not well suited to practice, while noting a pushback against formal methodologies. Others regard process adoption as a "waste of time," arguing that having a suite of techniques available to a company is both appropriate and important. Since the one-size-fits-all methodology is now widely seen as impossible, alternatives must be developed, particularly those that take into consideration human and organizational factors. The current most optimistic route, method engineering, possibly supplemented by method tailoring/customization, is the theme of this study.

3.2. Block Diagram and Working Principle

On the basis of the previously discussed research work, we come up with a block diagram of our system



Initial Block Diagram of The Project

Flow Sensors are used in our research to measure the water volume of this system, indicating how much water has traveled through. The greater the flow rate of water, the greater the flow speed. An initial block diagram is shown. To be accurate, the sensor must know the density of the water, which is provided by the water analysis data to the measurement system. A pH sensor, which measures the acidity or alkalinity of water with a value ranging from 0 to 14, is also useful. When the pH falls below seven, the water becomes more acidic. Any value more than seven indicates that the body is more alkaline. Each type of pH sensor measures water quality in a different way. TDS Sensors must detect Total Dissolved Solids (TDS) levels in water, which can be used to determine water quality. The Grove - TDS Sensor can be used in a variety of water quality applications, including TDS meters, well water, aquariums, and hydroponics. For our project, we employed extremely useful and effective instruments to determine the clarity and particle content in a water metering solution, as well as Turbidity sensors, which are used to reduce waste, improve yields, and monitor water quality in a variety of sectors.

When these sensors are linked to a microcontroller such as an Arduino uno, we can calculate the flow rate, check the volume of liquid that has traveled through a pipe, and adjust it as needed. Because our project is a wireless water meter solution, we selected General Packet Radio Services (GPRS), which is a best-effort packet-switching protocol for wireless and cellular network communication services. Because all packets are given the same priority and packet delivery is not guaranteed, it is deemed best effort. And it transmits processed data to the GPRS Module via the Arduino uno. In this project, we will use Arduino to create a water flow sensor. We will connect the water flow sensor to an Arduino and an LCD to display the volume of water that has passed through the valve. For this project, we will utilize a water flow sensor, which detects the flow rate of liquid using a hall effect. NodeMCU is an open-source platform based on ESP8266 that can link objects and allow data transfer over the Wi-Fi protocol. Furthermore, by supplying some of the most crucial characteristics of microcontrollers. Final block diagram of the project shown in fig 3.1.

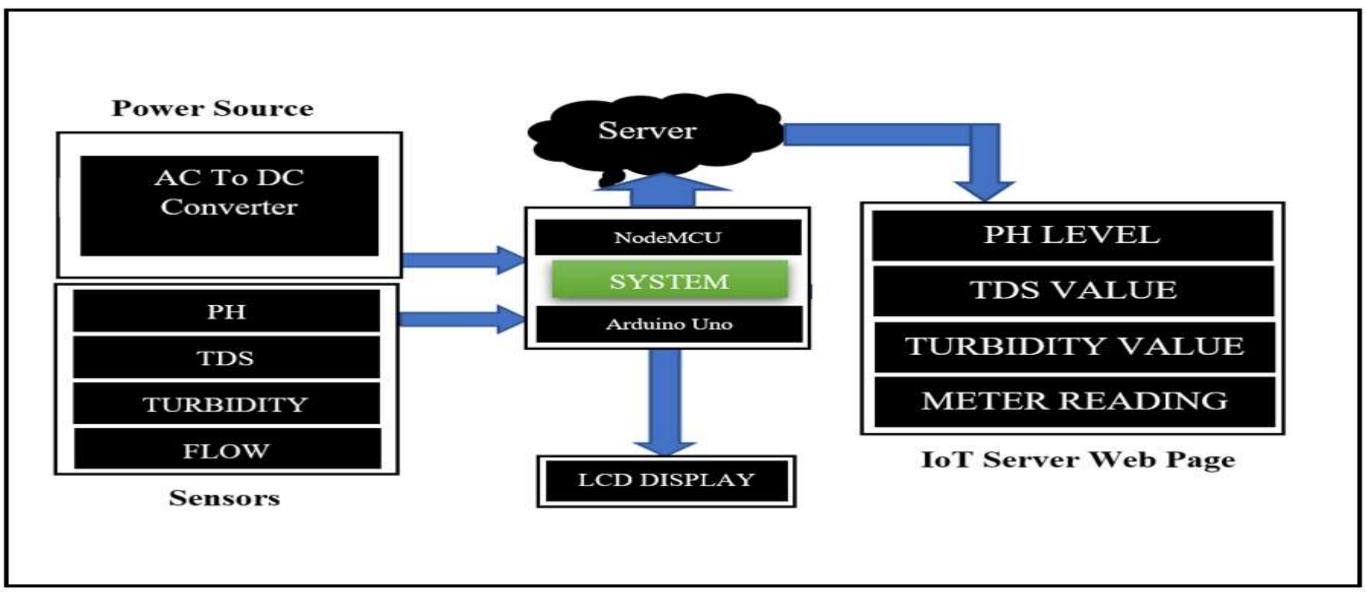


Figure 3.1. Block Diagram of The Project

3.3.Modeling

This is the prototype of the project module. Where all the sensors are connected to the Arduino Uno for getting an idea of the connection as well as a basic visualization of the project.

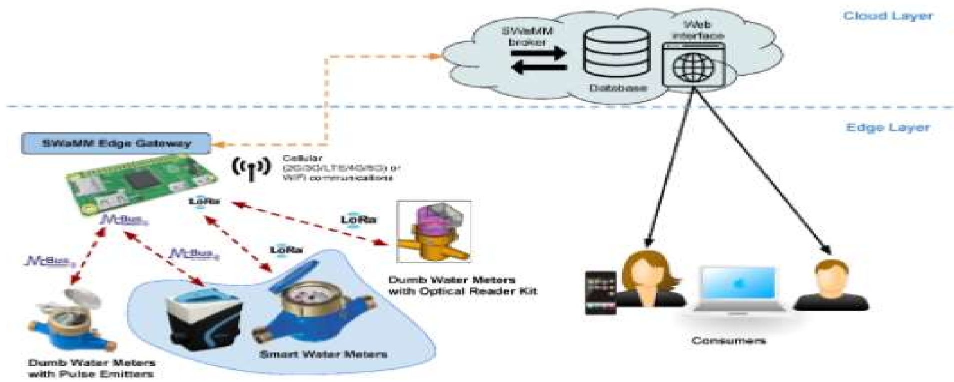


Figure 3.2. Model Design of Smart Water Metering System

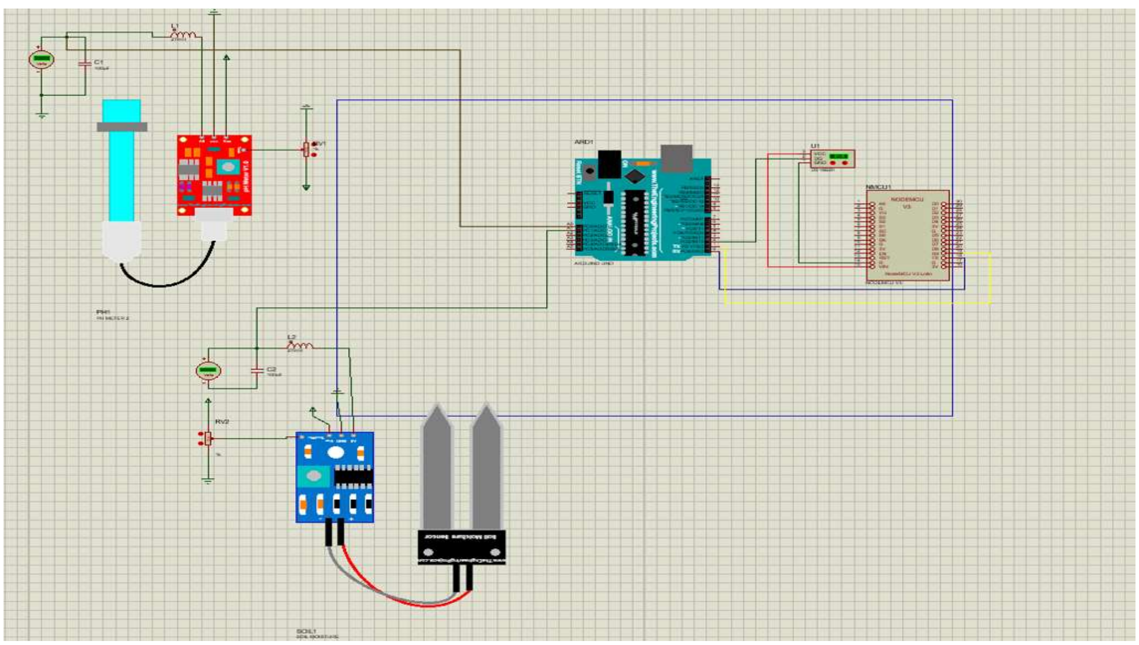


Figure 3.3. 2D Design of Project Prototype

In figure 3.2 and figure 3.3 is a basic model of the project. Figure 3.2 is describing the project model for Smart water metering system. Where meter reading from water meter and water quality reading from quality monitoring tank is sent to the system. From the system that data is sending to the server by Wi-Fi module. From the server all the data is updated in the website. After uploading any consumer or distributor who can excess to the server can see the data from the website.

In figure 3.3 are design of project prototype his shown where all the sensors are connected with Arduino UNO to receive the sensor data and then the data is send it through RX, TX pin of Arduino UNO to NodeMCU TX,RX pin. From NodeMCU the data is sending to the server. All these are designed in proteus Software.

3.4. Summary

The 2D view of the project is shown in this project modeling. Where the component connection and the basic operating technique have been generated. The Arduino Uno microcontroller is used to collect data from sensors for monitoring water quality and observing water flow meter readings, as well as storing the data. Nodemcu is used to link the device to the internet, and through the internet, anyone can view the water quality and flow meter readings.

Chapter 4

PROJECT IMPLEMENTATION

4.1. Introduction

Any project that is going to be completed successfully needs to be closely monitored. The electrical components that were employed in accordance with the work that was allocated to us for our project are discussed in this chapter, as well as the preparations that have been made for the execution of our suggested project in terms of the components of the simulation design. Any project that is going be implemented successfully requires careful oversight. This chapter addresses the electrical parts that were provided to us for our project, as well as the arrangements made for the implementation of our suggestions in terms of the project's simulation design, based on the work that was being done [7]. The hardware and simulation component's sorts of stages are taken into consideration by the project manager. Proteus 8.10 was used to run simulations based on software for this investigation. Project management covers not only how this is done but also the kinds of strategies that have previously been used for the accomplishment of similar goals by others. Both hardware and simulation have been used to occupy their respective positions inside the project. The many types of components used in this chapter will be covered.

4.2. Required Tools and Components

Table 4.2.1 Required components for the project.

S/L	Name of Components	Quantity
1	Arduino Uno R3	1
2	pH Sensor	1
3	Turbidity Sensor	1
4	TDS Sensor	1
5	Flow Sensor	1

4.2.1. Arduino Uno R3

The Arduino Uno microcontroller board is built around the ATmega328 shown in fig 4.1. The device has 20 digital input/output pins, 6 PWM outputs, 6 analog inputs, a 16 MHz resonator, a USB connector, a power jack, an ICSP header, and a reset button [2]. The microcontroller comes with everything it needs to function; all that is needed to get it started is the insertion of a USB cable, an AC-to-DC adapter, or a battery. The FTDI USB-to-serial driver chip is not utilized by the Uno, which is how it differentiates from all earlier boards. Instead, it has an ATmega16U2 that has been configured to work as a USB-to-serial converter. This additional microcontroller can be programmed by advanced users because it has its own USB bootloader. Since it has a significant support community, a huge range of support libraries, and hardware add-on "shields," the Arduino is an excellent entry-level platform for embedded electronics (for example, you can easily make your Arduino wireless with our Weixel shield). Remember that we also offer a Spark Fun Inventor's Kit that includes an Arduino Uno and a number of additional components (including a breadboard, sensors, jumper wires, and LEDs) that let you create a number of exciting starter projects.

• The Uno (R3) is currently in its third revision, which includes the following changes

• An ATmega16U2 chip replaced the earlier ATmega8U2 (8K flash) as the USB controller chip (16K flash). This does not increase the amount of flash or RAM that sketches can use.

• Three additional pins have been added, all of which are copies of earlier pins. Additionally, the I2C pins (A4, A5) have been moved to the side of the board close to AREF. The IOREF pin, which is a duplicate of the 5V pin, is located next to the reset pin.

• By moving the reset button closer to the USB port, it is now easier to use when a shield is present.

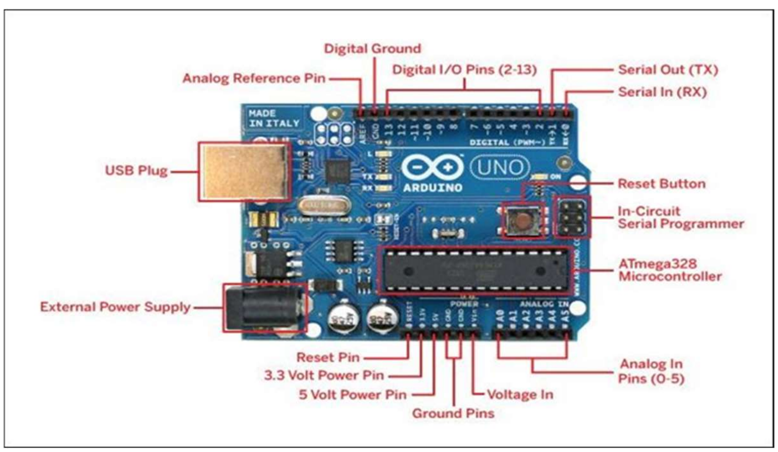


Figure 4.1 Arduino Uno R3

4.2.2. NodeMCU

A low-cost System-on-a-Chip (SoC) called the ESP8266 serves as the foundation of the open-source NodeMCU (Node Microcontroller Unit).

Figure 4.2 NodeMCU

The Espresso Systems-designed and -produced ESP8266 has all of the essential components of a computer, including CPU, RAM, networking (Wi-Fi), and even a contemporary operating system and SDK, shown in fig 4.2. This makes it a fantastic option for all types of Internets of Things (IoT) projects. The ESP8266 is difficult to access and use as a chip, though. For the simplest activities, like turning it on or sending a keystroke to the "computer" on the chip, you can use it with various pieces of equipment or solder wires with the proper analog voltage to its pins. Additionally, the controller must program it using simple machine instructions that the chip hardware can understand. This level of integration is not an issue using the ESP8266 as an embedded controller chip in mass-produced electronics. For amateurs, hackers, or students who want to test it out in their own IoT projects, it is a significant burden.

4.2.3. LCD DISPLAY

LCDs (Liquid Crystal Displays) are used in embedded system applications to display various system parameters and the state of the system. An LCD 16x4 is a device with 16 pins that contains two rows with room for 16 characters each. The LCD 16x4 can be used in either 4-bit or 8-bit mode. Additionally, you can create your own characters. In addition to the 8 data lines, it also has 3 control lines that can be used for control. In fig 4.3 it is shown.

Figure 4.3 16x4 Serial LCD Module Display for Arduino Assembled

4.2.4. FLOW SENSOR

To detect the flow rate of water and determine how much water has flowed through the pipe, a water flow sensor is mounted at the water source or pipe. Liters or cubic meters of water are moved every hour. To identify and gauge water flow, a hall sensor and a water rotor are both present. This theory explains how the rotor's spinning results in a voltage difference between the sensor's conductors. The rotor revolves and produces a voltage when the moving fan rotates as a result of water flow. A Hall sensor measures this induced voltage, which is then shown on the LCD display. It needs a breadboard connecting cable, a Hall-effect water flow sensor, a 16x2 LCD display, and an Arduino microcontroller board for processing. To gather the output from the Hall effect sensor, connect the black wire to ground and the yellow wire. In fig 4.4 a picture is shown.

Figure 4.4 Flow sensor

4.2.5. pH SENSOR

An electrical tool called a pH meter is used to determine the pH of any solution shown in fig 4.5. Important parts of a pH meter include a temperature sensor, a reference electrode, and a measuring electrode. A pH meter employs a temperature sensor to determine the pH of a suspension and estimates the voltage of an electrochemical cell. The majority of pH meters include numerous electrodes, and the temperature sensor and electrode are made in the same frame during manufacturing. The total potential or voltage is the algebraic sum of the potentials of the measuring electrode, the reference electrode, and the liquid junction. Calculate the potential difference (voltage) between the reference electrode submerged in the test sample solution and the measuring electrode's glass membrane. Temperature influences the voltage that develops in the glass electrode film, with a temperature coefficient of roughly 0.3% per °C.

Figure 4.5 pH sensor

4.2.6. TDS SENSOR

A TDS meter is a tiny, portable instrument used to show how much total dissolved solids are present in a solution (usually water) shown in fig 4.6. The conductivity of solutions is increased by dissolved ionized solids like salts and minerals, hence a TDS meter detects the conductivity of a solution and infers the TDS from that measurement. A basic TDS meter, for instance, would only count the total amount of dissolved solids in a solution, whereas a more sophisticated one might also detect salinity, temperature, etc. The operation of the water TDS meter is really intriguing. determines the water's electrical conductivity. The majority of water samples, as you are aware, contain minerals, ionized salts, etc. The conductivity of the solution is tended to increase by these factors. The conductivity of water is calculated and displayed using a water TDS meter. conductivity for both advantageous and detrimental minerals is provided. This is the fundamental justification for why water with a conductivity of zero or very high is not suitable for drinking. To count the dissolved ions in solution, use a TDS meter. This translates to an estimated milligrams per liter (mg/L) of Total Dissolved Solids (TDS).

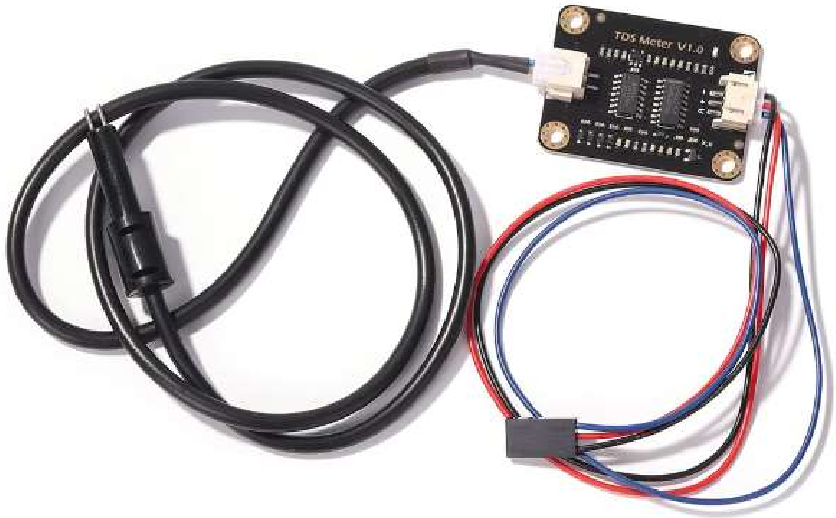


Figure 4.6 TDS Sensor

4.2.7. TURBIDITY SENSOR

The turbidity of the water or solution being studied is measured by a device known as a turbidity meter. An instrument with optical characteristics based on light scattering, or the ratio of reflected to incident light, is called an opacimeter. When all other circumstances are held constant, the concentration determines how much light is reflected from the suspension. Currently, there are two categories of general-use turbidity meters: Instruments for Sampling with Analytical Benchtop and Portable Benchtop devices are not appropriate for mobile use and are primarily employed as fixed laboratory equipment. Before using the instrument, it was set up so that the number listed was 0 or neutral. Measurements were then made by twisting the control knob to alter the reading until the value shown on the opacimeter's screen matched the default value. The basis of turbidity analysis is the measurement of transmitted light intensity as a function of dispersed phase concentration. The absorbed light becomes murky after being partially transmitted and partially absorbed by the water sample. As a result, the liquid becomes opaquer the lighter is absorbed. According to this idea, all samples examined have turbidities (turbidity) of less than 5 NTU, making them all acceptable for eating. In fig 4.7 shown a model of turbidity sensor.

Figure 4.7 Turbidity Sensor

4.3. Implemented Models

This project implementation is done in two ways, simulation model and hardware model.The simulation model combines the logical and mathematical ideas and uses computer software to try to replicate a real-world system. Contrastingly hardware model consists of the circuit designed to perform the referred operation.

4.3.1. Simulation Model

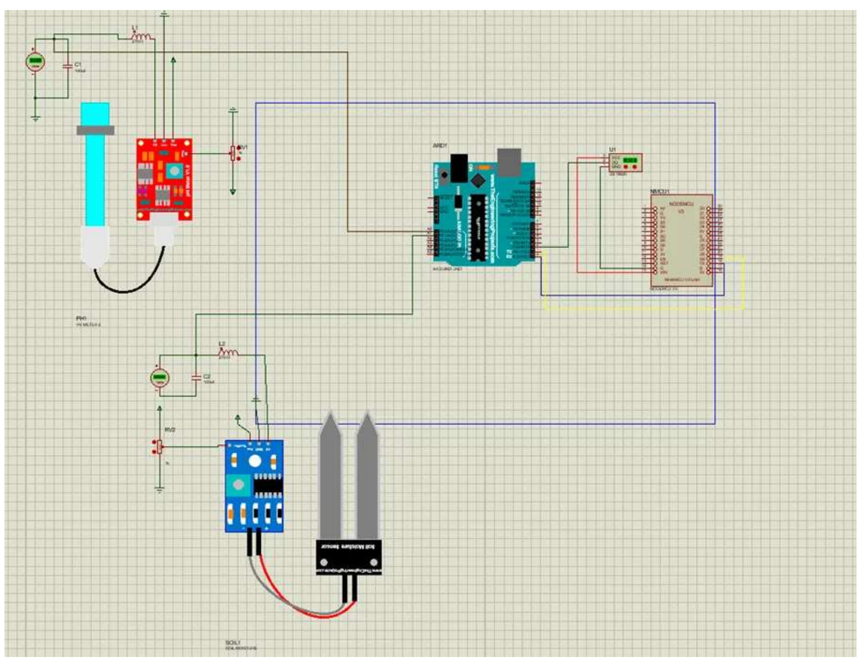


Figure 4.8 Simulation Model of Wireless Solutions for Smart Water Metering and Water Quality Monitoring

The entire simulation diagram which is shown in fig 4.8 for this project is displayed in above to show the procedure. It is only natural to gather simulation data and do an analysis on it when the circuit diagram execution is complete. Depending on the particulars of their circumstances, users could receive various results.

In fig 4.9 it visualized over all connection diagram of the project by Schematic diagram. Were all the sensor is connected with Arduino Uno for sending sensor data to Arduino. After that these data is transferred to NodeMCU to sent all the sensors data to the IoT based server.

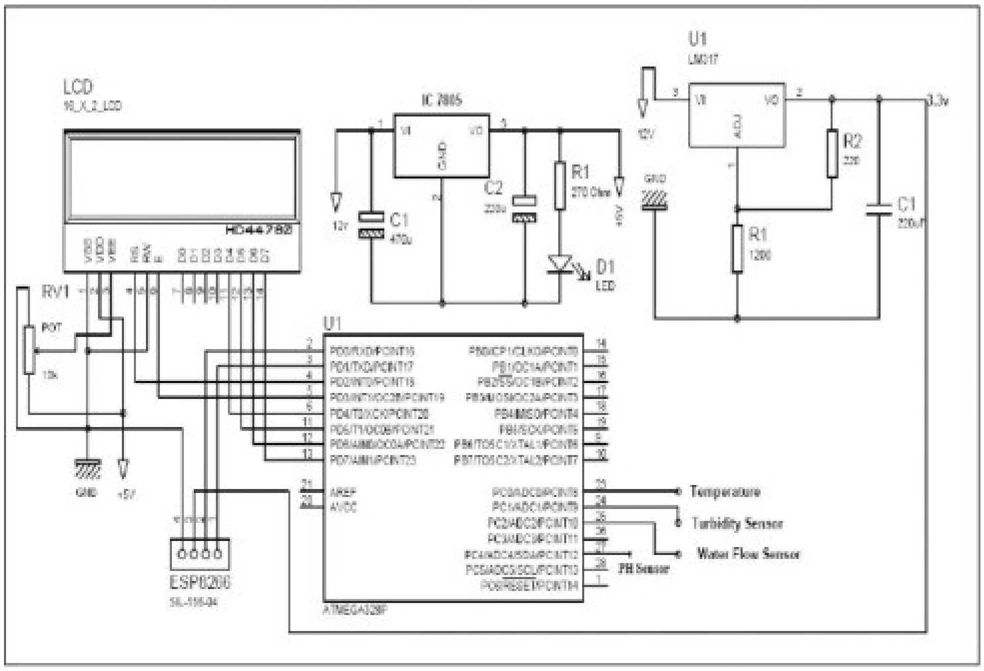


Figure 4.9 Schematic diagram of water quality monitoring system

Table 4.1 Individual Sensors Model Name

SENSOR	**MODEL**
Arduino uno	R3
Flow sensor	YF-S201
TDS SENSOR	Gravity TDS meter V1.0
Turbidity sensor	20120917
Node MCU	ESP8266MOD
LCD Display	16X4

With the advances in IoT technology, the water quality monitoring system is becoming smarter with reduced power consumption and ease of operation. The core controller is integrated with various sensors such as Flow Sensor, PH Sensor, TDS Sensor, Turbidity Sensor. The sensor leads are placed in the water to be tested. The sensor values will be processed by Arduino uno and the core controller 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.

4.3.2. Hardware Model

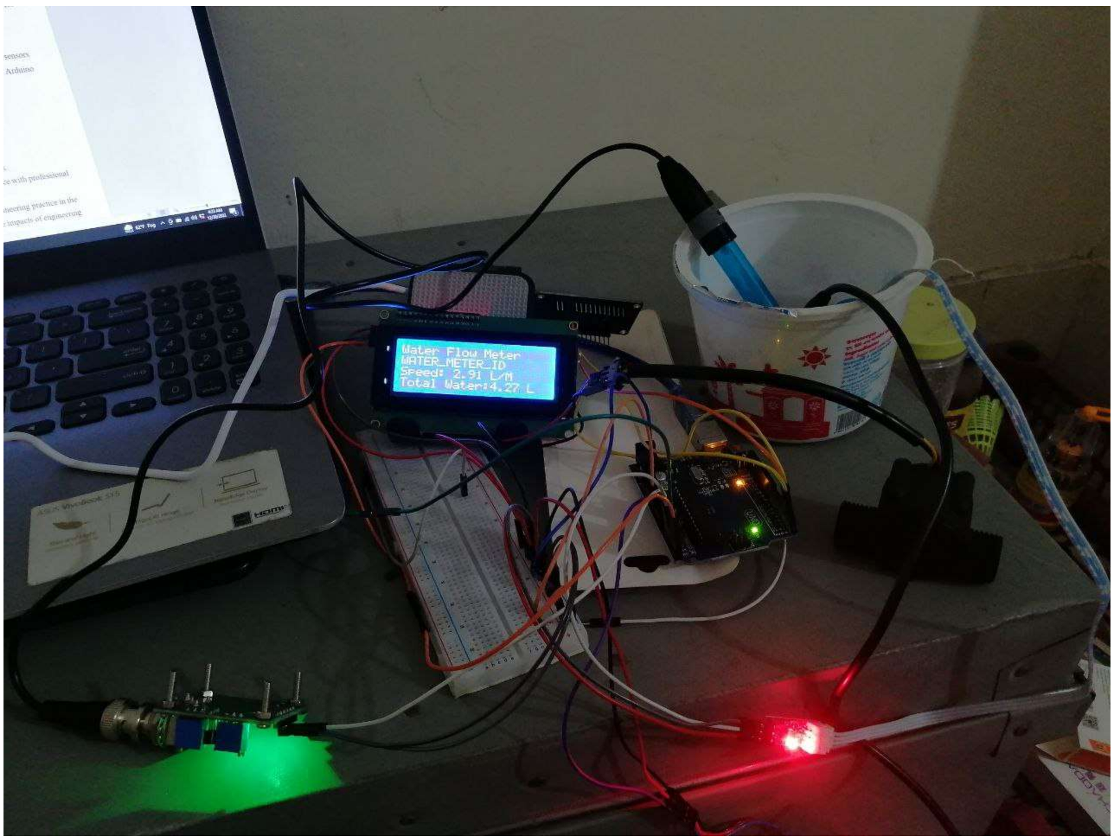


Figure 4.10 Hardware Implementation of Wireless Solutions for Smart Water Metering and Water Quality Monitoring

Overall project hardware implementation is shown in Figure 4.10. Where a microcontroller is positioned at the side of the device which is connected with the laptop to provide enough charge for running the device. The major components of the project are contained around the microcontroller. Such as the water flow sensor is used to measure the flow of water through the tubes which is inserted on a water tube. pH sensor is used for measuring the pH level of the water placed along with the water flow sensor on a water tube. The turbidity sensor helps to detect the number of wastes on water which is being placed on the water tank.

4.4. Engineering Solution in accordance with professional practices

We presented a comprehensive smart water metering solution that aims at tackling the heterogeneity of protocols and standards in a competitive and proprietary market and to avoid vendor and protocol lock-in. Water Pollution is a major threat to any country, as it affects health, economy and spoils bio- diversity. In this work, causes and effects of water pollution is presented, as well as a comprehensive review of different methods of water quality monitoring and an efficient IoT based method for water quality monitoring has been discussed. Although there have been many excellent smart water quality monitoring systems, still the research area remains challenging. This work presents a review of the recent works carried out by the researchers in order to make water quality monitoring systems smart, low powered and highly efficient such that monitoring will be continuous and alerts/notifications will be sent to the concerned authorities for further processing. The developed model is cost effective and simple to use (flexible). Three water samples are tested and based on the results, the water can be classified whether it is drinkable or not. As a engineer, the suggestion is to use latest sensors for detecting various other parameters of quality, use wireless communication standards for better communication and IoT to make a better system for water quality monitoring and the water resources can be made safe by immediate response.

4.5. Summary

The project was implemented by following all the safety measures. A simulation was being conducted first using the proteus 8 software, where the Arduino was setup as the main microcontroller to run the whole device. All other sensors were connected with it and observed through simulation. The simulated data was being noted. The hardware implementation was done with proper care. The water flow meter sensor, pH sensor, TDS sensor and turbidity sensor was connected with the microcontroller. The microcontroller is powered by a laptop. To control the device from far distance an esp8266MOD is being used to connect the device with the Wi-Fi. The output obtained from the device was being displayed on the LCD display which shows all the readings of the sensors connected. Thus the implementation of the project was successfully completed.

Chapter 5

RESULTS ANALYSIS & CRITICAL DESIGN REVIEW

5.1. Introduction

The outcome analysis phase of any project, which follows circuit implementation, is of utmost importance. Following the hardware and simulation section, this section of the study is essentially a summary of expected outcomes. If the circuit is properly connected, the result will be precise. There are numerous methods for developing wireless solutions for smart water metering and water quality monitoring, according to every analysis that has been done. The best thing about this idea is that it might turn out to be a low-effort way for WASA to make sure that water flow is observed and water quality is properly monitored. This technology is very useful for WASA to supply water with proper quality and quantity and providing a descent water distribution process. Wireless SWaMM serves with several features for water distribution and supply. This smart water metering and water quality monitoring system has proven to measure water flow rate. Water flow sensor is used to measure it. In terms of water quality check, pH meter is used. It helps to identify the water whether it is acidic water or basic water. Then the technology measures the total dissolved solid in water through TDS meter. Moreover, the system is designed with an essential feature of waste reduction along with water analysis through turbidity sensor. Bangladesh is a developing country, and yet many people in Bangladesh live in poverty. However, the smart water metering and water quality monitoring system is a device of minimal cost which will be affordable for WASA to distribute pure water in whole over the country. It has now been established that if this project is conducted, it will undoubtedly beneficial on a great extent.

5.2. Results Analysis

To obtain the result, two different sorts of approaches were used. While the second is a simulation result, the first is a hardware outcome. The project's simulation made it possible to observe the simulation result, and we were successful in receiving the result exactly as the software had anticipated. On the other hand, the hardware findings were gathered via the Arduino IDE serial monitor and the Think speak IoT cloud software. On both ends, data has been gathered from the hardware. In order to value the water quality, the readings from the PH meter, Total Dissolve Solid (TDS) meter, and Turbidity meter have all been thoroughly analyzed. The reading has been provided by both the hardware and the cloud. The areas: R/A, Kuratoli, Kuril Bisho Road, Mirpur 10, Northa, Nikunja and Ghat Par are selected to obtain the result.

5.2.1. Simulated Results

Table 5.1 Simulation result data table

Parameters	Value	Units
Ph Value	6	N/A
TDS	10	ppm
Turbidity	90	NTU

In this table 5.1, a quick analysis of the following circuit simulation outputs will be done. It is only logical to collect and analyze simulation data once the circuit schematic has been implemented. Depending on the situation, users could get different results.

5.2.2. Hardware Results

Both the hardware and simulation outcomes of this project have been accomplished satisfactorily. The circuit is placed within a circuit board that is placed atop a box in order to get the hardware effects. The microcontroller in the circuit connecting all the sensors was an Arduino UNO. The project has a number of outcomes, which are illustrated below in fig 5.1 is hardware result .

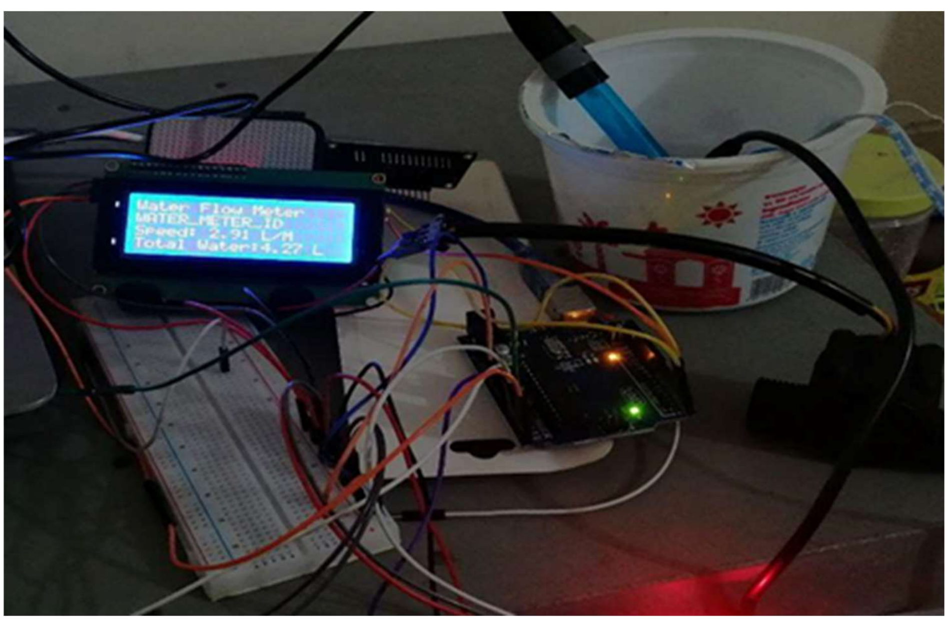


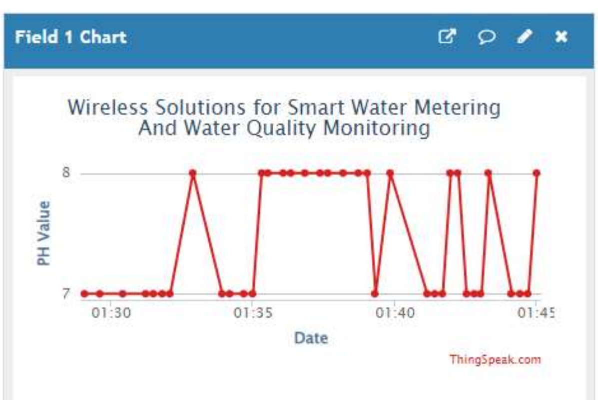
Figure 5.1 Hardware result (Water flow detection, pH measuring, Turbidity value, TDS detection).

Table 5.2. Data collected from hardware implementation.

PH Value	TDS Value	Turbidity	Water vol
7	288	460	6
7	286	192	6
8	288	452	6
7	288	223	6
7	286	199	6
8	288	462	7
7	288	238	7
8	286	183	7
7	288	213	7
8	288	467	7
8	292	375	7
8	290	205	7
8	290	646	8
7	290	205	8

IoT Cloud data of hardware result:

This IoT cloud take data from the hardware on every 15 second. In that case about every data of every 15 second has been send to the server.



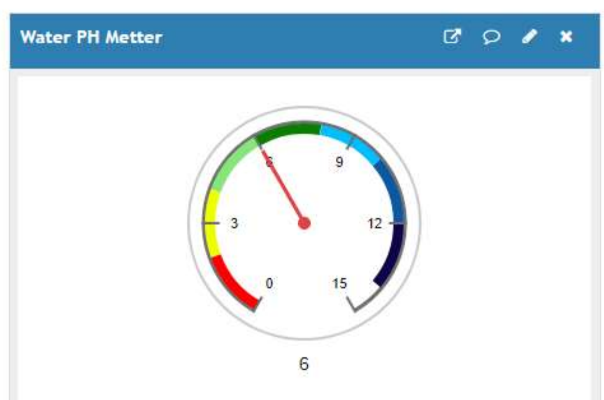


Figure 5.2 Simulated and cloud data result (output result of pH detection by the pH sensor)

Result 1: In fig 5.2 is showing the output result of pH detection which is performed by the pH sensor.

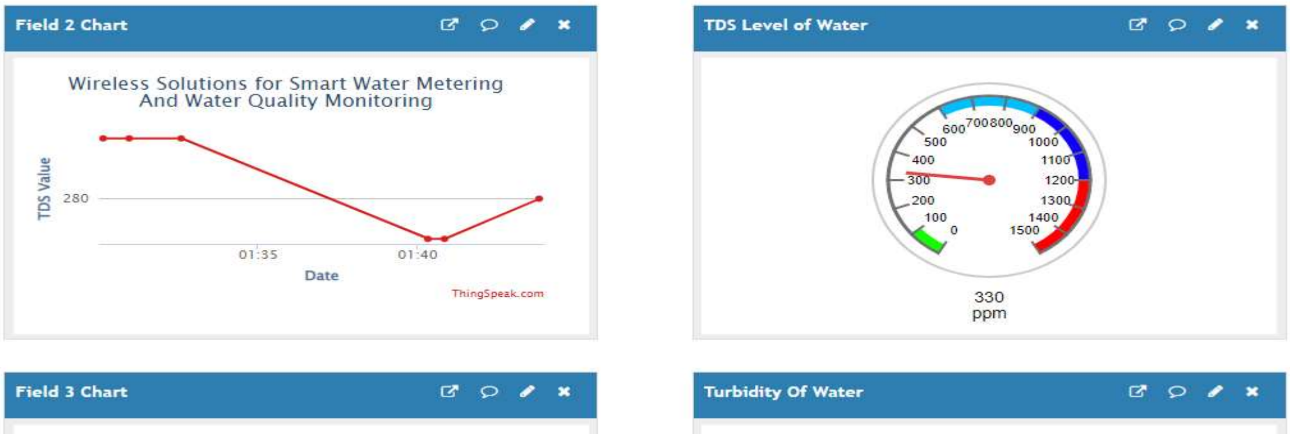


Figure 5.3 Simulated result (output result and cloud data result of total dissolved solids detection by the TDS sensor)

Result 2: In fig 5.3 is showing the output result of total dissolved solids (TDS)

Figure 5.4 Simulated result (output result and cloud data result of turbidity value through the Turbidity sensor)

Result 3: In fig 5.4 is showing the output reading of water flow through the Water Flow Meter sensor.

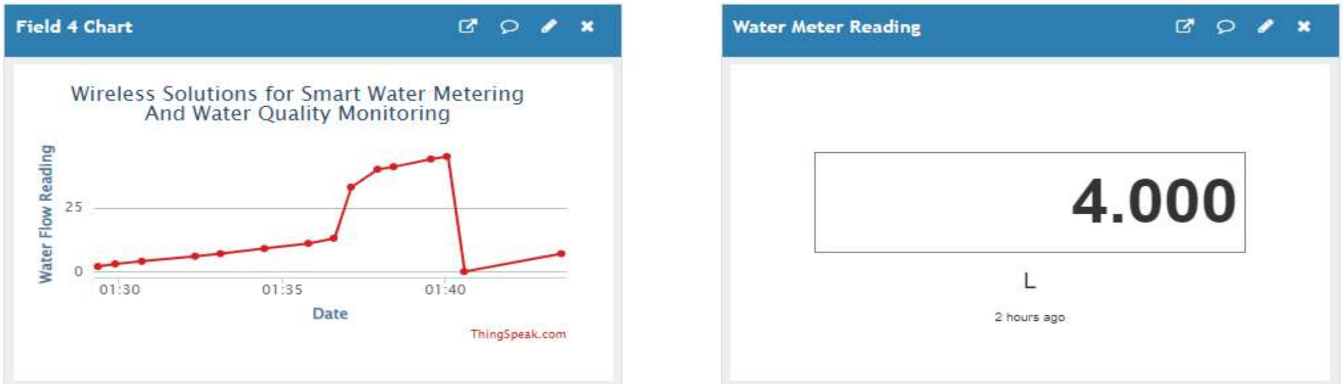


Figure 5.5 Simulated result (output result and cloud data result of water flow through the Water Flow Meter Sensor)

Result 4: In fig 5.5 is showing the output reading of water flow through the Water Flow Meter sensor.

5.3. Comparison of Results

There are several discrepancies between the hardware and simulation results of this research and other developed systems of smart water metering and water quality monitoring. A demonstration of this project is simulation. Hardware is how the project is put into practice. Although the simulation and hardware implementation were practically identical, the results varied slightly. In other parts of the project, the circuit diagram of hardware and simulation is quite the same. Although the whole circuit is placed over the bread board and in the simulation process, we can see the detailed diagram of the circuit. Furthermore, the results obtained from software is much accurate than the results gained from hardware. During the hardware process several factors may affect the process such as signal delay, power supply deficiency, lose connection, sensors heating issue etc. Apart these, the results from IDE serial monitor and cloud data are almost same. Fig 5.6 – 5.9 shown the comparison between sensor data of IDE serial monitor with web server value.

PH Value	TDS Value	Turbidity	Water vol
7	288	460	6
7	286	192	6
8	288	452	6
7	288	223	6
7	286	199	6
8	288	462	7
7	288	238	7
8	286	183	7
7	288	213	7
8	288	467	7
8	292	375	7
8	290	205	7
8	290	646	8
7	290	205	8

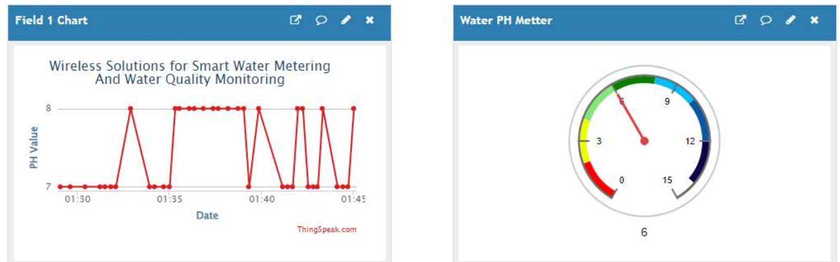


Figure 5.6 Comparison of pH reading

PH Value	TDS Value	Turbidity	Water vol
7	288	460	6
7	286	192	6
8	288	452	6
7	288	223	6
7	286	199	6
8	288	462	7
7	288	238	7
8	286	183	7
7	288	213	7
8	288	467	7
8	292	375	7
8	290	205	7
8	290	646	8
7	290	205	8

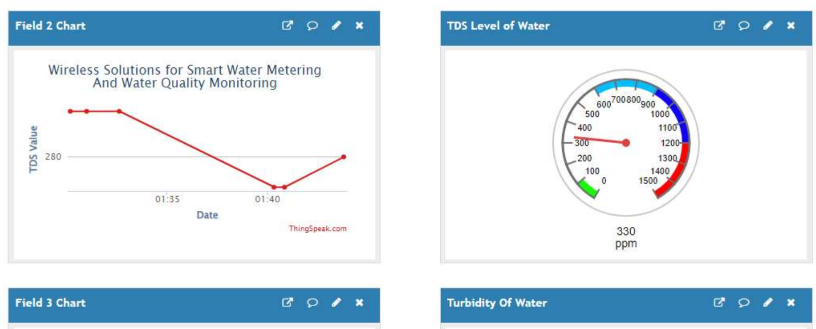


Figure 5.7 Comparison of TDS value

PH Value	TDS Value	Turbidity	Water vol
7	288	460	6
7	286	192	6
8	288	452	6
7	288	223	6
7	286	199	6
8	288	462	7
7	288	238	7
8	286	183	7
7	288	213	7
8	288	467	7
8	292	375	7
8	290	205	7
8	290	646	8
7	290	205	8

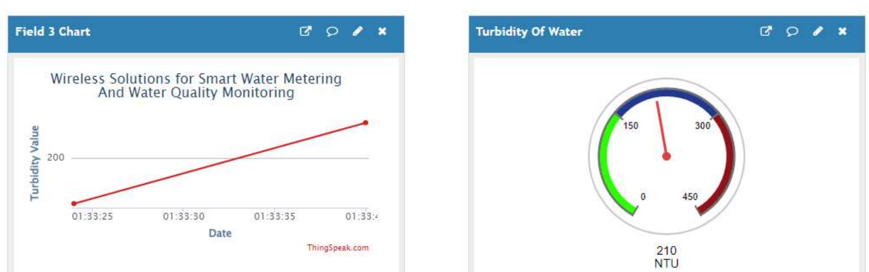
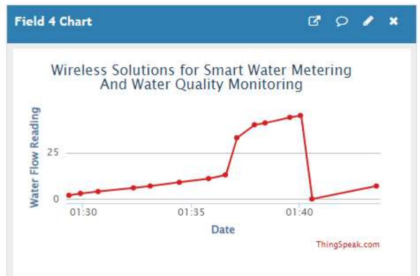


Figure 5.8 Comparison of turbidity value

PH Value	TDS Value	Turbidity	Water vol
7	288	460	6
7	286	192	6
8	288	452	6
7	288	223	6
7	286	199	6
8	288	462	7
7	288	238	7
8	286	183	7
7	288	213	7
8	288	467	7
8	292	375	7
8	290	205	7
8	290	646	8
7	290	205	8



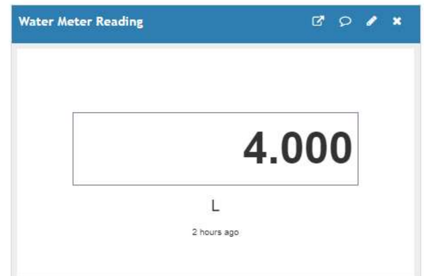


Figure 5.9 Comparison of water flow reading

5.4. Summary

On the basis of the result which have collected from both Arduino IDE serial monitor as well as thinkspeak IoT cloud, it could be say that both data are quite similar. From the IDE data sheet the visible PH value, TDS value, turbidity value, and water volume is similar to the IoT cloud result. As IoT cloud took every 15 second data from Arduino UNO through NodeMCU because of that few data error has occurred on the IoT based cloud. This cloud is also a server which can also monitor both privately and publicly. If anyone wants to observe this server privately they can observe it or if anyone wants to observe it publicly then anyone can observe the data as well as other information they can monitor it. The data which is shown in the thinkspeak IoT based server there for PH value is shown in different colour which indicates the the range of good water or which is good for drink or water quality say if the diet of the pH meter come to read on which is red zone which means the water quality is not good it is acidic water as well as if that indicator comes to the deep blue colour section then it mean it is alkaline which mean it is not good for drinking if the dial at green zone then the water is good which means it indicate the water level is at 7 which is which mean it is good. Same for the TDS reading and turbidity reading. Finally, the water meter reading which is the water volume it is in the digital reading meter with indicates how much water is flowing through the water flow meter. So it can we say that the way of getting the output is quite useful for both the user consumer as well as supplier or distributor.

Chapter 6

CONCLUSION

6.1. Summary of Findings

At this moment, it is possible to say that the project aims of creating and implementing Wireless SWaMM, a Middleware Solutions for Smart Water Metering and water monitoring for observing the water or liquid flow as well as observing the liquid or water quality has been totally completed. This wireless IoT middleware is now a technologically advanced which will inform about the quality, quantity of water and provide WASA with the best experience on water monitoring. When designing and carrying out this project, we made sure to use a method that was both economical and efficient. It provides consumers with flow sensor for water flow rate measurement, dispenses pH meter is for ensuring the water quality check. Then the technology helps to indicate Total Dissolved Solids in water using TDS meter. It also comes with a turbidity sensor to identify the clarity and particle content in water in the purpose of reducing waste, improving yields, and analyzing water quality. This project has a reasonable price tag, is trustworthy, consumes a little amount of power while performing all the given task mentioned above.

6.2. Novelty of the work

Every project has its own set of distinctive qualities that distinguish it from other projects, as well as make it more productive and lucrative than those other initiatives. This project now has a contemporary appearance and has reached new heights as a result of the additional modifications. The primary objective of this project is to measure the amount of water supplied to a consumer over a specified period for billing purposes, to track water usage, to measures the quantity (volume) of water and to igniting and exploding through using different technologies. The production cost of this project is being kept in a minimal limit and the maintenance cost is not so many too. This project is one of a kind which is being distinctive from other for some specific reasons. The wireless IoT middleware can handle multipurpose objectives such as water volume measuring, water tracking, water bill reducing, water quality (pH) measuring. Along with these all features, the system, SWaMM Edge Gateways will be used to collect data from other smart meters such as electricity and gas, as far as these smart meters will use supported wireless protocols. The sensors are controlled by the Arduino Uno microcontroller which is connected to the internet via Wi-Fi. Using the internet, Arduino Uno sends and receives the data or command to/from Cloud for performing the real-time operation. A user can control system using web interface. Basically, the project offers an SWaMM was specifically designed for smart water metering applications, its flexible design allows the middleware to be easily adopted for the smart metering of other commodities. Thus, with these distinctive features this wireless smart water metering and water quality monitoring system becomes completely unique from existing related projects.

6.3. Cultural and Societal Factors and Impacts

6.3.1. Cultural and Societal Factors Considered in Design

Special attention has been paid to the cultural and societal factors while constructing this project. This project is very different from other available devices on the market. While production care was taken to make it easy to carry and use for day-to-day life. This device is specially being built keeping in mind the cultural and social factors of Bangladesh. This type of device will be great to use in the household of Bangladesh people. As the number of household drinking water scarcity are increasing day by day with it the demand of testing the water quality has become a concern. To irradicate such issues this device will play a vital role. It will ensure the quality of the supplied water in great extent. This thing sets this project apart from all other projects. All modern equipment's like Arduino, Node MCU, GPRS, Flow sensor, TDS sensor, pH sensor, Turbidity sensor has been installed in this device. First, Arduino serves as a microcontroller, then the water flow meter sensor detects the flow of water passed through the tube. The Node MCU is used as another microcontroller which connects the sensors with Wi-Fi to make the device controllable from far distances too. A pH sensor detects the pH level of the water on the tank which will flow, through this it is possible to know the quality of the water. The turbidity sensor is used to detect the waste present in the water which will flow through the water flow meter. Though this project is completely a new concept in Bangladesh but this is built in such a way that everybody can use it easily. This project will have a significant impact on society. The users using it will have a better and easy way to access water using it. It will lessen the number of water impurity in great extent and provide a safe and better life to the users. This project's technical system is incredibly effective. This project has been completed by a small group of four persons with varying levels of experience and knowledge. The simulation designers are in frequent touch with the rest of the team members.

6.3.2. Cultural and Societal Impacts of the Proposed Design

A water flow meter sensor is employed in the proposed design to detect the speed of water flow, the speed is constantly been displayed on the LCD. The sensors are arranged in a particular way to detect different types of speed, humidity and pH level of the water. The sensors were tried to be implemented on the inside of the water flow meter to have the maximum output. But due to some limitations it has been placed on a demo water tank. A battery charges all these sensors to run properly. Infinite people will be able to get pure water freely and will be protected from any type of bad quality water by using this device. They will be able to have good quality of water without any difficulty. They can have pure water with more safety for daily life uses.

6.4. Engineering Solution in accordance with professional practices

The Wireless Solutions for Smart Water Metering and Water Quality Monitoring was successfully constructed and programmed to meet the requirements, and it has since shown excellent performance. The performance of the device was put to the test by using a variety of challenges, scenarios, and testing it in a variety of settings. The results showed that the device sensors functioned very well. The first thing that has to be considered when analyzing the safety of the user while using it detects the water flow and quality of water. Second, identifying the water flow of the water when they are using the device for water flow from the tank. The third issue that has to be addressed is the detection of pH level of water for examining the quality of water. And lastly connecting all the sensors with the Wi-Fi on internet.

6.5. Limitations of the Work

The technology of wireless smart water metering and water quality monitoring system has the potential to monitor water flow and to observe water quality. However, there are certain restrictions placed on the project. At this moment, the system is not able to provide output in every possible circumstance, and it may be more difficult to get the ideal output at the same time every time. However, if the design and implementation are done correctly, it is feasible to position the whole circuit in a single orientation the system will look more compact which will make it more user pleasant. On the other hand, the input approach used in this project brings up concerns that are not pertinent when using standard input. To measure water quality, pH sensor requires steady water pressure to function, which is not often the case in developing nations like Bangladesh. In addition, after implementing the system by WASA, customers would be required to pay for all water used (as indicated by the meter reading), even if some of it was lost due to leaks also If families with higher-than-average water consumption use a volume-based water meter instead of paying a flat monthly fee, they will probably spend more money on water. Due to the difficulty in predicting shifting water bills, customers may underestimate their water usage and the amount owed.

6.6. Future Scopes

By introducing a more effective programming approach that will be able to use the data more efficiently, the main focus of the following development will be on improving the performance of the system and lowering the amount of mistake. However, using higher-grade sensors to lessen the amount of mistake has the potential to greatly increase the usability of this project. Moreover, this platform is open and flexible, allowing for the addition of additional (bio) electrochemical sensors in the future (such as cutting-edge pH sensors or particular sensors for trihalomethanes, a common hazardous consequence of chlorine disinfection). It is clear that the water distribution network would greatly benefit from the downsizing and distribution of high-resolution sensors. By combining sensors and adding more features, it is possible to detect arsenic in water sources. Future work will include the creation of a dedicated OCR solution for dumb water meters that could provide better accuracy as well as the realization of a significantly improved version of the Optical Reader Kit, based on a low-power computing platform that allows it to operate for about 2 years on a couple of AA batteries. These efforts will be made in addition to the experimentation with new water meter models and more complex water leakage detection algorithms.

6.7. Social, Economic, Cultural and Environmental Aspects

6.7.1. Sustainability

The Wireless Solutions for Smart Water Metering and Water Quality Monitoring was successfully constructed to meet the requirements, and it has since shown excellent performance. The performance of the smart water metering and monitoring device was put to test by using a variety of challenges, scenarios and it functioned very well. The first thing that has to be considered when analyzing the quality of the water that the pH sensor and turbidity sensor detects and works properly in every condition. Secondly, identifying the flow of water should be properly examined. Lastly, connecting all the sensors through Wi-Fi to control it from remote distances. This will help the user for having water in sustainable amount and with less impurities.

6.7.2. Economic and Cultural Factors

The Wireless Solutions for Smart Water Metering and Water Quality Monitoring was successfully constructed to meet the requirements, and it has since shown excellent performance. The performance of the smart water metering and monitoring device was put to test by using a variety of challenges, scenarios and it functioned very well. The first thing that has to be considered when analyzing the quality of the water that the pH sensor and turbidity sensor detects and works properly in every condition. Secondly, identifying the flow of water should be properly examined. Lastly, connecting all the sensors through Wi-Fi to control it from remote distances. This will help the user for having water in sustainable amount and with less impurities.

6.8. Conclusion

The Wireless Solutions for Smart Water Metering and Water Quality Monitoring is a project which was developed to provide people with adequate amount of water and fresh water free from impurities. This project is a revolution in the sector of clean water which is able to provide people with water that is required for specific work. It was considered to be used as device to measure the flow of water for regular life use to save water from wastage, another important use of this device is to measure the pH level of water which will determine the quality of the water. These goals were successfully achieved using all the necessary sensors for determining the water flow, pH and turbidity of the water. The sensors were all controlled by a microcontroller to combine them together and work all along. Another microcontroller was being used to connect the sensors to Wi-Fi to make it wireless and easy to use from any where needed. This project serves the goal very drastically well to eradicate the problem of impure water and wastage of water. Thus, the project was successful and can bring the change in daily life of people if used properly.

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Appendix A

Datasheet of the ICs used

Arduino Uno

Overview

The Arduino Uno SMD is a version of the Arduino Uno, but uses an surface mount version of the Atmega328P instead of the through-hole version. This version was made in response to a shortage in supply of the through-hole Atmega328P. The board is based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards.

Figure 1: Top View Of Arduino Uno

Figure 2: Bottom View Of Arduino Uno

Summary

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)

Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

Power

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically.
External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.
The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.
The power pins are as follows:

VIN: The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
5V: The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply.
3V3: A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
GND. Ground pins.

Memory

The ATmega328 has 32 KB (with 0.5 KB used for the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

Input and Output

Each of the 14 digital pins on the Uno can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.

External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.

PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite() function.

SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.

LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Uno has 6 analog inputs, labeled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analogReference() function. Additionally, some pins have specialized functionality:

I2C: A4 (SDA) and A5 (SCL). Support I2C (TWI) communication using the Wire library. There are a couple of other pins on the board:

AREF. Reference voltage (**0 to 5V only**) for the analog inputs. Used with analogReference().

Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

See also the mapping between Arduino pins and ATmega328 ports.

Communication

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega8U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '8U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A SoftwareSerial library allows for serial communication on any of the Uno's digital pins.

The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation for details. For SPI communication, use the SPI library.

Programming

The Arduino Uno can be programmed with the Arduino software (download). Select "Arduino Uno from the **Tools > Board** menu (according to the microcontroller on your board). For details, see the reference and tutorials.

The ATmega328 on the Arduino Uno comes preburned with a bootloader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C header files).

You can also bypass the bootloader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header; see these instructions for details.

The ATmega8U2 firmware source code is available . The ATmega8U2 is loaded with a DFU bootloader. The Uno SMD has a pulldown resistor tying the HWB pin to ground, so all that's needed to enter DFU mode is to briefly short enough to short pins 5 and 6 of the 8U2 icsp connector. This will connect the

8U2 reset pin to ground. You can then use Atmel's FLIP software (Windows) or the DFU programmer (Mac OS X and Linux) to load a new firmware. Or you can use the ISP header with an external programmer (overwriting the DFU bootloader). See this user-contributed tutorial for more information.

Automatic (Software) Reset

Rather than requiring a physical press of the reset button before an upload, the Arduino Uno is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2 is connected to the reset line of the ATmega328 via a 100 nano-farad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino software uses this capability to allow you to upload code by simply pressing the upload button in the Arduino environment. This means that the bootloader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload.

This setup has other implications. When the Uno is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data.

The Uno contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it. It's labeled "RESET-EN". You may also be able to disable the auto-reset by connecting a 110 ohm resistor from 5V to the reset line; see this forum thread for details.

USB Overcurrent Protection

The Arduino Uno has a resettable polyfuse that protects your computer's USB ports from shorts and overcurrent. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.

Physical Characteristics

The maximum length and width of the Uno PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Four screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16"), not an even multiple of the 100 mil spacing of the other pins.

NodeMCU

NodeMCU is an open source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module. The term “NodeMCU” by default refers to the firmware rather than the DevKit. The firmware uses the Lua scripting language. It is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266. It uses many open source projects, such as lua-cjson, and spiffs.

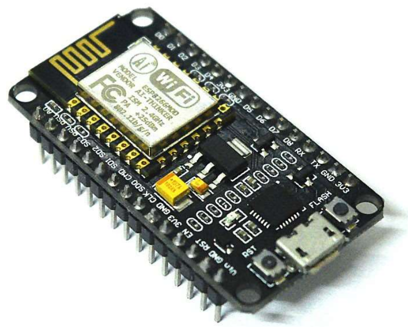
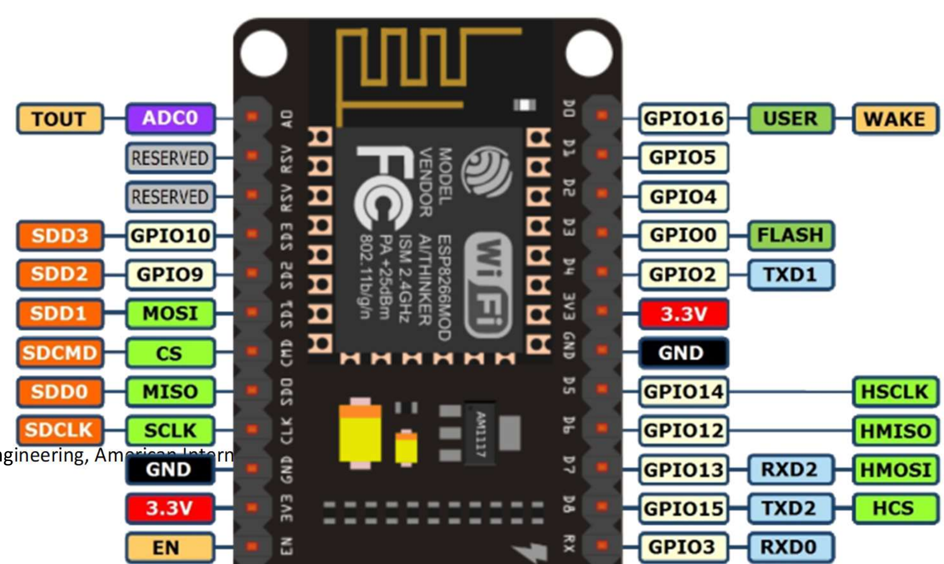


Figure 3: NodeMCU

Features

1. Version : DevKit v1.0
2. Bread board Friendly
3. Light Weight and small size.
4. 3.3V operated, can be USB powered.
5. Uses wireless protocol 802.11b/g/n.
6. Built-in wireless connectivity capabilities.
7. Built-in PCB antenna on the ESP-12E chip.
8. Capable of PWM, I2C, SPI, UART, 1-wire, 1 analog pin.
9. Uses CP2102 USB Serial Communication interface module.
10. Arduino IDE compatible (extension board manager required).
11. Supports Lua (alike node.js) and Arduino C programming language.

PINOUT DIAGRAM



pH Sensor

Our pH Sensor can be used for any lab or demonstration that can be done with a traditional pH meter, including: acid-base titrations, monitoring pH in an aquarium, and investigating the water quality of streams and lakes.

General

The pH Sensor measures the pH of aqueous solutions in industrial and municipal process applications. It is designed to perform in the harshest of environments, including applications that poison conventional pH sensors. All seals are dual o-ring using multiple sealing materials. The sensor is designed for use with the Omega PHTX-45 Monitor/Analyzer.

Sensor Features

A high volume, dual junction saltbridge is utilized to maximize the in-service lifetime of the sensor. The annular junction provides a large surface area to minimize the chance of fouling. Large electrolyte volume and dual reference junctions minimize contamination of the reference solution. The saltbridge is replaceable.

- The reference element of the sensor is a second glass pH electrode immersed in a reference buffer solution. This glass reference system greatly increases the range of sensor applications.
- An integral preamplifier is encapsulated in the body of the sensor. This creates a low impedance signal output which ensures stable readings in noisy environments and increases the maximum possible distance between sensor and transmitter to 3,000 feet (914 meters).
- System diagnostics warn the user in the event of electrode breakage, loss of sensor seal integrity or integral temperature element failure.
- Pt1000 RTD. The temperature element used in the PHE-45P sensor is highly accurate and provides a highly linear output.

Sensor Specifications

1. **Measuring Range** 0 to 14.00 pH
2. **Sensitivity** 0.002 pH
3. **Stability** 0.02 pH per 24 hours, non-cumulative
4. **Wetted Materials** PEEK, ceramic, titanium, glass, Viton, EDPM (optional: 316 stainless steel with 316SS body)
5. **Temperature Compensation** Pt1000 RTD
6. **Sensor Cable** 6 Conductor (5 are used) plus 2 shields,15 feet (4.6 meters) length standard
7. **Temperature Range** -5 to +95 °C (23 to 203 °F)
8. **Pressure Range** 0 to 100 psig
9. **Maximum Flow Rate** 10 feet (3 meters) per second
10. **Max. Sensor-Analyzer Distance** 3,000 feet (914 meters)
11. **Sensor Body Options** 1" NPT convertible, 1¼" insertion, 1½" or 2" sanitary-style
12. **Weight** 1 lb. (0.45 kg)

TDS Sensor

General

TDS (Total Dissolved Solids) indicates that how many milligrams of soluble solids dissolved in one liter of water. In general, the higher the TDS value, the more soluble solids dissolved in water, and the less clean the water is. Therefore, the TDS value can be used as one of the references for reflecting the cleanliness of water.

TDS pen is a widely used equipment to measure TDS value. The price is affordable, and it is easy to use, but it is not able to transmit data to the control system for online monitoring to do some water quality analysis. The professional instrument has high accuracy and can send data to the control system, but the price is expensive for the ordinary people. To this end, we have launched an analog TDS sensor kit which is compatible with Arduino, plug and play, easy to use. Matching with Arduino controller, you can build a TDS detector easily to measure the TDS value of liquid.

This product supports 3.3 ~ 5.5V wide voltage input, and 0 ~ 2.3V analog voltage output, which makes it compatible with 5V or 3.3V control system or board. The excitation source is AC signal, which can effectively prevent the probe from polarization and prolong the life of the probe, meanwhile, increase the stability of the output signal. The TDS probe is waterproof, it can be immersed in water for long time measurement.

Specification

Signal Transmitter Board

Input Voltage: 3.3 ~ 5.5V

Output Voltage: 0 ~ 2.3V

Working Current: 3 ~ 6mA

TDS Measurement Range: 0 ~ 1000ppm

TDS Measurement Accuracy: ± 10% F.S. (25 Ḫ)

Module Size: 42 * 32mm

Module Interface: PH2.0-3P

Electrode Interface: XH2.54-2P

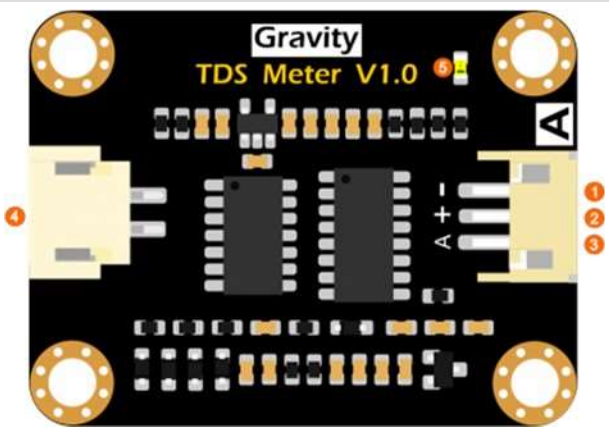
TDS probe

Number of Needle: 2 Total Length: 83cm

Connection Interface: XH2.54-2P Colour: Black

Other: Waterproof Probe

Board Overview



Num	Label	Description
1	-	Power GND(0V)
2	+	Power VCC(3.3 ~ 5.5V)
3	A	Analog Signal Output(0 ~ 2.3V)
4	TDS	TDS Probe Connector
5	LED	Power Indicator

Turbidity sensor

General

Turbidity sensor is a photoelectric turbidity sensor with analog signal output. It is powered by 5VDCwith low power consumption and uses infrared light source with wavelength of 940nm. The light emitted by the source will pass through the target liquid and received by the light detector in the senor. The light intensity is measured by the light detector and converted to analog signal to represent the turbidity of target liquid.AZDM01 is designed to be able measure the turbidity in real-time. AZDM01 has outstanding features, such as simple structure, snap installation, waterproof, fast response, high reliability and stability, low cost, simple drive circuit etc.

Working Principle

Turbidity has a built-in light detector and a light-emitting element as infrared light source. The target liquid flows in the direction indicated by the blue arrow and the emitted light pass through the liquid indicated by the red arrow. The light intensity is reduced due to the absorption in liquid and the absorption rate depends on the liquid turbidity, thus, the light intensity detected by the light detector is varied by the turbidity of liquid. The turbidity can be derived based on the output signal of the light detector.

Sensor Specification

1. Supply voltage — DC:5.0 V (4.8-5.5 V)
2. Minimum supply current — 20 mA
3. Typical supply current — 25 mA
4. Maximum supply current — 50 mA
5. Typical power — 125 mW
6. Sampling period — >= 100 ms/time
7. Output method — Analog signal
8. Warm-up time — >= 100 ms
9. Operating temperature — 4℃～85℃
10. Working humidity — 0～95%RH
11. Service life — >10 years (25℃)

Num	Label	Description
1	+	Power VCC(3.3 ~ 5.5V)
2	-	Power GND(0V)
3	A	Output Signal

Water Flow Sensor

General

Water flow sensor consists of a plastic valve body, a water rotor, and a hall-effect sensor. When water flows through the rotor, rotor rolls. Its speed changes with different rate of flow. The hall effect sensor outputs the corresponding pulse Signal.

Sensor Components

No.	Name	Quantity	Material	Note
1	Valve body	1	PA66+33%glass fiber	
2	Stainless steel bead	1	Stainless steel SUS304	
3	Axis	1	Stainless steel SUS304	
4	Impeller	1	POM	
5	Ring magnet	1	Ferrite	
6	Middle ring	1	PA66+33%glass fiber	
7	O-seal ring	1	Rubber	
8	Electronic seal ring	1	Rubber	
9	Cover	1	PA66+33%glass fiber	
10	Screw	4	Stainless steel SUS304	3.0*11
11	Cable	1	1007 24AWG	

Specification

items	value
Mini. Wokring Voltage	DC 4.5V
Max. Working Current	15mA(DC 5V)

Working Voltage	5V～24V
Flow Rate Range	1～30L/min
Load Capacity	≤10mA(DC 5V)
Operating Temperature	≤80Ḥ
Liquid Temperature	≤120Ḥ
Operating Humidity	35%～90%RH
Water Pressure	≤2.0MPa
Storage Temperature	-25Ḥ～+80Ḥ
Storage Humidity	25%～95%RH

Reading Water Flow rate with Water Flow Sensor

This is part of a project I have been working on and I thought I would share it here since there have been a few threads on how to read water flow rate in liters per hour using the Water Flow Sensor found in the Seeed Studio Depo. It uses a simple rotating wheel that pulses a hall effect sensor. By reading these pulses and implementing a little math, we can read the liquids flow rate accurate to within 3%. The threads are simple G¾ so finding barbed ends will not be that hard.

Appendix B

iThenticate Plagiarism Report

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ORIGINALITY REPORT

15%
SIMILARITY INDEX

PRIMARY SOURCES

1	Varsha Lakshmikantha, Anjitha Hiriyannagowda, Akshay Manjunath, Aruna Patted, Jagadeesh Basavaiah, Audre Arlene Anthony. "IoT based Smart Water Quality Monitoring System", Global Transitions Proceedings, 2021 Crossref	308 words —	2%
2	link.springer.com Internet	251 words —	2%
3	www.ncbi.nlm.nih.gov Internet	152 words —	1%
4	Aritra Ray, Shreemoyee Goswami. "IoT and Cloud Computing based Smart Water Metering System", 2020 International Conference on Power Electronics & IoT Applications in Renewable Energy and its Control (PARC), 2020 Crossref	113 words —	1%
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6	www.coursehero.com Internet	99 words —	1%

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8	Nelson Pimenta, Paulo Chaves. "Study and design of a retrofitted smart water meter solution with energy harvesting integration", Discover Internet of Things, 2021 Crossref	57 words — < 1%
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10	Raad AL-Madhrahi, Nayef.A.M. Alduais, Jiwa Abdullah, Hairulnizam B. Mahdin et al. "An Efficient IoT-based Smart Water Meter System of Smart City Environment", International Journal of Advanced Computer Science and Applications, 2021 Crossref	54 words — < 1%
11	"Technical Advancements of Machine Learning in Healthcare", Springer Science and Business Media LLC, 2021 Crossref	48 words — < 1%
12	Saroja Kumar Rout, Bibhuprasad Sahu, Brojo Kishore Mishra, Nalinikanta Routray, Pradyumna Kumar Mohapatra. "Chapter 22 Intelligent Cloud and IoT-Based Voice-Controlled Car", Springer Science and Business Media LLC, 2023 Crossref	43 words — < 1%
13	www.powtoon.com Internet	43 words — < 1%
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15	Anisha, R Ankith Menon, Archana Prabhakar. "Electronically controlled water flow restrictor to limit the domestic wastage of water", 2017 International conference on Microelectronic Devices, Circuits and Systems (ICMDCS), 2017 Crossref	30 words — < 1%
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25 S Satheesh Kumar, A Abhishek, R Deepak Raj, S N T Gokul, Pradeep Pushpanathan. "IoT based Novel Portable Water Quality Monitoring for Micro Industries", 2022 6th International Conference on Devices, Circuits and Systems (ICDCS), 2022 16 words — < 1%
Crossref

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27 Saed Tarapiah, Shadi Atalla. "Public Transportation Management System based on GPSWiFi and Open Street Maps", International Journal of Advanced Computer Science and Applications, 2015 13 words — < 1%
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28 Hoan Nguyen Duc, Thao Nguyen Manh, Huy Trinh Le, Fabien Ferrero. "Research and Implement Embedded Artificial Intelligence in Low-Power Water Meter Reading Device", 2021 International Conference on Advanced Technologies for Communications (ATC), 2021 12 words — < 1%
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