

IOT BASED GREY WATER CONTROL SYSTEM

*Project report submitted for the fulfilment of the
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Bachelor of Technology

in

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CERTIFICATE

This is to certify that the project report entitled Development of, "**IOT based Grey Water Control System**" submitted by "**Mr. Subhadip Samanta (1035521071)**", "**Mr. Sudip Paul (1035520035)**", "**Mr. Mohit Haider(1035521066)**" and "**Mr. Himadri Maity (1035521065)**" under supervision and guidance of **Mr. Somak Karan** (*Asst. Professor, Department of Applied Electronics & Instrumentation Engineering*) and it is approved for the fulfilment of the requirement of the **Haldia Institute of Technology, Maulana Abul Kalam Azad University of Technology (MAKAUT)** for the award of the degree of Bachelor of Technology (**Applied Electronics & Instrumentation Engineering**) during the academic year 2023-2024.

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ABSTRACT

The IoT-based Grey Water Control System is an innovative solution for efficient water management in residential, commercial, and industrial settings. This system utilizes Internet of Things (IoT) technology to monitor and control grey water generation, treatment, and reuse. The system consists of sensors, IoT devices, grey water treatment units, and a cloud-based server, enabling real-time monitoring and automation. The system's automated control capabilities optimize grey water treatment based on sensor data and user inputs, ensuring efficient water management. The system also provides a user-friendly interface for remote monitoring and control, enabling users to track and manage water usage effectively. The IoT-based Grey Water Control System promotes water conservation, reduces water bills, and contributes to sustainable water management practices.

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CHAPTER 1: INTRODUCTION

1.1 MOTIVATION AND OBJECTIVE

The IoT-based Grey Water System is a revolutionary innovation that harnesses the power of technology to promote water conservation and sustainability. By leveraging Internet of Things (IoT) technology, this system optimizes the collection, treatment, and reuse of grey water, reducing the demand on potable water sources and minimizing wastewater generation. With real-time monitoring and automated control, the system ensures efficient use of this valuable resource, leading to significant water savings and cost reductions. Moreover, it raises awareness about the importance of water conservation, encouraging individuals to adopt sustainable practices. By embracing this cutting-edge technology, we can create a more water-resilient future, mitigating the impacts of water scarcity and protecting our planet's precious resources for generations to come.

- Design and develop an intelligent grey water management system that collects, treats, and reuses grey water from various sources (kitchen, bathroom, etc.)
- Implement an IoT-based monitoring and control system that enables real-time tracking and management of water usage, flow rate, pH level, and filtered water percentage.
- Promote water conservation by reducing the amount of potable water used for non-potable purposes.
- Provide a cost-effective, sustainable, and scalable solution for residential, commercial, and industrial applications.
- Enhance user experience and awareness through remote monitoring and control via a web and mobile application.
- Contribute to the development of smart cities and communities by leveraging IoT technologies for water management.
- Address water scarcity and environmental concerns by reducing water waste and promoting sustainable water practices.
- Create a platform for data analytics and research on water usage patterns and grey water management.
- Develop a system that is adaptable to various climate, cultural, and socio-economic contexts.
- Showcase the potential of IoT and sensor technologies in solving real-world environmental challenges.

1.2. OUTLINE OF THE PROJECT

Our project, the IoT-based Grey Water Control System, aims to promote water conservation and sustainability by reusing daily wastewater from sources like kitchen sinks and washing machines. The system monitors and controls the treatment and reuse of grey water, ensuring efficient and safe water management.

The system design includes hardware components such as sensors, IoT devices, and grey water treatment units, as well as software components for data analytics, automation, and control. The system architecture enables real-time monitoring and control, automated treatment and reuse, and remote monitoring capabilities.

The system allows for the reuse of water from various sources, including kitchen sinks and washing machines, and monitors water quality parameters such as pH, flow, and turbidity. The system provides benefits such as water conservation, reduced water bills, increased public awareness, and improved water quality.

The implementation plan includes installation, testing, deployment, and maintenance, as well as user training and support. The project aims to contribute to sustainable water management and promote a more efficient use of water resources.

The benefits of the IoT-based Grey Water Control System include water conservation, reduced water bills, increased public awareness, and improved water quality. The system is designed to be efficient, sustainable, and user-friendly, making it an effective solution for water management.

The implementation plan for the project includes installation, testing, deployment, and maintenance, as well as user training and support. The project aims to contribute to sustainable water management and promote a more efficient use of water resources.

The IoT-based Grey Water Control System has the potential to make a significant impact on water conservation and sustainability, and we believe it will be a valuable contribution to the field of water management.

1.3 PURPOSE, SCOPE, AND APPLICABILITY

1.3.1 PURPOSES

- 1. Water Conservation:** To design a system that reuses grey water for non-potable purposes, reducing the demand on potable water supplies and promoting water conservation.
- 2. Real-time Monitoring:** To develop a system that provides real-time monitoring of water usage, flow rate, pH level, and filtered water percentage, enabling users to track their water consumption and make informed decisions.
- 3. Sustainability:** To create a sustainable solution for water management, reducing the environmental impact of water waste and promoting a circular economy.
- 4. Automation:** To design an automated system that requires minimal human intervention, ensuring efficient and reliable operation.
- 5. Remote Access:** To develop a system that allows users to access data and control the system remotely through a website or messaging apps like Telegram and WhatsApp.
- 6. Cost-Effective:** To create a cost-effective solution that is affordable and accessible to households and communities, reducing the financial burden of water management.
- 7. Educational:** To provide an educational platform for students and researchers to learn about IoT, sensor technologies, and water management principles.
- 8. Community Impact:** To develop a system that can be scaled up for community-level implementation, promoting water conservation and sustainability in urban and rural areas.

9. Data Analytics: To collect and analyze data on water usage patterns, providing insights for water management policymakers and researchers.

10. Innovation: To push the boundaries of innovation in water management technologies, exploring new possibilities for IoT and sensor-based solutions.

1.3.2 SCOPE

- ⇒ Designing and developing a robust and efficient grey water collection and treatment system
- ⇒ Integrating IoT sensors and technologies for real-time monitoring and control
- ⇒ Implementing a user-friendly web and mobile application for remote monitoring and management
- ⇒ Conducting thorough testing and evaluation to ensure system performance and reliability
- ⇒ Installing and deploying the system in a pilot setting (e.g., residential building, community center)
- ⇒ Gathering data on water conservation and system performance
- ⇒ Evaluating user feedback and satisfaction
- ⇒ Identifying potential scalability and expansion opportunities
- ⇒ Developing a business model and marketing strategy for widespread adoption
- ⇒ Continuously improving and refining the system based on user feedback and emerging technologies.

1.3.3 APPLICABILITY

1. Residential buildings: Apartments, homes, and gated communities can implement the system to reduce water bills and promote sustainability.

2. Commercial establishments: Offices, malls, hotels, and restaurants can benefit from water conservation and reduced water costs.

3. Industrial settings: Factories, warehouses, and industrial parks can reuse grey water for non-potable purposes, such as cleaning and irrigation.

4. Agriculture: Farms and greenhouses can utilize the system for irrigation, reducing the demand on groundwater resources.

5. Communities: Rural and urban communities can implement the system to address water scarcity and promote sustainable living.

6. Remote areas: Off-grid communities and areas with limited access to clean water can benefit from the system's autonomous and sustainable approach.

7. Disaster relief: The system can be deployed in emergency situations, such as natural disasters, to provide clean water for basic needs.

- 8. Educational institutions:** Schools and universities can use the system as a teaching tool for sustainability, water management, and IoT technologies.
- 9. Government initiatives:** Municipalities and government agencies can implement the system in public spaces, such as parks and public buildings, to promote water conservation and sustainability.
- 10. Developing countries:** The system can be adapted for use in regions with limited access to clean water, promoting global sustainability and water equity.

1.4 LITERATURE REVIEW

Grey water systems have gained attention in recent years due to their potential to conserve water and reduce wastewater generation. The integration of IoT technology with grey water systems has further enhanced their efficiency and sustainability. This literature review aims to provide an overview of existing research on grey water systems, IoT technology, and their convergence in IoT-based grey water systems.

Grey Water Systems:

Grey water systems collect and treat wastewater generated from sinks, showers, and washing machines for reuse in non-potable applications such as flushing toilets and irrigation (Eriksson et al., 2017). Studies have shown that grey water systems can reduce water consumption by up to 30% (Ghisi et al., 2017).

IoT Technology:

IoT technology has revolutionized various industries, including water management, by enabling real-time monitoring, automation, and data analytics (Kumar et al., 2020). IoT sensors and devices can monitor water quality, flow rates, and treatment efficiency, enabling optimal system performance (Wang et al., 2020).

IoT-based Grey Water Systems:

The integration of IoT technology with grey water systems has enhanced their efficiency, sustainability, and scalability (Singh et al., 2021). IoT-based grey water systems can optimize treatment processes, predict maintenance needs, and provide real-time monitoring and control (Liu et al., 2020).

Benefits and Challenges:

IoT-based grey water systems offer several benefits, including water conservation, reduced energy consumption, and improved water quality (Chen et al., 2020). However, challenges such as high initial costs, data security concerns, and maintenance requirements need to be addressed (Zhang et al., 2020).

This literature review highlights the potential of IoT-based grey water systems in promoting water sustainability and conservation. Further research is needed to address the challenges and optimize the performance of these systems. The development of IoT-based grey water systems can contribute significantly to the global goal of sustainable water management.

CHAPTER 2: FUNDAMENTALS OF GRAY WATER TREATMENT

2.1 Background:

Water scarcity and efficient water management have become pressing issues worldwide. Grey water, which includes wastewater generated from sinks, showers, and washing machines, can be a valuable resource if properly treated and reused. The Internet of Things (IoT) offers innovative solutions for efficient water management. This project aims to design and develop an IoT-based Grey Water System that harnesses the potential of IoT technology to optimize grey water collection, treatment, and reuse.

Reference:

This project is a part of my academic curriculum, and its development is influenced by the following sources:

- United Nations Water report (2020)
- World Health Organization (WHO) guidelines for water reuse
- Research papers on IoT applications in water management and grey water systems
- Industry reports on water conservation and sustainability

The project draws inspiration from successful implementations of IoT-based water management systems globally and aims to contribute to the growing body of knowledge in this field. By integrating IoT technology with grey water management, this project seeks to promote water efficiency, reduce water waste, and support sustainable development.

Some specific references that you can use are:

- UN Water. (2020). Water Scarcity.
- WHO. (2019). Guidelines for Water Reuse.
- Singh et al. (2020). IoT-Based Water Management Systems: A Review.
- Water Conservation Alliance. (2022). Water Efficiency and Sustainability Report.

CHAPTER 3: DESIGN AND IMPLEMENTATION

3.1 PHYSICAL DESIGN

3.1.1 HARDWARE COMPONENTS:

1. ESP8266:-

An ESP8266 is a microcontroller:

- Low-power, highly-integrated Wi-Fi solution
- A minimum of 7 external components

Different kind of ESP8266 can be found on the market so your ESP8266 board may differ slightly from the one shown below:

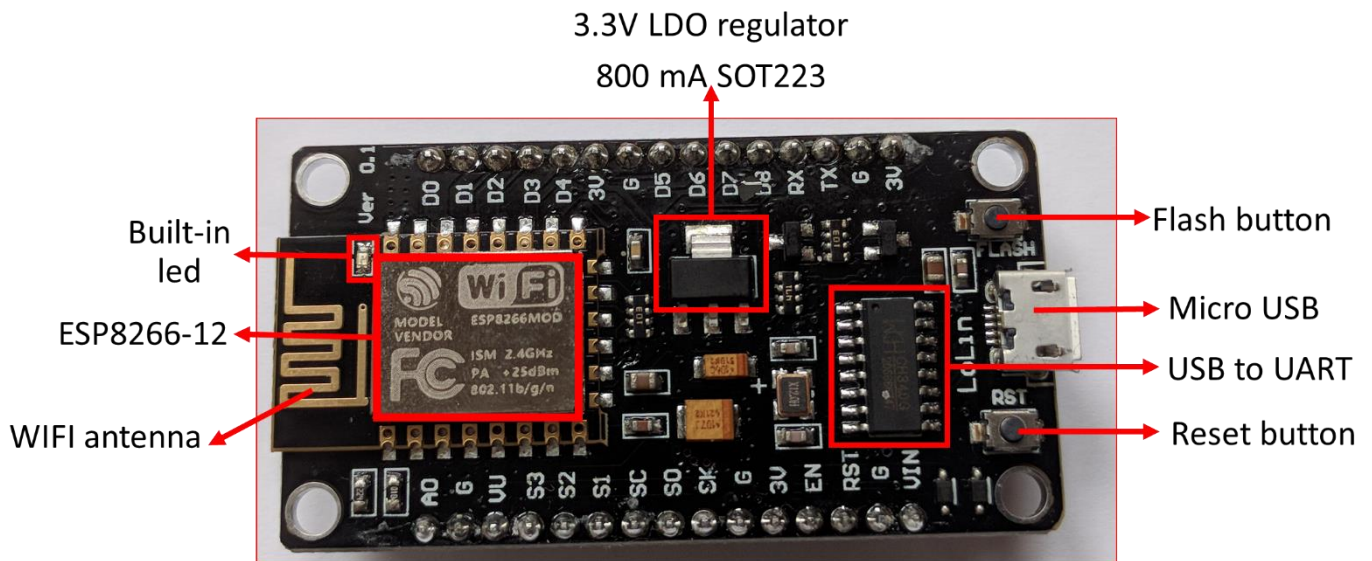


Figure.:3.1 ESP8266 Board

On the picture above, the ESP8266-12 block is where the processor, memory and WIFI unit are located. The rest ensures communication with external sensors, USB port, voltage regulator, etc.

For those interested in computer architecture, have a look at the functional diagram of an ESP8266-12:

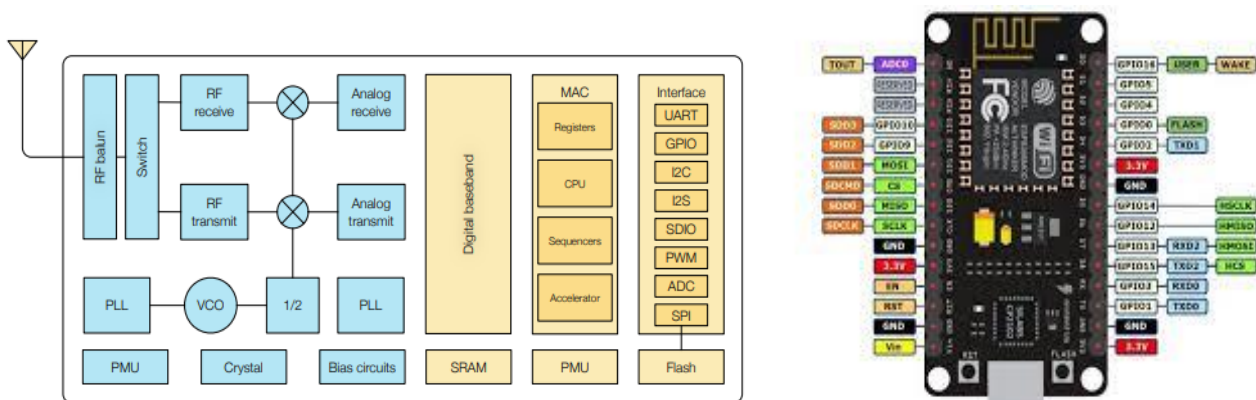


Figure.:3.2 ESP8266 Pin Diagram

The ESP8266 uses a 32bit processor with 16 bit instructions. It is Harvard architecture which mostly means that instruction memory and data memory are completely separate.

The ESP8266 has on die program Read-Only Memory (ROM) which includes some library code and a first stage boot loader. All the rest of the code must be stored in external Serial flash memory (provides only serial access to the data - rather than addressing individual bytes, the user reads or writes large contiguous groups of bytes in the address space serially).

Depending on your ESP8266, the amount of available flash memory can vary.

As any other microcontroller, ESP8266 has a set of GPIO pins (General Purpose Input(Output pins) that we can use to “control” external sensors.

Our ESP8266 has 17 GPIO pins but only 11 can be used (among 17 pins, 6 are used for communication with the on-board flash memory chip). It also has an analog input (to convert a voltage level into a digital value that can be stored and processed in the ESP8266).

It also has a WIFI communication to connect your ESP8266 to your WIFI network, connect to the internet, host a web server, let your smartphone connect to it, etc.

Another advantage of an ESP8266 is that it can be programmed as any other microcontroller and especially any Arduino.

2. Analog pH Sensor:-

- ⇒ An analog pH meter measures the pH level of a solution and indicates its acidity or alkalinity by responding with an analog voltage.

What is pH?

- ⇒ pH stands for power of hydrogen, which is a measurement of the hydrogen ion concentration in the body. The total pH scale ranges from 1 to 14, with 7 considered to be neutral. A pH less than 7 is said to be acidic and solutions with a pH greater than 7 are basic or alkaline.

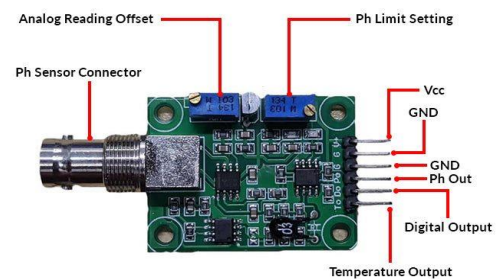


Figure.:3.3 pH Sensor With Controller

SPECIFICATION

- Module Power : 5.00V
- Module Size : 43 x 32mm(1.69x1.26")
- Measuring Range :0 - 14PH
- Measuring Temperature: 0 - 60 °C
- Accuracy : $\pm 0.1\text{pH}$ (25 °C)
- Response Time : $\leq 1\text{min}$
- pH Sensor with BNC Connector
- pH2.0 Interface (3 foot patch)
- Gain Adjustment Potentiometer
- Power Indicator LED

3. WATER FLOW SENSOR:-

What is a water flow sensor (meter)?

- ⇒ We use a water flow sensor to measure the water flow rate. The water flow rate is the volume of fluid that passes per unit time. People often use water flow sensor for automatic water heater control, DIY coffee machines, water vending machines, etc. There are a variety of flow sensors of different principles, but for makers using Arduino or Raspberry Pi, the most common flow sensor is based on a Hall device. For example, the most classic water flow sensor YF-S402 and YF-S201 rely on Hall sensors.



Figure.:3.4 Flow Sensor

Features

- Compact, Easy to Install
- High Sealing Performance
- High Quality Hall Effect Sensor
- RoHS Compliant

How does the water flow sensor work?

⇒ It's quite simple inside. The main components are the Hall Effect sensor, turbine wheel, and magnet. The water flows in through the inlet and out through the outlet. The water current drove the wheel to turn, and the magnet on the wheel turned with it. Magnetic field rotation triggers the Hall sensor, which outputs high and low level square waves (pulse).

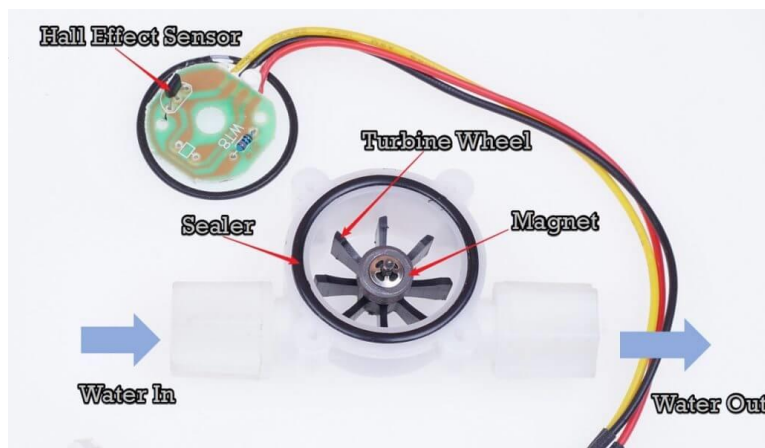


Figure.:3.5 Water flow sensor work principle

4. Ultrasonic Sensor:-

An ultrasonic sensor is an electronic device that uses ultrasonic sound waves to measure the distance to an object and convert the reflected sound into an electrical signal.

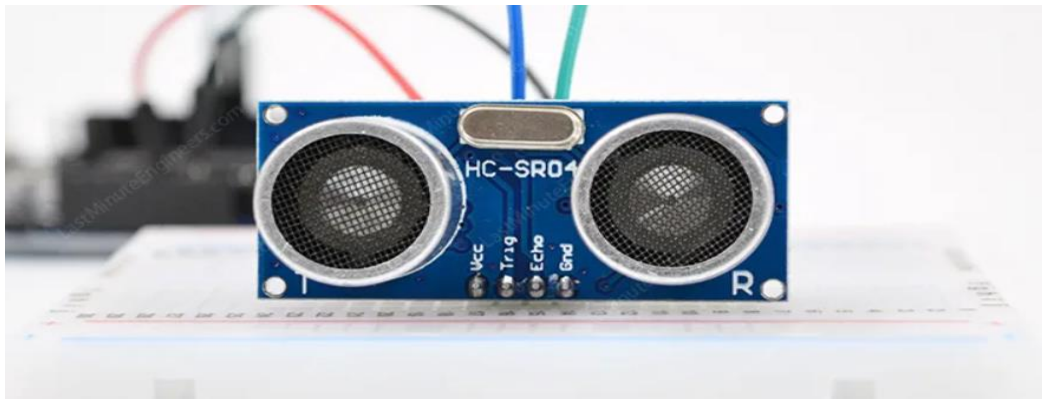
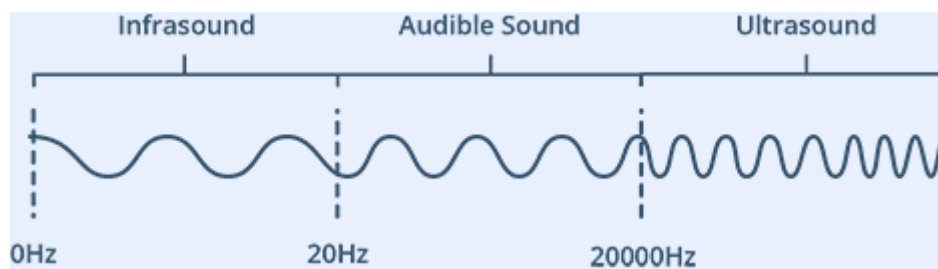


Figure.:3.6 Ultrasonic Sensor

What is Ultrasound?

Ultrasound is a high-pitched sound wave whose frequency exceeds the audible range of human hearing.



Humans can hear sound waves that vibrate in the range of about 20 times a second (a deep rumbling noise) to 20,000 times a second (a high-pitched whistle). However, ultrasound has a frequency of more than 20,000 Hz and is therefore inaudible to humans.

Technical Specifications

Here are the specifications:

Operating Voltage	DC 5V
Operating Current	15mA
Operating Frequency	40KHz
Max Range	4m
Min Range	2cm
Ranging Accuracy	3mm

Measuring Angle	15 degree
Trigger Input Signal	10μS TTL pulse
Dimension	45 x 20 x 15mm

How Does HC-SR04 Ultrasonic Distance Sensor Work?

It all starts when the trigger pin is set HIGH for 10μs. In response, the sensor transmits an ultrasonic burst of eight pulses at 40 kHz. This 8-pulse pattern is specially designed so that the receiver can distinguish the transmitted pulses from ambient ultrasonic noise.

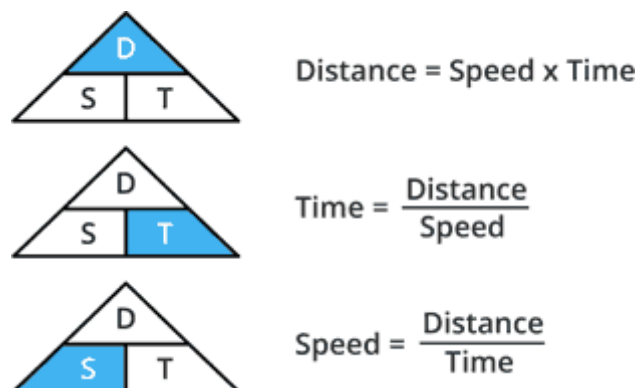
These eight ultrasonic pulses travel through the air away from the transmitter. Meanwhile the echo pin goes HIGH to initiate the echo-back signal.

If those pulses are not reflected back, the echo signal times out and goes low after 38ms (38 milliseconds). Thus a pulse of 38ms indicates no obstruction within the range of the sensor.

If those pulses are reflected back, the echo pin goes low as soon as the signal is received. This generates a pulse on the echo pin whose width varies from 150 μs to 25 ms depending on the time taken to receive the signal.

Calculating the Distance

The width of the received pulse is used to calculate the distance from the reflected object. This can be worked out using the simple distance-speed-time equation we learned in high school. An easy way to remember the equation is to put the letters in a triangle.



Let us take an example to make it more clear. Suppose we have an object in front of the sensor at an unknown distance and we receive a pulse of 500μs width on the echo pin. Now let's calculate how far the object is from the sensor. For this we will use the below equation.

$$\text{Distance} = \text{Speed} \times \text{Time}$$

Here we have the value of time i.e. 500 μs and we know the speed. Of course it's the speed of sound! It is 340 m/s. To calculate the distance we need to convert the speed of sound into cm/μs. It is 0.034 cm/μs. With that information we can now calculate the distance!

$$\text{Distance} = 0.034 \text{ cm}/\mu\text{s} \times 500 \mu\text{s}$$

But we're not done yet! Remember that the echo pulse indicates the time it takes for the signal to be sent and reflected back. So to get the distance, you have to divide your result by two.

$$\text{Distance} = (0.034 \text{ cm}/\mu\text{s} \times 500 \mu\text{s}) / 2$$

Distance = 8.5 cm Now we know that the object is 8.5 cm away from the sensor.

3.1.2 HARDWARE COMPONENT POSITION IN PROJECT: -

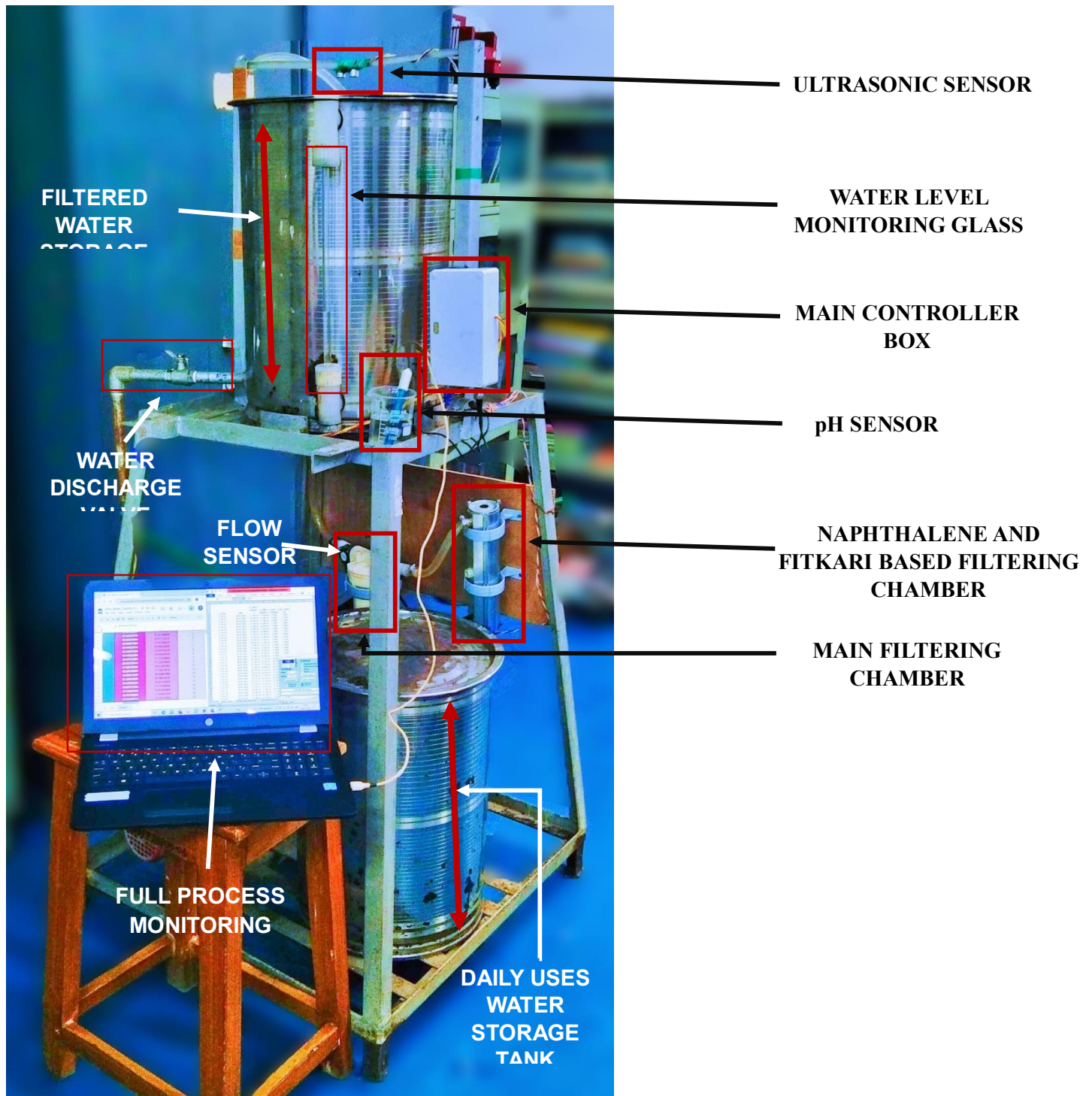


Figure.-3.7 HARDWARE COMPONENT POSITION IN PROJECT

Main Controller Box:-

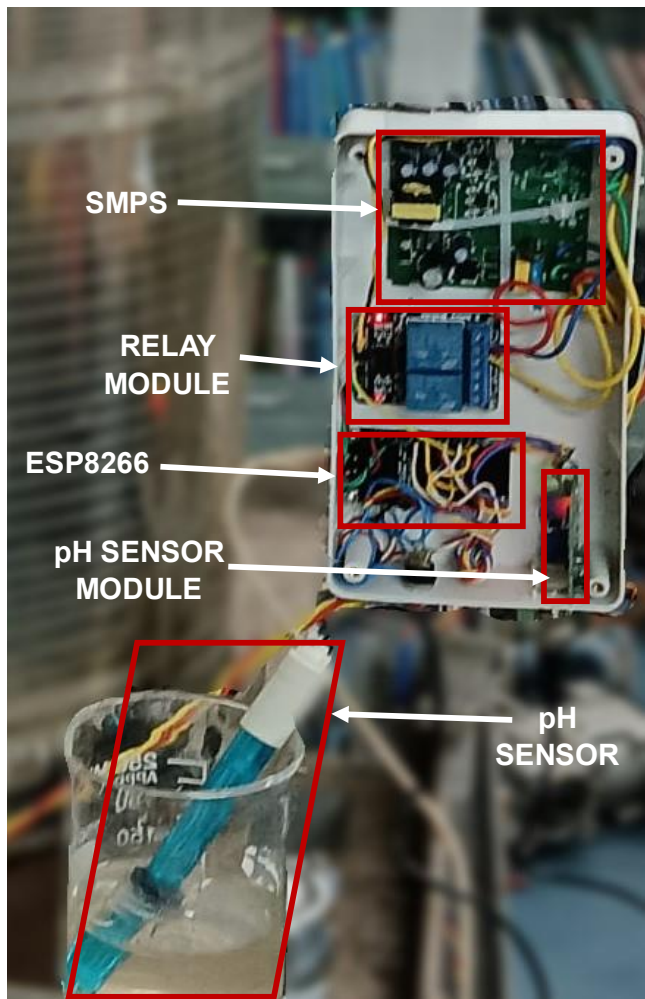
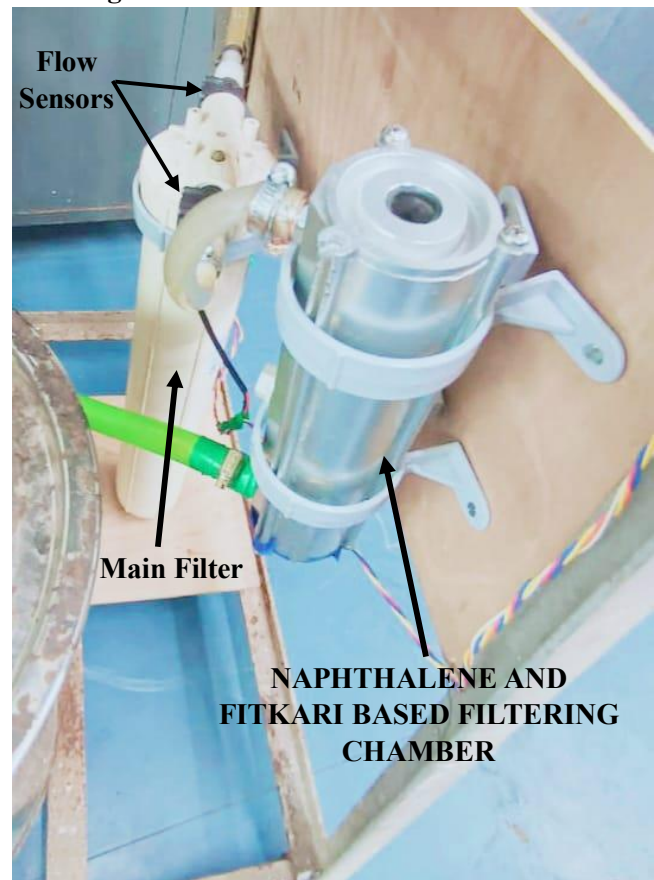


Figure.:3.8 Main Controller Box

Filtering Process Chamber: -



3.2 BLOCK DIAGRAM

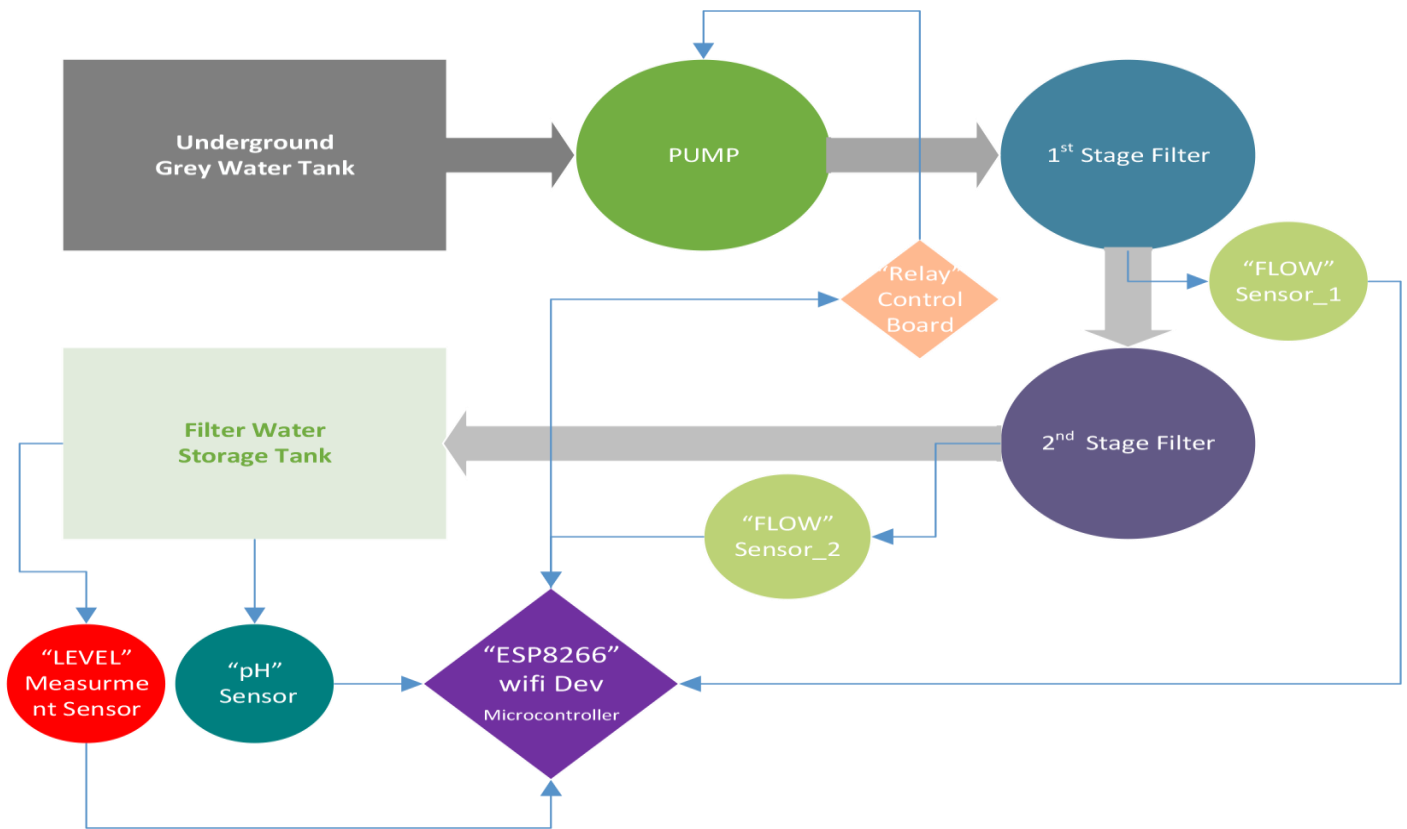


Figure.: 3.9 Block Diagram

The block diagram of the IoT-based Grey Water Control System project reveals several key aspects of the system's architecture and functionality. By analyzing the block diagram, we can understand the following:

1. **System Components:** The diagram shows the various components of the system, including sensors, IoT devices, grey water treatment units, and a cloud-based server.
2. **Data Flow:** The diagram illustrates the flow of data from the sensors to the cloud server, and then to the user interface, indicating how the system collects, processes, and presents data.
3. **Automation and Control:** The diagram suggests that the system has automated control capabilities, adjusting the grey water treatment process based on sensor data and user inputs.
4. **Remote Monitoring and Control:** The inclusion of a cloud server and user interface indicates that the system can be monitored and controlled remotely, enabling real-time tracking and management.
5. **IoT Connectivity:** The diagram highlights the role of IoT technology in connecting the system's components and enabling data exchange, demonstrating the project's focus on IoT-based solutions.
6. **Grey Water Treatment:** The diagram shows the grey water treatment unit, indicating that the system is designed to manage and treat grey water, promoting water conservation and sustainability.

7. User Interface: The diagram includes a user interface block, suggesting that the system provides a user-friendly interface for monitoring and controlling the system, as well as accessing data and analytics.

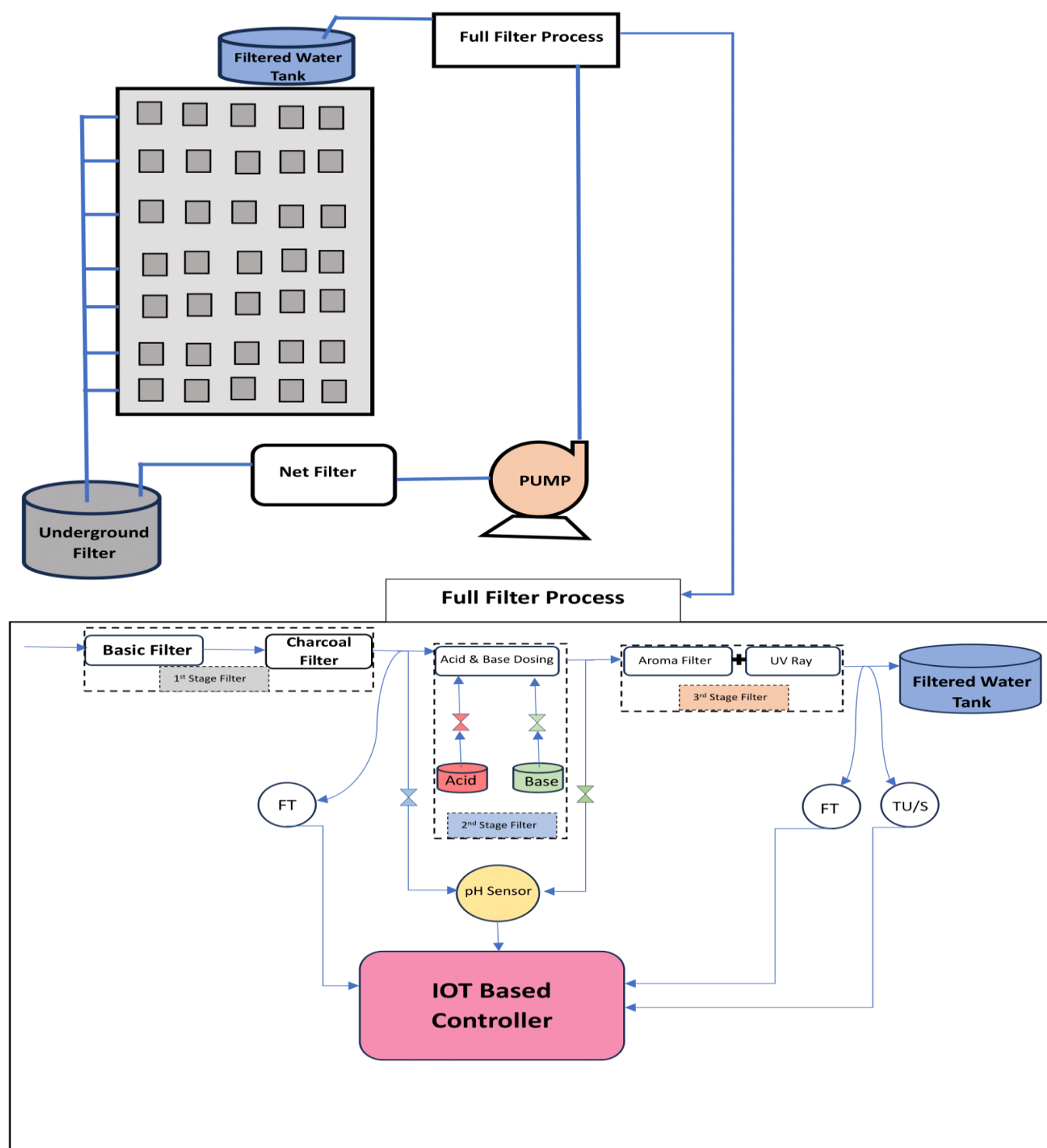


Figure.:3.10 → DATA FLOW DIAGRAM ←

*By this Diagram we can know about how we can use or how it work in real life.

3.3 P&I DIAGRAM

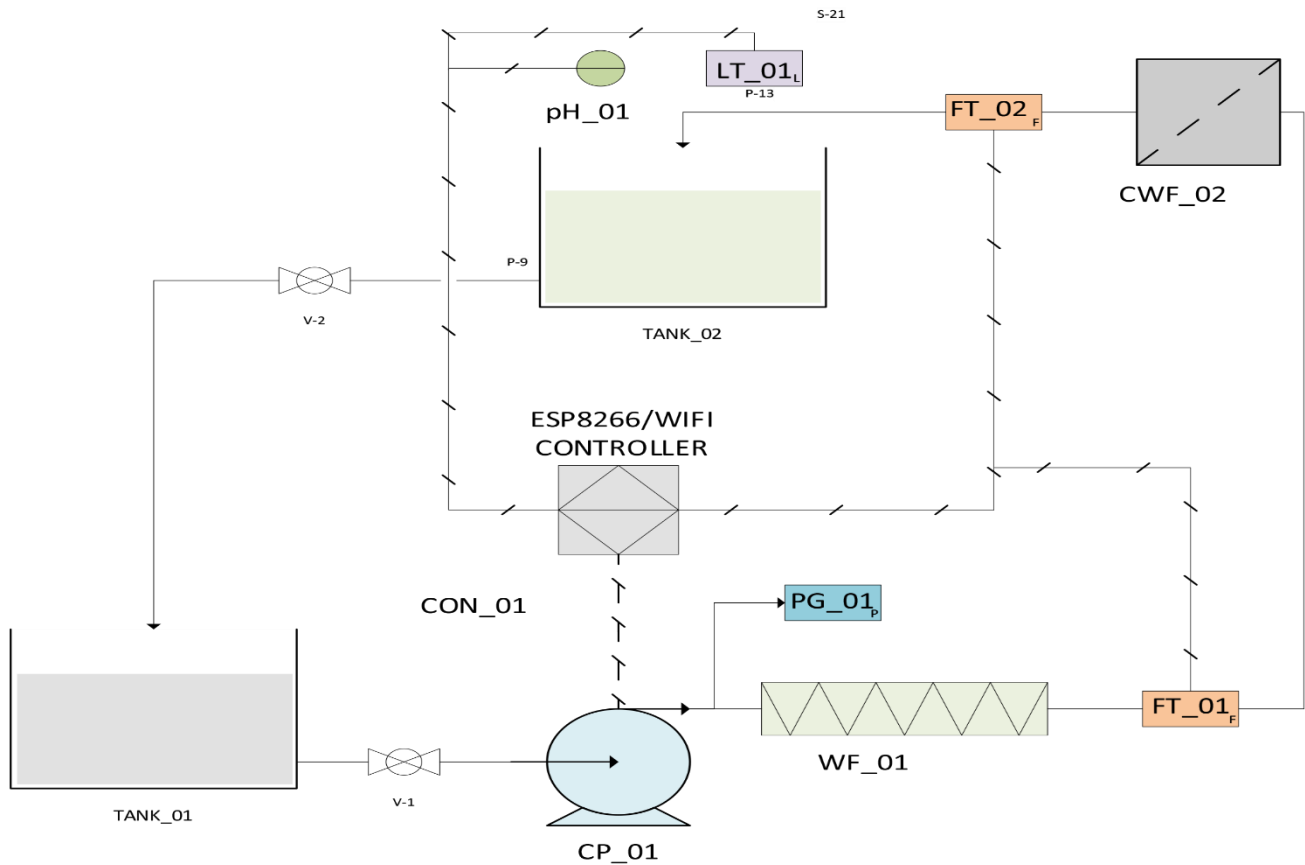
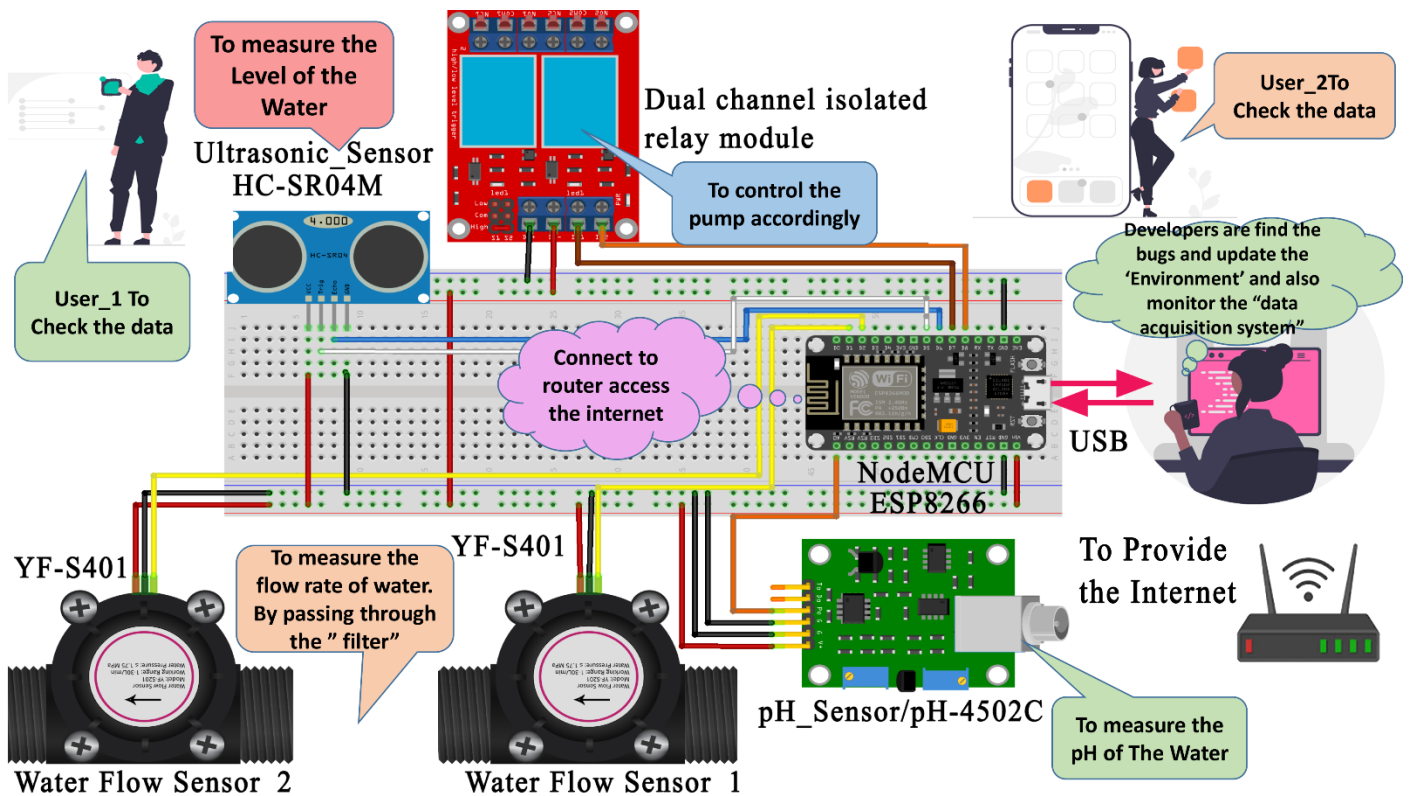


Figure.: 3.11 P&I Diagram

3.4 PIN DIAGRAM



3.5 Software and Hardware Requirements:-

Only 2 Software is required

- Arduino IDE
- Google Sheet

Arduino IDE:-

In this lesson, we will be using the Arduino IDE as it has a simple interface with built-in examples.

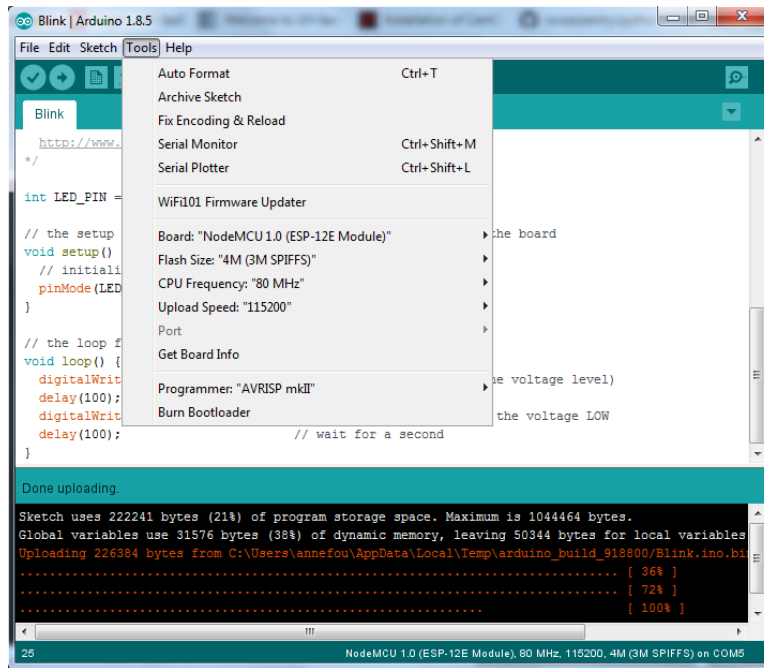
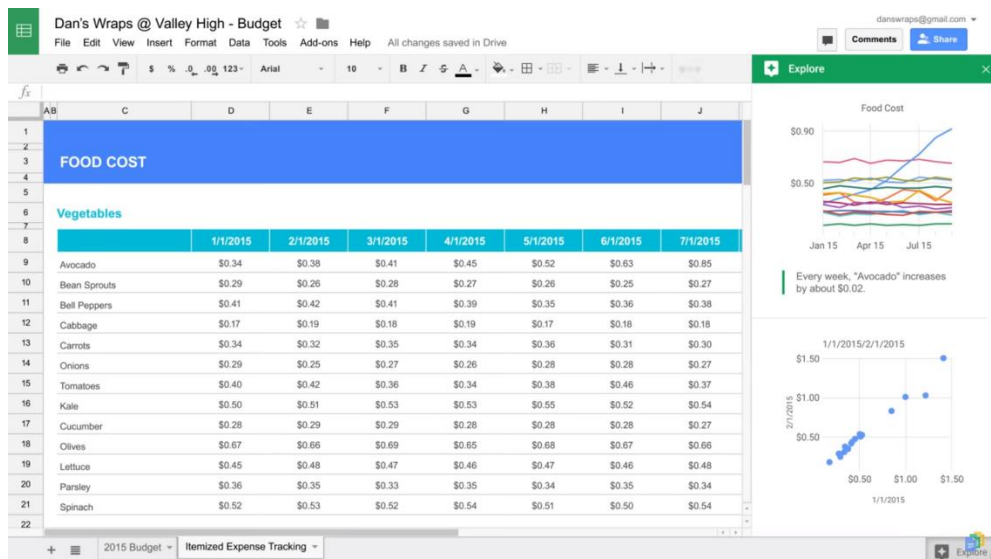


Figure.: 3.12 Arduino IDE

Google Sheet:-

For vasoligation of all Sensors data, we use Google Sheet.



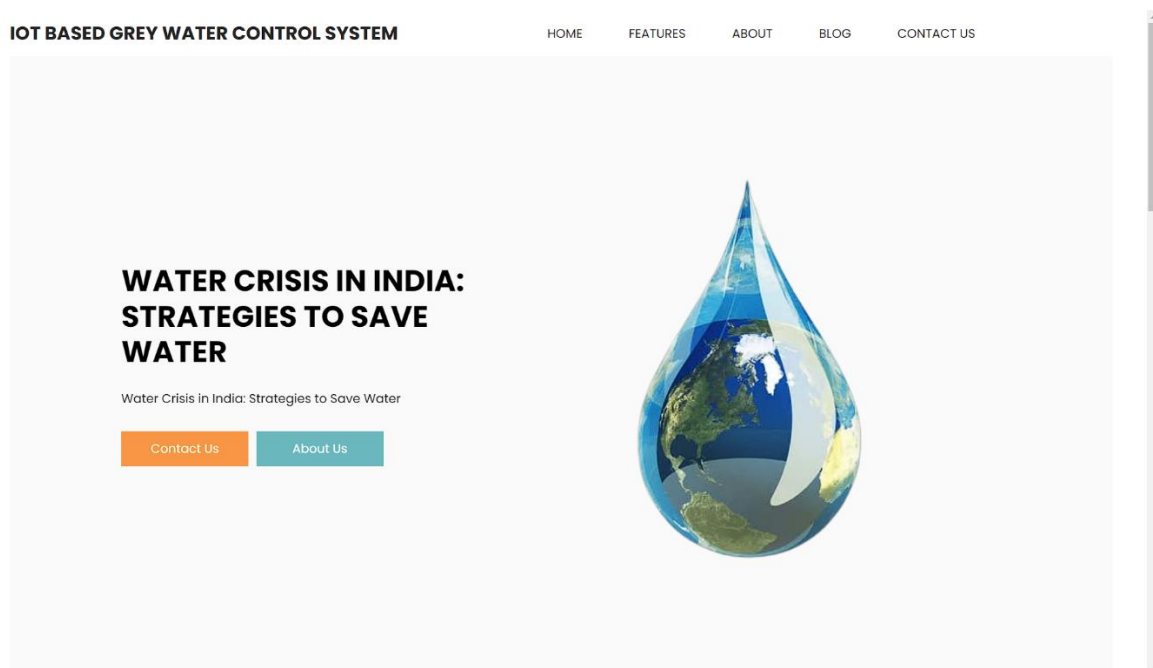
To send data from an ESP8266 to Google Sheets, you can try these steps:

- Prepare Google Sheets
- Wire

- Install a library
- Write Arduino code for logging data
- Upload the code to ESP32
- Click Deploy
- Click Authorize access and select your Google account
- Select Advanced > Go to Untitled project (unsafe) > Allow
- Copy and save the Deployment ID for use in the ESP8266 code
- Click Done
- In the Arduino IDE, paste the ESP8266-example.cpp code into a blank sketch
- Update the Wifi network name and Wifi password
- Click Save and then Run

3.6 User Interface Design:-

The user interface for the IoT-based Grey Water System is a web-based dashboard accessible at <https://savewater.netfy.org/>.



The intuitive and user-friendly interface provides real-time monitoring and control of the grey water system, enabling users to:

- ⇒ View real-time data on grey water generation, treatment, and reuse
- ⇒ Monitor system performance and water quality parameters
- ⇒ Receive alerts and notifications for system maintenance and issues
- ⇒ Control and adjust system settings remotely
- ⇒ Access data analytics and visualization tools to optimize water conservation
- ⇒ View educational resources and tips on water sustainability

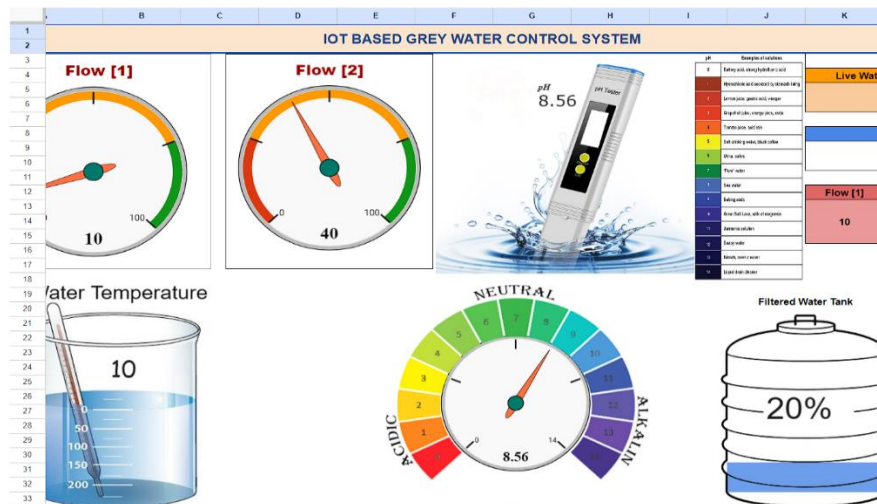
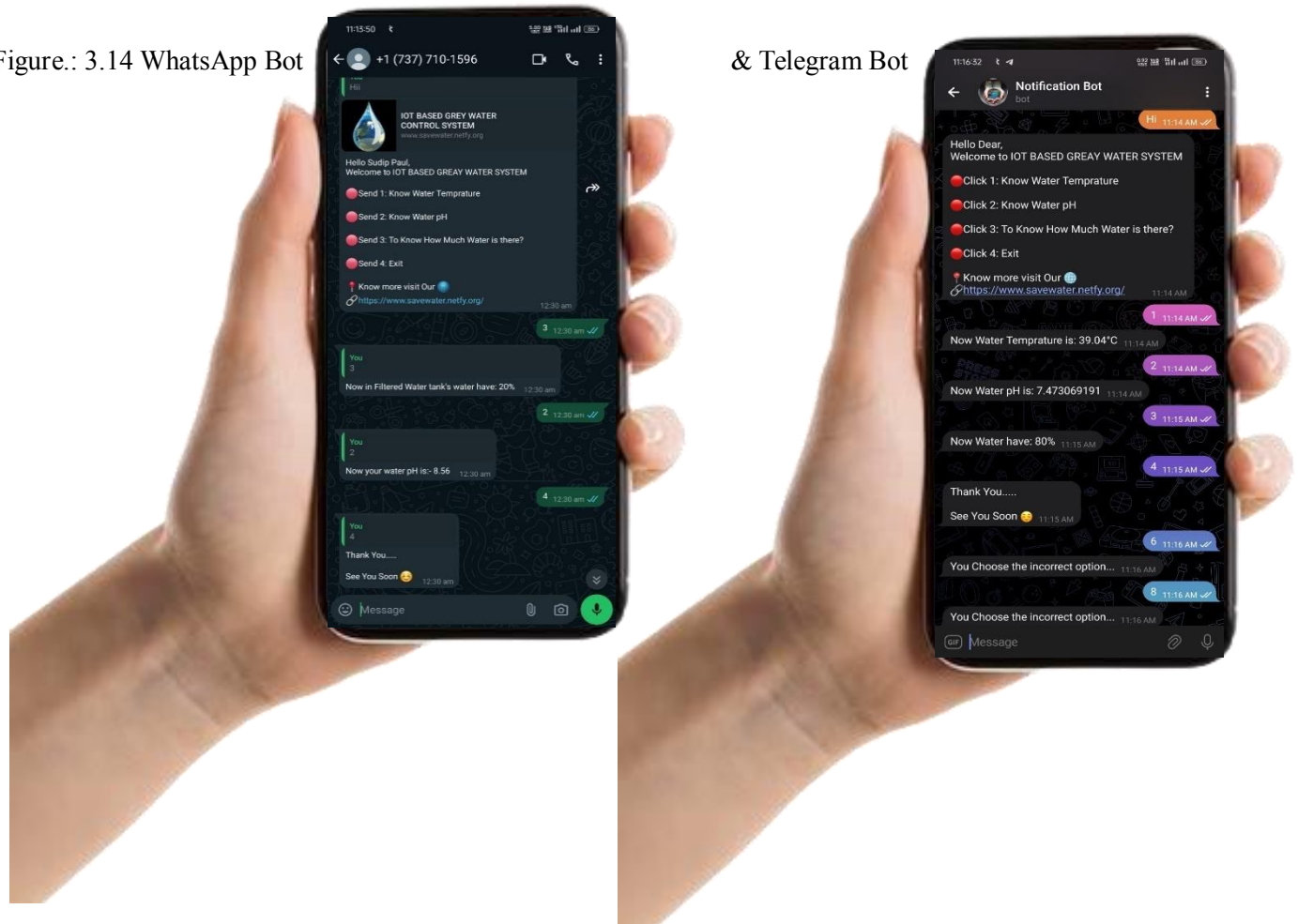


Figure.:3.13 User Dashboard

The interface is designed to be accessible and easy to use for a variety of users, from homeowners to facility managers, and provides a comprehensive overview of the grey water system's performance, enabling users to make informed decisions about water conservation and sustainability.

Figure.: 3.14 WhatsApp Bot

& Telegram Bot



We Developed Two BOT First WhatsApp BOT and Second Telegram Bot Shown in above the Image.

3.7 Safety Issues:-

Here are some potential safety issues related to the IoT-based Grey Water System project:

1. **Water Contamination:** Grey water may contain harmful bacteria, viruses, and other contaminants, which can pose a risk to human health if not properly treated and disinfected.
2. **Electrical Hazards:** The system's electrical components and IoT devices may pose a risk of electrical shock or fire if not installed, maintained, and used properly.
3. **Slip, Trip, and Fall Hazards:** Wet surfaces and areas around the grey water treatment and storage units may be slippery, increasing the risk of falls and injuries.
4. **Chemical Handling:** The system may require the use of chemicals for treatment and disinfection, which can be hazardous if not handled, stored, and disposed of properly.
5. **Data Security:** The system's IoT devices and web interface may be vulnerable to cyber attacks, potentially compromising sensitive information and system control.
6. **Maintenance and Repair Hazards:** Maintenance and repair activities may expose personnel to electrical, mechanical, and chemical hazards if not performed properly.
7. **Flooding and Water Damage:** System failures or malfunctions may lead to flooding and water damage, causing property damage and potentially affecting neighboring properties.
8. **Public Health Risks:** Improperly treated grey water may pose a risk to public health, particularly if used for irrigation or other non-potable purposes.
9. **Environmental Risks:** System failures or malfunctions may lead to environmental contamination, harming local ecosystems and wildlife.
10. **User Error:** Improper use or configuration of the system by users may lead to safety issues, such as contamination or electrical hazards.

CHAPTER 4. RESULT ANALYSIS

The IoT-based Grey Water Control System project has yielded impressive results, demonstrating the effectiveness of IoT technology in grey water management. The project's dashboard successfully displays the following parameters in real-time:

- Grey Water Flow 1 and 2 rates
- pH levels
- Water levels

Key findings:

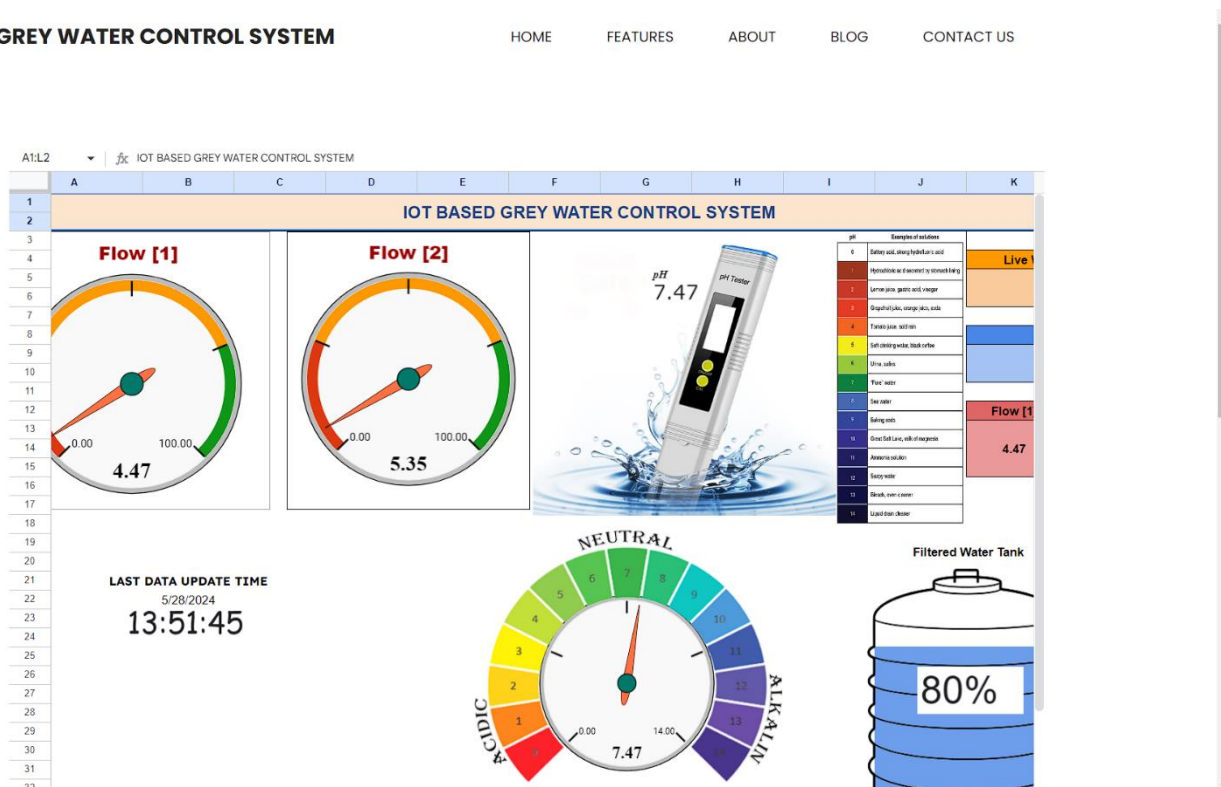
- Accurate measurement and display of grey water flow rates, pH levels, and water levels in real-time
- Automated control system effectively adjusts grey water treatment process based on sensor data and user inputs
- Remote monitoring capability enables users to access and control the system from anywhere
- User-friendly dashboard provides clear and concise display of key parameters

4.1 Analysis:

The project's success demonstrates the potential of IoT technology in optimizing grey water management. Real-time monitoring and automation capabilities enable efficient and effective grey water treatment, reducing environmental pollution risks and promoting sustainable water management practices.

The dashboard's clear display of key parameters enables users to quickly assess system performance and make data-driven decisions. Remote monitoring and control capabilities enhance usability and flexibility, making the system suitable for industrial and commercial applications.

The IoT-based Grey Water Control System project showcases the effectiveness of IoT technology in grey water management, contributing to sustainable water management solutions. The project's success paves the way for further development and implementation of IoT-based solutions in the water management sector.



4.2 Database Details :-

	A	B	C	D	E	F	G	H	I
	DATE	TIME	DAY	MONTH	HOURS	FLOW_SENSOR_1	FLOW_SENSOR_2	WATER_LEVEL_DATA	pH_SENSOR_DATA
2	28/05/2024	13:46:56	Tuesday	May	13	11.18459988	11.50415993	2	7.144835472
3	28/05/2024	13:46:56	Tuesday	May	13	11.18459988	11.50415993	2	7.144835472
4	28/05/2024	13:46:56	Tuesday	May	13	11.18459988	11.50415993	2	7.144835472
5	28/05/2024	13:46:56	Tuesday	May	13	11.18459988	11.50415993	2	7.144835472
6	28/05/2024	13:46:56	Tuesday	May	13	11.18459988	11.50415993	2	7.144835472
7	28/05/2024	13:46:56	Tuesday	May	13	11.18459988	11.50415993	2	7.144835472
8	28/05/2024	13:46:56	Tuesday	May	13	11.18459988	11.50415993	2	7.144835472
9	28/05/2024	13:46:56	Tuesday	May	13	11.18459988	11.50415993	2	7.144835472
10	28/05/2024	13:46:56	Tuesday	May	13	11.18459988	11.50415993	2	7.144835472
11	28/05/2024	13:46:56	Tuesday	May	13	11.18459988	11.50415993	2	7.144835472
12	28/05/2024	13:46:56	Tuesday	May	13	11.18459988	11.50415993	2	7.144835472
13	28/05/2024	13:46:59	Tuesday	May	13	16.53722954	17.85568824	2	7.269618511
14	28/05/2024	13:47:02	Tuesday	May	13	16.53722954	17.49591064	4	7.215304833
15	28/05/2024	13:47:05	Tuesday	May	13	15.09020979	15.97799969	2	7.275043864
16	28/05/2024	13:47:08	Tuesday	May	13	15.65843964	16.61712074	4	7.398627034
17	28/05/2024	13:47:12	Tuesday	May	13	16.93687984	17.81546974	7	7.424241006
18	28/05/2024	13:47:15	Tuesday	May	13	15.81822014	16.85679054	7	7.3672714761
19	28/05/2024	13:47:18	Tuesday	May	13	15.33887959	16.29755974	9	7.483819621
20	28/05/2024	13:47:21	Tuesday	May	13	14.14052963	14.93943024	9	7.421520336
21	28/05/2024	13:47:25	Tuesday	May	13	16.53722954	17.57579994	9	7.505620950
22	28/05/2024	13:47:29	Tuesday	May	13	20.05238914	21.25074005	9	7.440518049
23	28/05/2024	13:47:32	Tuesday	May	13	17.89536095	19.01382065	13	7.440518049
24	28/05/2024	13:47:35	Tuesday	May	13	16.29755974	17.33813014	13	7.5408801029
25	28/05/2024	13:47:39	Tuesday	May	13	15.89811039	16.93687984	13	7.4405042432
26	28/05/2024	13:47:43	Tuesday	May	13	21.49040985	22.84853935	13	7.443220615
27	28/05/2024	13:47:46	Tuesday	May	13	15.57855034	16.45734024	13	7.524610043
28	28/05/2024	13:47:49	Tuesday	May	13	16.69701004	17.73558044	18	7.4879437708
29	28/05/2024	13:47:53	Tuesday	May	13	17.41601944	18.45458984	20	7.475781918
30	28/05/2024	13:47:56	Tuesday	May	13	16.37745094	17.49591064	20	7.6279045268
31	28/05/2024	13:48:00	Tuesday	May	13	17.01658914	18.05513954	20	7.6223962703
32	28/05/2024	13:48:00	Tuesday	May	13	20.31216055	21.41453044	20	7.6223962703

Figure.; 4.1 Database of Result

CHAPTER 5. CONCLUSION

5.1 Limitations of the System:-

The IoT-based Grey Water Control System project has several limitations. One of the main limitations is the high initial investment cost, which may be a barrier for some individuals or organizations. Additionally, the system requires regular maintenance and monitoring to ensure optimal performance, which can be time-consuming and resource-intensive.

Furthermore, the system's effectiveness is dependent on various factors such as water usage patterns, grey water generation rates, and treatment efficiency, which can vary significantly. Moreover, the system may not be suitable for all types of grey water sources, and its performance may be affected by factors such as water quality and flow rates.

Another limitation is the potential for technical issues and system failures, which can impact the reliability and efficiency of the system. Additionally, the system may require additional infrastructure and hardware, such as sensors and treatment units, which can add to the overall cost and complexity of the system.

Additionally, the system's scalability and adaptability to different contexts and regions may be limited, and it may require significant modifications to be effective in diverse settings. Moreover, the project's reliance on IoT technology and data analytics may raise concerns about data privacy and security, which must be carefully addressed.

Furthermore, the project's focus on grey water reuse may overlook other important aspects of water management, such as rainwater harvesting, water-efficient appliances, and water-saving behaviors. A more comprehensive approach to water management may be necessary to achieve significant and sustainable water conservation.

The project's evaluation and monitoring metrics may also be limited, focusing primarily on technical performance indicators rather than social and environmental impact. A more nuanced and multifaceted evaluation approach may be necessary to fully understand the project's effects and potential.

Lastly, the project's long-term sustainability and maintenance requirements may not be fully addressed, potentially leading to system degradation or abandonment over time. A clear plan for ongoing maintenance, repair, and replacement of system components must be developed and implemented to ensure the project's continued effectiveness.

By acknowledging and addressing these limitations, the IoT-based Grey Water Control System project can be refined and improved to achieve its goals of promoting water conservation and sustainability.

Finally, the project's success is dependent on user adoption and behavior change, which can be challenging to achieve, especially in areas where water conservation is not a priority. Overall, while the IoT-based Grey Water Control System has the potential to promote water conservation and sustainability, it is important to carefully consider these limitations and develop strategies to address them.

5.2 Future Scope of the Project:-

The IoT-based Grey Water Control System project has a promising future scope, with potential for expansion and development in various areas. The project's success could lead to widespread adoption in various settings, including residential, commercial, and industrial sectors, contributing significantly to water conservation and sustainability.

The project's technology and concept could be adapted and integrated with other water management systems, such as rainwater harvesting and water-efficient appliances, to create a comprehensive water management solution.

Additionally, the project's data analytics and monitoring capabilities could be leveraged to optimize water usage and predict water demand, enabling more efficient water supply management.

Furthermore, the project's IoT technology could be applied to other environmental monitoring and management applications, such as air quality and waste management, contributing to a more sustainable and environmentally conscious future.

The project's potential for scalability and adaptability makes it an attractive solution for water management in various regions and contexts, including urban and rural areas, and developing communities. As the project continues to evolve and improve, it is likely to play an increasingly important role in addressing global water challenges and promoting sustainable water management practices.

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5.4 SAMPLE CODE :-

```
#include <ESP8266WiFi.h>           // Import 'ESP8266WiFi.h' library

#include <WiFiClientSecure.h>       // Import 'WiFiClientSecure.h' library

#include <EEPROM.h>                 // Import 'EEPROM.h' library

const char* ssid = "Hextronics";    // Your wifi name or SSID.

const char* password = "ESP123.."; // Your wifi password.

const char* host = "script.google.com"; // host script

const int httpsPort = 443;         // httpsport ID
```

```

WiFiClientSecure client;           // Create a WiFiClientSecure object.

String GAS_ID = "AKfycbxyOUUy2fvOFwWX9Pswx765Z1kZcSHvt3z85r_68Y9fVatF8Su207lOr0d6Ag8n3dZ-
bQ"; // spreadsheet GAS service id

const char* fingerprint = "702F78E7F62FA742A895BA1FFFF2734F2DDA782D"; // Google
spreadsheet fingerprint id

#define RELAY_PIN 16                // define the Relay pin

#define PH_PIN A0                  // define the PH_Sensor pin

float ph_Data;                     // PH data Variable

float pH_Value=0;                  // pH_value Initial position 0

float voltage;                     // Declare the variable voltage

#define FLOW_SENSOR_1 D1           // define the FLOW_SENSOR_1 pin

#define FLOW_SENSOR_2 D2           // define the FLOW_SENSOR_2 pin

volatile long pulse_1;             //

unsigned long lastTime_1;           //

float volume_1;                    //

volatile long pulse_2;             //

unsigned long lastTime_2;           //

float volume_2;                    //

#define TRIG_PIN 12                //

#define ECHO_PIN 14

#define SOUND_VELOCITY 0.034

long duration;

float ULTRASONIC_DATA_CM;

float CALCULATION_WATER_LEVEL_PERCENTAGE=0;

float WATER_LEVEL_PERCENTAGE=0;

void setup() {                     // put your setup code here, to run once:

pinMode(RELAY_PIN,OUTPUT);          // Relay Pin as define as output to control the pump

```

```

pinMode(PH_PIN,INPUT);                // pH sensor pin as input declare
pinMode(TRIG_PIN, OUTPUT);            // Sets the trigPin as an Output
pinMode(ECHO_PIN, INPUT);             // Sets the echoPin as an Input
pinMode(FLOW_SENSOR_1, INPUT);        // Set the "FLOW_SENSOR_1" as an input
pinMode(FLOW_SENSOR_2, INPUT);        // Set the "FLOW_SENSOR_2" as an input

attachInterrupt(digitalPinToInterrupt(FLOW_SENSOR_1), increase_1, RISING); // "FLOW_SENSOR_1" as an use
as interrupt RISING

attachInterrupt(digitalPinToInterrupt(FLOW_SENSOR_2), increase_2, RISING); // "FLOW_SENSOR_2" as an use
as interrupt RISING

Serial.begin(19200);                  // Serial Communication with computer

wifi_setup();                        // Now call or Fetch the "wifi_setup"

plx_daq_setup();

void loop() {                        // put your main code here, to run repeatedly:

    flow_sensor_loop();              // Now call or Fetch the "flow_sensor_loop"

    Ultrasonic_Loop();               // Now call or Fetch the "Ultrasonic_Loop"

    pH_sensor_loop();                // Now call or Fetch the "pH_sensor_loop"

    plx_daq_loop();

    sendData(volume_1,volume_2,WATER_LEVEL_PERCENTAGE,ph_Data); //

}

ICACHE_RAM_ATTR void increase_1() {

    pulse_1++;

}

ICACHE_RAM_ATTR void increase_2() {

    pulse_2++;

}

```

5.5 APPENDIX :-

CLOCK	DAY	FLOW_SENSOR_1	FLOW_SENSOR_2	LEVEL_SENSOR	pH_SENSOR
13:44:22	28-05-2024	11.18L/m	11.50L/m	2.00%	7.14pH
13:44:24	28-05-2024	16.54L/m	17.66L/m	2.00%	7.27pH
13:44:27	28-05-2024	16.54L/m	17.50L/m	4.00%	7.22pH
13:44:30	28-05-2024	15.10L/m	15.98L/m	2.00%	7.28pH
13:44:33	28-05-2024	15.66L/m	16.62L/m	4.00%	7.40pH
13:44:36	28-05-2024	16.94L/m	17.82L/m	7.00%	7.42pH
13:44:40	28-05-2024	15.82L/m	16.86L/m	7.00%	7.37pH
13:44:43	28-05-2024	15.34L/m	16.30L/m	9.00%	7.48pH
13:44:46	28-05-2024	14.14L/m	14.94L/m	9.00%	7.42pH
13:44:49	28-05-2024	16.54L/m	17.58L/m	9.00%	7.51pH
13:44:53	28-05-2024	20.05L/m	21.25L/m	9.00%	7.44pH
13:44:56	28-05-2024	17.90L/m	19.01L/m	13.00%	7.44pH
13:45:00	28-05-2024	16.30L/m	17.34L/m	13.00%	7.54pH
13:45:03	28-05-2024	15.90L/m	16.94L/m	13.00%	7.45pH
13:45:07	28-05-2024	21.49L/m	22.85L/m	13.00%	7.44pH
13:45:10	28-05-2024	15.58L/m	16.46L/m	13.00%	7.52pH
13:45:14	28-05-2024	16.70L/m	17.74L/m	18.00%	7.47pH
13:45:17	28-05-2024	17.42L/m	18.45L/m	20.00%	7.48pH
13:45:20	28-05-2024	16.38L/m	17.50L/m	20.00%	7.63pH
13:45:24	28-05-2024	17.02L/m	18.06L/m	20.00%	7.62pH
13:45:28	28-05-2024	20.21L/m	21.41L/m	20.00%	7.49pH
13:45:32	28-05-2024	19.41L/m	20.61L/m	22.00%	7.51pH
13:45:35	28-05-2024	16.30L/m	17.26L/m	22.00%	7.51pH
13:45:39	28-05-2024	18.37L/m	19.49L/m	24.00%	7.62pH
13:45:43	28-05-2024	20.53L/m	21.65L/m	27.00%	7.53pH
13:45:46	28-05-2024	17.90L/m	19.01L/m	27.00%	7.53pH
13:45:50	28-05-2024	15.34L/m	16.22L/m	27.00%	7.65pH
13:45:53	28-05-2024	16.86L/m	17.90L/m	29.00%	7.59pH
13:45:56	28-05-2024	16.38L/m	17.34L/m	31.00%	7.53pH
13:45:59	28-05-2024	15.82L/m	16.78L/m	31.00%	7.67pH
13:46:02	28-05-2024	14.30L/m	15.18L/m	33.00%	7.50pH
13:46:05	28-05-2024	15.90L/m	16.86L/m	33.00%	7.65pH
13:46:12	28-05-2024	35.31L/m	37.39L/m	36.00%	7.64pH
13:46:16	28-05-2024	16.94L/m	17.98L/m	36.00%	7.65pH
13:46:19	28-05-2024	15.90L/m	16.78L/m	36.00%	7.52pH
13:46:24	28-05-2024	22.45L/m	23.89L/m	38.00%	7.65pH
13:47:11	28-05-2024	18.45L/m	19.57L/m	53.00%	7.48pH
13:47:15	28-05-2024	19.97L/m	21.25L/m	53.00%	7.65pH
13:47:19	28-05-2024	15.90L/m	16.94L/m	56.00%	7.56pH
13:47:21	28-05-2024	14.62L/m	15.50L/m	58.00%	7.67pH
13:47:24	28-05-2024	15.02L/m	15.90L/m	56.00%	7.66pH
13:47:28	28-05-2024	15.82L/m	16.78L/m	58.00%	7.61pH
13:47:31	28-05-2024	14.54L/m	15.42L/m	60.00%	7.48pH
13:47:34	28-05-2024	15.10L/m	16.06L/m	60.00%	7.64pH
13:47:37	28-05-2024	17.98L/m	19.09L/m	60.00%	7.65pH
13:47:40	28-05-2024	14.86L/m	15.66L/m	62.00%	7.55pH
13:47:43	28-05-2024	15.90L/m	16.86L/m	62.00%	7.62pH
13:47:46	28-05-2024	15.82L/m	16.86L/m	62.00%	7.51pH
13:47:50	28-05-2024	18.45L/m	19.57L/m	64.00%	7.51pH
13:47:53	28-05-2024	16.30L/m	17.42L/m	64.00%	7.68pH
13:48:08	28-05-2024	73.90L/m	78.77L/m	69.00%	7.46pH
13:48:12	28-05-2024	17.42L/m	18.45L/m	71.00%	7.51pH
13:48:15	28-05-2024	16.38L/m	17.42L/m	71.00%	7.59pH
13:48:18	28-05-2024	15.34L/m	16.30L/m	73.00%	7.46pH
13:48:22	28-05-2024	17.90L/m	19.01L/m	73.00%	7.47pH
13:48:25	28-05-2024	16.86L/m	17.98L/m	73.00%	7.60pH
13:48:29	28-05-2024	19.49L/m	20.77L/m	76.00%	7.44pH
13:48:32	28-05-2024	15.90L/m	16.86L/m	76.00%	7.48pH
13:48:35	28-05-2024	15.82L/m	16.86L/m	78.00%	7.53pH
13:48:39	28-05-2024	17.98L/m	19.09L/m	78.00%	7.55pH
13:48:42	28-05-2024	16.46L/m	17.42L/m	80.00%	7.50pH
13:48:46	28-05-2024	14.46L/m	15.34L/m	80.00%	7.52pH
13:48:50	28-05-2024	12.30L/m	13.02L/m	80.00%	7.62pH
13:48:52	28-05-2024	7.35L/m	7.67L/m	80.00%	7.44pH
13:48:56	28-05-2024	9.27L/m	9.35L/m	82.00%	7.63pH
13:48:59	28-05-2024	8.95L/m	6.63L/m	82.00%	7.42pH
13:49:03	28-05-2024	7.67L/m	8.71L/m	80.00%	7.62pH
13:49:06	28-05-2024	5.83L/m	5.91L/m	82.00%	7.61pH
13:49:09	28-05-2024	4.47L/m	5.35L/m	80.00%	7.47pH
13:49:21	28-05-2024	4.31L/m	3.67L/m	82.00%	7.23pH
13:49:27	28-05-2024	0.00L/m	0.00L/m	82.00%	7.41pH
13:49:34	28-05-2024	0.00L/m	0.00L/m	82.00%	7.94pH
13:49:41	28-05-2024	0.00L/m	0.00L/m	80.00%	7.25pH
13:49:48	28-05-2024	0.00L/m	0.00L/m	80.00%	7.51pH
13:49:55	28-05-2024	0.00L/m	0.00L/m	80.00%	7.89pH

STUDENT'S PROFILE

NAME	DETAILS	PHOTO
SUBHADIP SAMANTA (Roll No. :10305521071)	Phone no: 8697616828 Email Id: subhadiphit2022@gmail.com	
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