NSBM Green University

Faculty of Computing

PUSL2022 Introduction to IOT (23/AY/AU/M)

Rainwater pH Quality Monitoring System

Internet of Things (IoT) Group Project

Project Initiation Document

	Group Number	Group DX
	Student ID (Plymouth)	Name (as appeared on DLE)
1	10899245	Deshitha Bandara
2	10898559	Ayagama Ekanayaka
3	10898764	Gajasinghe Gajasinghe
4	10899273	Rajakaruna Gunawardhana
5	10898717	Hasindi Weraniyage
6	10898720	Hitige Wijewardhane

Content

Project Background

The Rainwater pH Monitoring System project seeks to provide a long-term system for continually monitoring and recording rainfall pH values. This is critical since pH levels influence the environment, infrastructure, and public health. The technology will aid in the identification of acid rain concerns as well as the evaluation of air pollution control efforts. It comprises a weather-resistant pH sensor, a microprocessor for data interpretation, and a data transmission module. The system is ecologically beneficial because it runs on renewable energy. Overall, this initiative helps to save the environment by providing long-term rainfall pH level observations that are dependable.

Literature Review

- Monitoring System Water pH Rate: A study discusses the importance of monitoring the pH rate, turbidity, and temperature of river water. While this study focuses on river water, the methods and approaches could potentially be applied to rainwater as well.
- IoT-Based Smart Water Quality Monitoring: This paper discusses recent techniques and trends in IoT-based water quality monitoring[2]. It highlights the use of sensors for measuring parameters like pH and temperature, and the use of Wi-Fi for real-time data transmission.

- Ground and River Water Quality Monitoring: A study presents a smartphone-based pH sensor for monitoring the quality of ground and river water. This approach could be adapted for rainwater monitoring, offering a portable and accessible solution.
- Rainwater Harvesting Systems: A comprehensive environmental assessment of rainwater harvesting systems is discussed. The literature reported that rainwater harvesting systems might reduce the runoff volume from 13 to 91%, indicating potential benefits.
- Critique: While these studies provide valuable insights, there are some gaps and shortcomings. For instance, most of the existing literature focuses on monitoring the quality of ground and river water, with less emphasis on rainwater. Additionally, while IoT-based solutions offer real-time monitoring, they may not always be feasible in remote or resource-constrained settings. Furthermore, the use of smartphone-based sensors, while innovative, may not always provide the level of accuracy required for scientific or regulatory purposes.

Aim

This project aims to develop a Rainwater pH Monitoring System using IoT and edge computing technologies. The goal is to continuously monitor and record rainfall pH levels, providing valuable data for environmental monitoring and research. The system includes a weatherresistant pH sensor, a microcontroller for data processing, and a Wi-Fi module for data transmission. The collected data is stored in the cloud for analysis, enabling trend analysis, event detection, and predictive modeling. A user-friendly interface allows real-time data visualization, and an alarm system provides timely warnings when pH levels exceed specified criteria. This technology enhances our understanding of environmental changes and supports decision-making processes for environmental preservation and public health.

Objectives

- Long-Term Stored Data: This is about collecting historical pH measurements over time, gathered from various sensors monitoring rainwater quality. The data is stored in databases or repositories.
- Rainwater pH Quality Monitoring System: Measuring and recording the pH levels in rainwater is critical for assessing its quality and safety for drinking, irrigation, and industrial use.
- Meaningful Analysis: Data analysis extracts insights and patterns from stored data to inform decision-making or research.
- Trends and Patterns Analysis: Identify recurring patterns or trends in rainwater pH levels through long-term data analysis. This can reveal seasonal variations, long-term changes,

and unusual events that occurred during monitoring, providing insights into factors affecting rainwater quality.

- Environmental Considerations: Rainwater quality depends on environmental factors like pollution, weather, and location. The project aims to evaluate their effect on pH levels, identifying sources of variation.
- Gaining Insights Over Time: The project analyzes long-term rainwater quality trends for researchers and decision-makers.

System Overview

I. Sensor Integration

- LM35 Temperature Sensor
- pH Sensor
- Conductivity Sensor
- Turbidity Sensor
- ARM 11 Raspberry Pi3

II. Edge Computer System

- It is important to accurately measure the pH level to efficiently monitor rainwater quality. Environmental pH sensors built just for outdoor conditions should be used for this purpose. The software produced must be able to properly read the data from the pH sensors and, if required, turn on alerts if the pH level exceeds a particular range.

  It is also important to consider data storage, visualization, and notifications since these aid in understanding acquired data. pH readings must be calibrated and tested regularly to guarantee accuracy.

  Compliance with legislation, deployment, data management, remote access, data transfer, and maintenance are all critical concerns for effective system functioning.

III. Data Processing

- In the process of monitoring rainwater pH levels, data collection is the initial step, where voltage output from the pH sensor is recorded. Subsequently, data conversion is carried out to translate this raw data into meaningful pH values using calibration curves. To ensure data accuracy, filtering techniques such as moving averages or median filters may be applied, followed by data aggregation over specific time intervals. The aggregated data is then subjected to analysis, potentially involving statistical or machine learning methods, to uncover trends and patterns. Finally, the results are presented through data visualization techniques like graphs or charts, and the comprehensive data is stored for future reference, possibly in a database or a cloud storage system.

IV. IoT Devices and Their Connectivity

- Wi-Fi is a popular communication technology that allows for simple and quicker access without the need for extra infrastructure. It is interoperable with most devices and supports numerous IoT protocols, allowing sensors and cloud services to transfer data easily. Wi-Fi also facilitates data transfer for cloud services and platforms, enabling IoT data to be stored, analyzed, and processed in real time. Wi-Fi connections are normally robust and reliable, ensuring that cloud and IoT devices are always connected. Wi-Fi networks utilize strong security protocols like WPA3 to safeguard information transfer, protecting the safety and privacy of sent data.

V. Data Storage Methods

- When collecting data from sensors like pH levels and temperature, there are two storage options. First, the data can be stored locally on the device, which allows for quick access to recent data and prevents data loss during a network outage. Second, the data can be periodically uploaded to a cloud storage system. This provides several advantages, including access to data from anywhere, easy data sharing, and the ability to store large amounts of data for a long time.

VI. System Interface

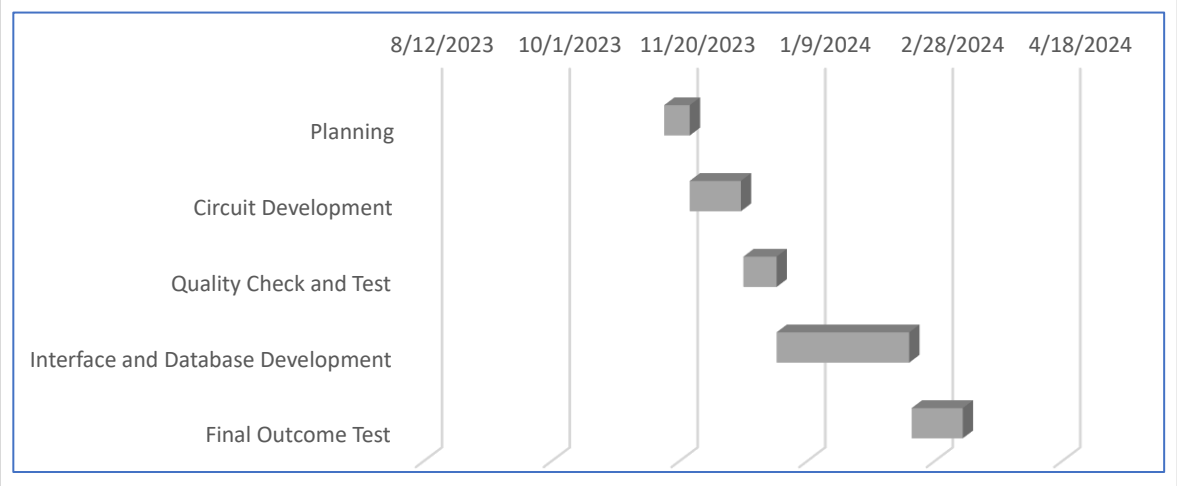
- System Understanding: To monitor a rainwater pH system, first understand how to measure pH levels and temperature, determine the acceptable range, and identify necessary actions if levels fall outside that range.
- Collecting information: Decide how to collect data, perhaps using pH sensors and temperature sensors that transmit to a central system.
- Data Visualization: Data needs clear visualization. Use graphs or alerts to show pH level changes over time and in different locations.
- System Management and Administration: A user-friendly dashboard is required for the system administrators to manage sensors, alerts, and users efficiently.
- System Configuration: The system must be customizable for different users, including pH level settings, measurement frequency, and alerts.
- User Interface (UI) Design: The user interface should be easy to use and accessible to all levels of technical expertise whilst providing clear information.
- Testing and Iteration: To ensure the system works as expected, it should be tested under different conditions, issues fixed, and continuous improvements made based on user feedback.

Expected Outcomes

- The eventual goal is to create a complete Rainwater pH Quality Monitoring System. The pH level of rainwater will be continually monitored and recorded by this device, giving significant data for environmental monitoring and research. It will comprise a weatherresistant pH sensor for continuous acidity monitoring, a microprocessor for converting raw sensor readings into usable pH values, and a Wi-Fi module for constant data transfer. Data will be captured and saved in the cloud for long-term trend analysis, event detection, and predictive modeling. The device will also have a user-friendly interface for real-time data visualization and an alert system to provide timely warnings when pH levels surpass predefined thresholds. This technology will improve our understanding of environmental changes and aid in decision-making for environmental protection and public health.

Timelines

Task	Start Date	End Date	Duration
Planning	11/14/2023	11/24/2023	10
Circuit Development	11/24/2023	12/14/2023	20
Quality Check and Test	12/15/2023	12/28/2023	13
Interface and Database Development	12/28/2023	2/18/2024	52
Final Outcome Test	2/19/2024	3/10/2024	20



References

- (No date c) *Paper open access monitoring system water ph rate ... - researchgate*. Available at:

https://www.researchgate.net/publication/338845742_Monitoring_system_water_pH_rate_turbidity_and_temperature_of_river_water/fulltext/5e2f7fac299bf10a6598edf1/Monitoring-system-water-pH-rate-turbidity-and-temperature-of-river-water.pdf (Accessed: 09 November 2023).

- (No date b) *Monitoring system water ph rate, turbidity, and temperature of river water*. Available at: https://www.researchgate.net/publication/338845742_Monitoring_system_water_pH_rate_turbidity_and_temperature_of_river_water (Accessed: 09 November 2023).
- Jan, F., Min-Allah, N. and Düştegör, D. (2021) *IOT based smart water quality monitoring: Recent techniques, trends and challenges for domestic applications*, *MDPI*. Available at: https://www.mdpi.com/2073-4441/13/13/1729 (Accessed: 09 November 2023).
- Dutta, S., Sarma, D. and Nath, P. (2015) *Ground and river water quality monitoring using a smartphone-based ph sensor*, *AIP Publishing*. Available at: https://pubs.aip.org/aip/adv/article/5/5/057151/979645/Ground-and-river-water-qualitymonitoring-using-a (Accessed: 09 November 2023).
- (No date a) *Harvesting systems: A literature review - researchgate*. Available at: https://www.researchgate.net/publication/363181261_Comprehensive_Environmental_Assessment_of_Rainwater_Harvesting_Systems_A_Literature_Review/fulltext/6310b07b5eed5e4bd1398b25/Comprehensive-Environmental-Assessment-of-Rainwater-HarvestingSystems-A-Literature-Review.pdf (Accessed: 09 November 2023).
- Zulkifli, C.Z. *et al.* (2022) *IOT-based Water Monitoring Systems: A systematic review*, *MDPI*. Available at: https://www.mdpi.com/2073-4441/14/22/3621 (Accessed: 09 November 2023).
- (No date a) *Report no. 425 rainwater harvesting: A comprehensive review of …* Available at: https://repository.lib.ncsu.edu/bitstream/handle/1840.4/8170/1_NC-WRRI425.pdf?sequence=2 (Accessed: 09 November 2023).

Group Contribution

	Plymouth ID	**Name (As appeared on DLE)**	**Contributed section**
1	10899273	Rajakaruna Gunawardhana	Sensor Integration
2	10899245	Deshitha Bandara	Edge Computer System
3	10898720	Hitige Wijewardhane	Data Processing
4	10898559	Ayagama Ekanayaka	IoT Devices and Their Connectivity

5	10898764	Gajasinghe Gajasinghe	Data Storage Methods
6	10898717	Hasindi Weraniyage	System Interface