IoT Based Water Contamination Detection System

Session: BSc. Spring 2020

Project Supervisor: Prof Dr Rabia Noor Enam

Submitted By

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Certification

IOT BASED WATER CONTAMINATION DETECTION SYSTEM

Certification

This is to certify that ISMAIL ZAHEER SHEIKH, **2020-CE-037** and **MUHAMMAD HASSAN, 2020-CE-007, SYEDA REEBA HASAN 2020-CE-005, IRFAN HAIDER, 2020-CE-003** have successfully completed the final project **IOT BASED WATER CONTAMINATION DETECTION SYSTEM** at the **SSUET** to fulfill the partial requirement of the degree **COMPUTER ENGINEERING.**

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IOT BASED WATER CONTAMINATION DETECTION

Sustainable Development Goals

(Please tick the relevant SDG(s) linked with FYDP)

SDG No	Description of SDG	SDG No	Description of SDG
SDG 1	No Poverty	SDG 9	Industry, Innovation, and Infrastructure
SDG 2	Zero Hunger	SDG 10	Reduced Inequalities
SDG 3	***Good Health and Well Being***	SDG 11	Sustainable Cities and Communities
SDG 4	Quality Education	SDG 12	Responsible Consumption and Production
SDG 5	Gender Equality	SDG 13	Climate Change
SDG 6	***Clean Water and Sanitation***	SDG 14	Life Below Water
SDG 7	Affordable and Clean Energy	SDG 15	Life on Land
SDG 8	Decent Work and Economic Growth	SDG 16	Peace, Justice and Strong Institutions
		SDG 17	Partnerships for the Goals

	Range of Complex Problem Solving		
	Attribute	**Complex Problem**	
1	Range of conflicting requirements	Involve wide-ranging or conflicting technical, engineering and other issues.	
2	Depth of analysis required	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	
3	Depth of knowledge required	Requires research-based knowledge much of which is at, or informed by, the forefront of the professional discipline and which allows a fundamentals-based, first principles analytical approach.	
4	Familiarity of issues	Involve infrequently encountered issues	
5	Extent of applicable codes	Are outside problems encompassed by standards and codes of practice for professional engineering.	
6	Extent of stakeholder involvement and level of conflicting requirements	Involve diverse groups of stakeholders with widely varying needs.	
7	Consequences	Have significant consequences in a range of contexts.	
8	Interdependence	Are high level problems including many component parts or sub-problems	
	Range of Complex Problem Activities		
	Attribute	**Complex Activities**	
1	Range of resources	Involve the use of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies).	
2	Level of interaction	Require resolution of significant problems arising from interactions between wide ranging and conflicting technical, engineering or other issues.	
3	Innovation	Involve creative use of engineering principles and research-based knowledge in novel ways.	
4	Consequences to society and the environment	Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation.	
5	Familiarity	Can extend beyond previous experiences by applying principles-based approaches.	

Abstract

The IoT-Based Water Contamination Detection System presents a cutting-edge solution designed to monitor and ensure the safety of water in pipelines. Leveraging advanced sensor technologies and Internet of Things (IoT) principles, this system excels in the swift detection of water contamination. The primary objective is to provide real-time alerts through a user-friendly mobile application, allowing immediate actions to be taken. With a commitment to ensuring safe water distribution, this system aligns with the evolving landscape of IoT technologies for a healthier and more sustainable future.

Undertaking

I certify that the project **IOT BASED WATER CONTAMINATION DETECTION SYSTEM** is our own work. The work has not, in whole or in part, been presented elsewhere for assessment. Where material has been used from other sources it has been properly acknowledged/ referred.

ISMAIL ZAHEER SHEIKH

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Acknowledgement

We truly acknowledge the cooperation and help make by PROF DR RABIA NOOR ENAM**, DIRECTOR** of **ORIC.** She has been a constant source of guidance throughout the course of this project. We would like to PROF DR RABIA NOOR ENAM**, DIRECTOR** of **ORIC.** for her help and guidance throughout this project.

We are also thankful to our friends and families whose silent support led us to complete our project.

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List of Acronyms

IOT : Internet of things

LoRaWAN: Long Range Wide Area Network

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List of Equations

Equation 1: LoraWAN Multihop Time 3

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Chapter 1

1.1 Introduction

Water, the basic and most important need of life is facing extraordinary challenges like pollution, climate change and even global warming to some extent. Therefore, access to safe and clean water has become a critical global priority. Therefore, the purpose of this project which is "IoT based Water Quality monitoring system" is to address these daily life challenges and to provide them a real time, accurate and cost-effective solution for monitoring various water quality parameters (like turbidity and TDS levels) and to make public health safe. For this, we have used IoT devices like Arduino and LoRaWAN module, sensors like turbidity and TDS, which provides wireless and long-range data transmissions from one point to another. Whenever a turbidity/TDS value becomes high, an alert will be generated and will be sent as a notification to mobile phones which will be part of our mobile application.

1.2 Statement of the problem

Access to clean and uncontaminated water is a fundamental necessity for communities worldwide. However, the increasing threats of water pollution pose a significant challenge to ensuring the safety of water supplies. The current methodologies for monitoring water quality, particularly in pipelines, often lack the immediacy required to address contamination events promptly. There is a pressing need for a comprehensive and real-time solution that not only detects water contamination in pipelines but also initiates swift and effective responses to safeguard public health.

1.3 Goals/Aims & Objectives

The primary goal of this FYP is to build a robust and scalable IoT devicee for a broad water quality monitoring. The goals are as under:

1) Selecting and integrating appropriate sensors to observe water quality parameters, in our case, sensors were turbidity and TDS.
2) Setting a secure and reliable platform for real time data transmission from sensors to a centralized cloud platform. For this communication, we have used LoRa module which is a long-range device used to transmit data from one place to another place, and that last node will be responsible to send data to cloud, in our case, we have used firebase to store real time data.
3) Implemented an automated system which is, whenever turbidity or TDS value exceeds above limit which is not safe for human health, an alert in the form of notification will be triggered and will be ultimately sent to the user of that mobile application with the name of area and a triggered message.
4) Ultimate goal is to expand its coverage in the future and to make sure that scalability and performance is not compromised.

1.4 Motivation

Some real motivations for us during the development of this project were:

1) Everybody is deeply concerned about water pollution and its effect on human's health, that is what forced us to develop a solution for this using IoT which could help us contribute to the goodness of our society.
2) We saw an opportunity to build a successful business by commercializing our solution, which is right now the need of the world, especially this city, by addressing the significant need of the market and providing the required solution to them.
3) On the other hand, this project maps 3 SDGs (Sustainable development goals) like Clean water and sanitation, Good health and well-being, and Climate action, which is a contribution to global sustainability efforst.
4) In our project, we are dealing with real time water quality monitoring data which will be shown on a mobile application, which can help communities, authorities and other water board people manage water resources effectively.
5) We were interested in contributing to the advancement of IoT-based water monitoring technologies, which leads to further research opportunities and other industrial collaborations.

1.5 Assumption and Dependencies

1. Assumptions:
   - User adoption of mobile app for alerts.
   - Adequate cellular network coverage.
   - Reliable power sources (or solar alternatives).
   - Accurate sensor measurements.
   - LoRaWAN network availability.
   - Feasible maintenance and calibration.
   - Data security measures implemented.
   - Regulatory compliance of sensors and data collection.
2. Dependencies:
   - Hardware: Arduino, LoRaWAN modules, sensors, power sources.
   - Software: Arduino firmware, mobile app, server infrastructure.
   - Connectivity: LoRaWAN/alternative, cellular network.
   - Human Resources: Technical expertise, community engagement.

   Consider: Data visualization, scalability, sustainability.

1.6 Methods

Data Acquisition:

- Deploy sensor-equipped Arduino devices at water sources.
- Sensors measure turbidity and TDS at predetermined intervals.
- Arduino processes sensor data and calculates relevant parameters.
- LoRaWAN modules transmit data to a central server wirelessly.

Data Processing and Analysis:

- Data is analyzed in real-time for anomalies and high/low parameter values.
- Alerts are triggered based on pre-defined thresholds for turbidity and TDS.

Alerting and Notification:

- Alerts are pushed to the mobile app of registered users.
- Mobile app displays water quality information and relevant alerts.

1.7 Report Overview

This project delves into the development of an IoT-based water quality monitoring system, aiming to tackle water quality issues and prioritize public health. Leveraging Arduino devices and LoRaWAN technology, this system delivers real-time, accurate, and cost-effective water quality data (turbidity and TDS) through a dedicated mobile application. Upon detecting critical parameter levels, the system triggers instant alerts, empowering users to make informed decisions.

Chapter 2

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2.1 Water Contamination detection Process

2.1.1 Internal Working of System

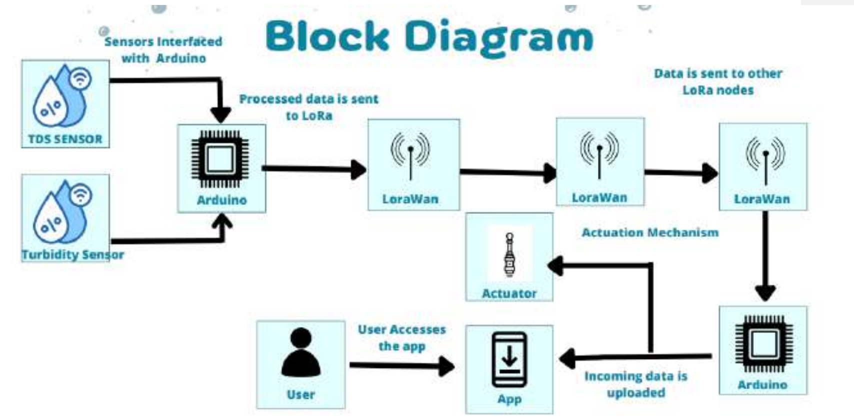

Figure 1: Internal Working of System

2.1.2 Project Design Plan

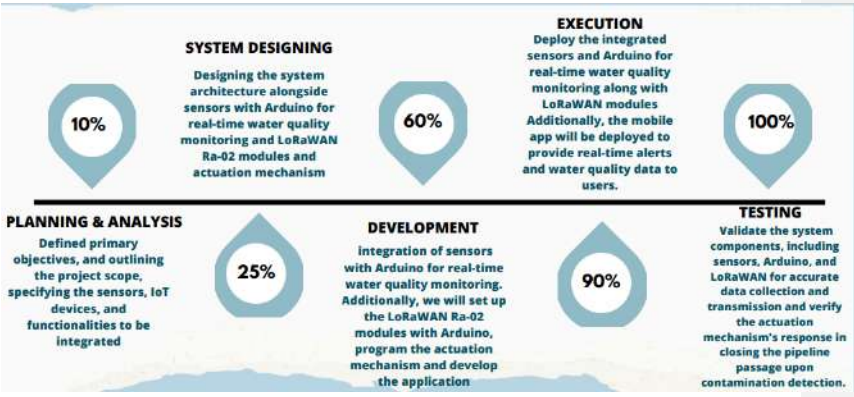

Figure 2: Design Plan

2.1.1 Project Value Proposition

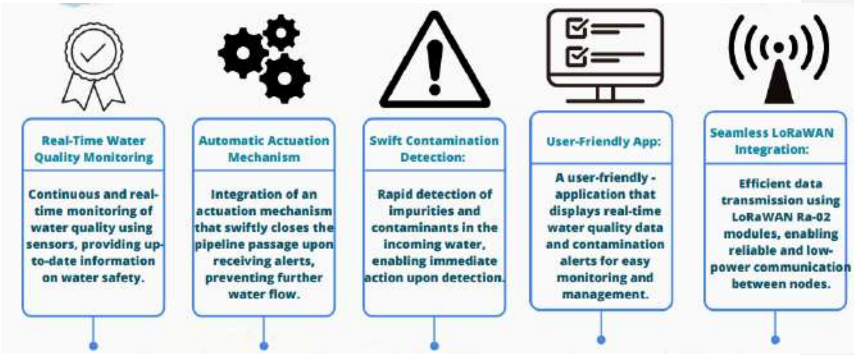

Figure 3: Value Proposition

Chapter 3

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Commented [IZS10R9]: Yes sir the equation is needed to determine to calculate the time for multihopping I have mentioned it in the document

3.1 LoraWAN Multihop time

1. Equation for calculating the total data transfer time from node A to Node C

In this section, we introduce a critical equation to calculate the time it takes for data to travel from Node A to Node C in a LoRaWAN network with multihop capability.

Equation for Total Data Transfer Time:

$$\begin{cases} 2+t & \text{when } t < 4 \\ t & \text{when } t \geq 4 \end{cases}$$

Equation 1: Total Data Transfer Time

This equation essentially provides a way to compute the total time required for data transfer based on a parameter *t*, representing the delay in the algorithm.

Understanding the Conditions:

- ***Condition 1 (When t < 4):*** If the delay (*t*) is less than 4 seconds, the total transmission time is calculated as 2+*t*. This indicates a specific scenario where a shorter delay triggers an additional fixed time of 2 seconds.
- ***Condition 2 (When t ≥ 4):*** Conversely, if the delay (*t*) is greater than or equal to 4 seconds, the total transmission time simplifies to just *t*. This reflects a different scenario where the fixed additional time is not needed.

Chapter 4

2. 4.1 Proposed Solution/Results & Discussion

Subsequent experiments were meticulously designed to scrutinize the intricate relationship between delay and multihopping efficiency. The delay parameter within the intermediate node's configuration was systematically adjusted, spanning a range from 2 to 6 seconds. These adjustments allowed us to assess the impact of varying delay times on the efficiency of multihopping in LoRaWAN networks. For each specific delay setting, a series of data transmission sessions was carried out, each meticulously monitored to record the time taken for the receiver node to capture, process, and interpret the transmitted data packets.

Time (sec)	Delay	Details
1	0	No data obtained
1.5	5	Data packets are repeated after 1 cycle
2	6	Data packets are repeated after 1 cycle
3	7	Data packets are repeated after 1 cycle
4	4	No repitation occurs in receiving data packets and 4 sec for transmission
4.5	5	5 seconds for transmission
5	5	5 seconds for transmission
6	6	6 seconds for transmission
7	7	7 seconds for transmission
8	8	8 seconds for transmission
9	9	9 seconds for transmission

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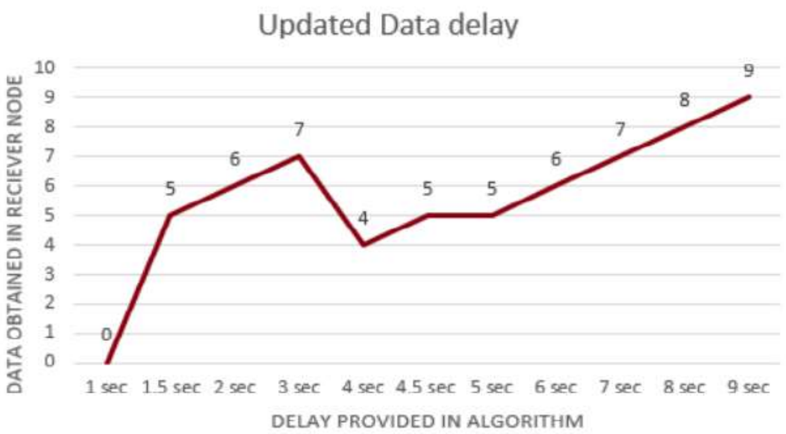

Chapter 5

3. 6.1 Summary and Future work

This project successfully developed and implemented an IoT-based water quality monitoring system, addressing vital public health concerns. The system harnesses the power of Arduino devices and LoRaWAN technology to deliver real-time, accurate, and cost-effective monitoring of key water quality parameters (turbidity and TDS). Through a dedicated mobile application, users receive instant alerts for critical parameter levels, empowering them to make informed decisions and prioritize their health.

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Summary

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This project successfully developed and implemented an IoT-based water quality monitoring system, addressing vital public health concerns. The system harnesses the power of Arduino devices and LoRaWAN technology to deliver real-time, accurate, and cost-effective monitoring of key water quality parameters (turbidity and TDS). Through a dedicated mobile application, users receive instant alerts for critical parameter levels, empowering them to make informed decisions and prioritize their health.

Future Work

While this project demonstrates the system's potential, further advancements can enhance its impact:

Expanding capabilities: Integrating additional sensors for a more comprehensive water quality analysis, including pH, temperature, and bacterial contamination.

Scalability: Exploring cost-effective methods for large-scale deployment, enabling wider community coverage and enhanced data collection.

Data analysis and visualization: Developing advanced data analytics tools to identify trends, predict potential issues, and provide actionable insights for informed decision-making.

Chapter 6

7.1 Conclusion & Recommendation

In conclusion, this project has successfully demonstrated the feasibility and effectiveness of an IoT-based water quality monitoring system. By harnessing the power of Arduino devices and LoRaWAN technology, this system offers a real-time, accurate, and cost-effective solution for monitoring vital water quality parameters. Through a dedicated mobile application, users are empowered to make informed decisions and prioritize their health by receiving instant alerts for critical parameter levels.

This project is not just a technological innovation, but a step towards safeguarding public health by ensuring access to clean and safe water. Moving forward, expanding the system's capabilities, increasing its scalability, and fostering community engagement hold immense potential to revolutionize water quality monitoring and empower communities to actively participate in protecting their health and environment. This system provides a promising foundation for building a future where clean water is a reality, not a privilege.