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Resilience Network for general flood forecast information / flood warning system

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Abstract

This project presents a solution for water level monitoring using an ESP8266 microcontroller and an ultrasonic sensor. The aim is to develop an IoT-based system that accurately measures water levels, processes the data, and transmits it to the cloud. The ESP8266 acts as a Wi-Fi hotspot and repeater, extending network coverage and enabling connectivity with other nodes. The ultrasonic sensor provides precise measurements, while the cloud platform enables efficient data storage, analysis, and remote access. Benefits include improved monitoring efficiency, reduced manual effort, and enhanced accessibility to real-time data. The wireless connectivity covers large distances, making it suitable for extensive network coverage. The cloud integration offers seamless data management, empowering decision-makers with valuable insights for water resource management. The project contributes to the field of water level monitoring, providing a cost-effective, scalable, and efficient solution. It demonstrates the capabilities of IoT devices and cloud integration in addressing real-world challenges. The outcomes have the potential to enhance flood management, water resource planning, and environmental monitoring. This project showcases the integration of IoT technologies, microcontrollers, and cloud platforms for comprehensive water level monitoring.

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Introduction

The aim of this project is to develop a system that utilizes an ESP8266 microcontroller and an ultrasonic sensor for water level measurement and cloud data transmission. By combining these technologies, the project offers an efficient and cost-effective solution for monitoring water levels and accessing the collected data remotely. The ESP8266 microcontroller acts as a Wi-Fi hotspot and repeater, allowing seamless connectivity and data transmission to the Arduino IOT cloud. The

ultrasonic sensor accurately measures water levels, providing real-time data for various applications such as flood monitoring, reservoir management, and irrigation control. The integration with cloud platforms enables users to access and analyse the data from anywhere, facilitating timely decision-making and resource management. With its wireless connectivity, affordability, and scalability, this project has the potential to revolutionize water level monitoring and contribute to sustainable water resource management practices and warn before a flood happen making people prepare for the flood event by taking action like evacuating

Research

Globally a total of 432 catastrophic events were recorded, which is considerably higher than the average of 357 annual catastrophic events for 2001-2020. Floods dominated these events, with 223 occurrences, up from an average of 163 annual flood occurrences recorded across the 2001-2020 period. During its monsoon season (June to September), India experienced a series of deadly floods that claimed 1,282 lives. In July, the Henan Flood in China was particularly severe, resulting in 352 deaths, 14.5 million people affected, and a cost of 16.5 billion US$. In

the same month, the Nuristan Floods in Afghanistan resulted in 260 fatalities. In July, the Central European Floods and subsequent landslides resulted in 40 billion US$ of economic costs in Germany alone and stood as the second most costly disaster.

In Sri Lanka we only have two seasons. Rainy season and the dry season which mean there will be two to three month of raining continuously.

Flooding in Sri Lanka brings forth numerous adverse consequences, impacting the country in various ways. Firstly, it endangers human lives, as rising water levels can lead to drownings and injuries during evacuation attempts. Such tragedies inflict profound grief and trauma upon affected communities.

Moreover, flooding wreaks havoc on the country's infrastructure. Roads, bridges, buildings, and utilities suffer extensive damage, disrupting transportation systems and impeding access to essential services. The subsequent costs of repairing or rebuilding damaged infrastructure strain the country's already limited resources.

Additionally, flooding displaces people from their homes, forcing them into temporary shelters or the homes of relatives and friends. This displacement and homelessness create social and economic hardships, disrupting livelihoods and exacerbating the burdens on individuals and the government alike.

Furthermore, Sri Lanka's agricultural sector, which forms a vital part of the economy, bears the brunt of flooding. Crops are decimated by

floodwaters, resulting in significant economic losses for farmers. This loss not only jeopardizes food security but also disrupts income stability and rural livelihoods.

In the wake of flooding, the risk of waterborne diseases escalates. Contamination of water sources and inadequate sanitation in flooded areas contribute to the spread of diseases like cholera, typhoid, and diarrhea. Vulnerable populations are particularly at risk, exacerbating the health burden on communities.

Lastly, flooding causes environmental degradation. Erosion, water pollution from debris and contaminants, and disruption of ecosystems are prevalent consequences. The loss of vegetation, soil erosion, and sedimentation in rivers and wetlands disrupt the delicate ecological balance, leading to long-term ecological consequences.

Addressing the challenges posed by flooding is of paramount importance for Sri Lanka. Implementing effective flood monitoring systems, such as the low-cost and easily implementable project described earlier, can contribute to early warning systems, improved disaster response, and enhanced protection of lives and infrastructure. Moreover, investing in flood mitigation measures, resilient infrastructure, and community education will bolster the country's ability to mitigate the adverse effects of flooding and build resilience for future events. By prioritizing these measures, Sri Lanka can mitigate the devastating impact of flooding, safeguard its people, and protect its vital infrastructure and ecosystems.

Between December 22 and 23, 2018, severe thunderstorms in northern Sri Lanka brought more than 250mm of rain. According to numerous reports, this represents the largest daily rainfall total for high lands since 1983 On December 22, 2018, high land had 365.1mm of rain in less than 24 hours. The middle lands receives 1,340mm of rainfall on average each year

Due to its two unique monsoon seasons, Sri Lanka frequently sees seasonal flooding. The likelihood of flooding varies depending on the season. Generally speaking, during the Southwest monsoon, which occurs between May and September every year, the western and southern provinces are more vulnerable to flooding, whereas the northern and north-central provinces are more likely to be flooded during the Northeast monsoon, which occurs between December and February every year (Ministry of Disaster Management, 2018). Tropical cyclones and tropical depressions commonly occur in the Bay of Bengal throughout the summer and bring heavy precipitation to Sri Lanka in addition to the monsoon seasons.

Torrential rain during the same monsoon season caused flooding in Sri Lanka a year later (May 2017). It affected at least half a million people and resulted in 140 deaths with widespread losses in Colombo, Gampaha, Kalutara, Galle and Matara. Due to the level of flooding in and around Colombo being less than the previous year (i.e. May 2016), the economic damage was lower, estimated at around LKR 29.05 billion (USD $160 million).

Sri Lanka’s National Insurance Trust Fund (NITF) operates a nationwide disaster relief programme – National Natural Disaster

Insurance Scheme (NNDIS) - helping low income homeowners and microenterprises recover from natural disasters such as flooding. The NNDIS scheme is predominantly focused on supporting those in informal or semi-permanent houses, many of whom live within the floodplain of rivers such as the Kelani Ganga. These types of villages were among the worst affected during the 2016 and 2017 floods.

Country	Economic Losses (US$ billion)
China	18.4
India	7.6
Japan	2
Thailand	0.6
Vietnam	0.5
Pakistan	0.4
Bangladesh	0.3
Philippines	0.3
Indonesia	0.2
Cambodia	0.1
Laos	0.1
Myanmar	0.1
Nepal	0.1
Sri Lanka	0.1
Afghanistan	<0.1
Bhutan	<0.1
Iran	<0.1

Background, Objectives and Deliverables

Background and Project Objectives

Flooding, Flooding cost many problems in every country around the world it unpredictable and cannot be stopped. In average flooding cost problem in 2 ways. To people life and country, itself. People lose their loved ones, their houses get destroyed and loose many of their valuable items. Also, after flood happen people having trouble rebuilding themself up. Also after a flood happen there is always some disease spreading.

- Waterborne Diseases: Flooding can contaminate water sources with sewage, bacteria, viruses, and parasites, leading to diseases such as cholera, typhoid fever, hepatitis A, and dysentery. Consuming or coming into contact with contaminated water can result in severe gastrointestinal illnesses.
- Vector-Borne Diseases: Stagnant water left behind after a flood provides breeding grounds for mosquitoes and other disease-carrying vectors. Mosquito-borne diseases like dengue fever, malaria, and Zika virus can quickly spread in flood-affected areas, putting the population at risk
- Respiratory Infections: Mold growth and dampness in flooded buildings can contribute to respiratory infections, including allergic reactions, asthma exacerbations, and fungal infections. Breathing in airborne contaminants and pollutants released during and after a flood can also lead to respiratory problems.
- Gastrointestinal Infections: Poor sanitation, limited access to clean water, and improper handling of food can lead to gastrointestinal infections such as gastroenteritis and food poisoning.

Contaminated food, inadequate hand hygiene, and improper food storage can contribute to the spread of these diseases.

- Mental Health Issues: Flooding can have a significant impact on mental health, causing stress, anxiety, depression, and post-traumatic stress disorder (PTSD). Displacement, loss of belongings, and disruption of normal routines can contribute to these psychological issues.

People life at a risk even after the flood happen. Specially pregnant woman's, kids and old peoples. I personally have my own fair share of suffering.

As a country, government they have face this problem in another way. They need to deploy emergency life support troops and services, most of them are military also its very common to Landslides to happen during the flood so there will be in need of constructing machine deploying them as soon as possible is not easy. Because Landslides can be a bother when those machines reaching their locations since. Like always every second help is late to receive there can lives reaching for death.

After the flood happen health services are needed since after every flood happen there is going to be new or old disease so that going harm people even after the flood. And another big problem country face is specially country like Sri Lanka because small country and having long

rainy season is damages to the food chain. That make low supply of food either because of there field are down in water or because of Landslides the roads are blocked or the bridges are too risky to cross. People will easy get sick because of body not having energy and in other areas people will face high prices of food items are not having food at all.

With all this having the government of the country will be forced to import food from another country which will cost a lot money and deploying machines, military and heath services going cost a lot of money to the government this impact the economy of the country and impact is double because if the country is exporting foods to other countries that will be on hold as spending money to import the food from other countries will cost money so the country income will be low and expense will rice. But at the end people taxpayers of the country will be the one who have to pick up the bill

flood can not be stopped because water need to be travel from higher point to lower point which is sea. But what we can do is prepare for it before it happen. This way we will be able to keep the casualties to the low as much we can.

In my project I am building a monitoring system that can monitor the water level. So people who responsible can know flooding before it happen and wan the authorities to act. Saving many troubles before it happens. Interesting this about this project is there will be no need for having a Wi-Fi at the every places that the device going to be planted because in this project I use Mesh technology. It’s a Wi-Fi mesh. You can

also called it as a partial mesh where not all nodes are connect to every other nodes but connected to central node trough other nodes. When the first device got connect to the Wi-Fi it will measure the water level as well as act as hotspot or as a repeater for other node and other node will do the same. Devices will be planted both sides in the river or the water stream to a zigzag pattern on the platform that similar to Bisokotuwa/sluice gate. This will prevent any disturbance for the ultrasonic senor such as floating object on the ultrasonic sensor way. If this happen information about the water will be fouls. And planting on a structure like this will also prevent from getting stolen.

The device will monitor the water level using an ultrasonic sensor then will send the data to the cloud Dahs bored that make it easier for user to understand. I am using Arduino IOT Cloud. I have tired using Cayenne My Device which not supported to ESP and then the Google IOT platform. But now I am using Arduino IOT cloud.

Feasibility

Suggested system will be easy to interact because of having an GUI. Also using cloud mean user can monitor the data from anywhere in the world. Also cloud enables update over the air so if the system need to be updated user can updated it using cloud app

- Technical Feasibility: From a technical standpoint, this project is feasible. The utilization of an ESP8266 microcontroller, ultrasonic sensor, and cloud connectivity provides the necessary hardware and software components to measure water levels and transmit the data to the cloud. The availability of these components and their compatibility make the technical implementation feasible.

- Economic Feasibility: Examining the project's cost-effectiveness is necessary to determine its economic viability. The hardware costs are kept reasonably low thanks to the use of commonly accessible and affordable components like the ESP8266 microcontroller and ultrasonic sensor. Utilizing cloud connectivity also gets rid of the requirement for pricey infrastructure. Overall, the project is financially viable since it provides a more cost flood monitoring solution than current systems.

- Operational Feasibility: Examining the operational feasibility involves evaluating the practicality of implementing and maintaining the system. The project utilizes user-friendly interfaces to access real-time water level data, making it easy for individuals, emergency responders, and authorities to utilize the

system effectively. The system's ability to act as a Wi-Fi hotspot or repeater simplifies the process of connecting neighboring nodes and expands the data collection network. These features contribute to the operational feasibility of the project.

- Environmental and Social Feasibility: Considering the environmental and social impact of the project is crucial. By providing real-time water level data and enhancing flood monitoring capabilities, this project contributes to the safety and well-being of individuals and communities. It enables proactive measures to mitigate the impact of flooding, reducing property damage and potential loss of life. The system also facilitates data collection for research and planning purposes, leading to informed decision-making and the development of effective flood mitigation strategies.

Deliverables

- Cloud monitoring: since the devices are connected to the cloud it user can monitor it anywhere from the earth. It also real time monitoring and you also can connect other services to the cloud
- Using ultrasonic waves: because of this the device will be not get in touch with water preventing it damaged by water or getting rusty.

- Wi-Fi mesh: because of this all the nodes will have internet access. One node will connect to the Wi-Fi and act as a hotspot/ repeater so other nodes can connect as well.

Technologies

- ESP8266 Microcontroller: The ESP8266 microcontroller serves as the central processing unit of the system. It is a low-cost and highly versatile microcontroller with built-in Wi-Fi capabilities, making it ideal for connecting to the internet and transmitting data to the cloud. The ESP8266 enables communication between the ultrasonic sensor and the cloud platform, ensuring seamless data transfer
- Ultrasonic Sensor: An ultrasonic sensor is employed to measure the water level accurately. It emits high-frequency sound waves and measures the time taken for the waves to bounce back after hitting the water surface. This data is then converted into distance, providing real-time water level readings. Ultrasonic sensors are widely used due to their reliability, cost-effectiveness, and non-contact measurement capabilities
- A Wi-Fi mesh network is a type of wireless network architecture that consists of multiple Wi-Fi nodes working together to provide seamless coverage and improved performance. In a traditional Wi-Fi network, a single wireless router is responsible for transmitting the signal and connecting devices. However, in a mesh network, multiple interconnected nodes collaborate to create a unified and extended network. Each node in a Wi-Fi mesh network serves as a Wi-Fi access point and a router. They

communicate with each other wirelessly, forming a self-configuring and self-healing network. This means that if one node fails or experiences a weak signal, the other nodes automatically reroute the data to ensure uninterrupted connectivity.

- MQTT (Message Queuing Telemetry Transport) is a lightweight messaging protocol designed for efficient communication between devices and applications in a publish-subscribe model. It is widely used in Internet of Things (IoT) and other machine-to-machine (M2M) scenarios where low bandwidth, high latency, and limited resources are common.

- The MQTT protocol operates on a client-server architecture, where a broker acts as an intermediary between publishers and subscribers. The publisher sends messages, known as "publish" messages, to the broker with a specified topic. Subscribers, on the other hand, subscribe to specific topics of interest and receive messages published under those topics.

Literature review

For several purposes, such as flood management, water resource planning, and environmental monitoring, water level monitoring is essential. Traditional methods of measuring water levels entail manually gathering data or using wired sensors, which can be time-consuming and restrict data accessibility. The emergence of IoT technology in recent years has paved the way for more sophisticated and effective monitoring systems.

IoT devices and sensors have been the subject of numerous research on water level monitoring. These experiments show how ultrasonic sensors can measure water levels correctly and how well they work with microcontrollers like the ESP8266. Ultrasonic sensors provide non-contact and accurate measurements by measuring the distance between the sensor and the water's surface using sound waves.

IoT device and cloud platform integration has become a well-liked strategy for data archiving, analysis, and remote access. Scalability, data redundancy, and real-time monitoring are all features of cloud-based solutions. IoT-based water level monitoring systems have been successfully implemented by researchers, who used cloud platforms for data transmission and analysis.

The usage of microcontrollers, like the ESP8266, for wireless connectivity and data transfer is a crucial topic that has been covered in the literature. By acting as Wi-Fi hotspots or repeaters, these microcontrollers increase network coverage and make it possible to send data to the cloud. Studies have shown that employing ESP8266 microcontrollers in IoT applications, such as water level monitoring, is both feasible and beneficial.

The literature review also emphasizes the value of alarms, remote monitoring, and real-time data access for water level monitoring devices. Proactive responses to shifting water levels are made possible by timely notifications, reducing risk and promoting sound decision-making.

Despite the fact that recent study has made a substantial contribution to the discipline, there are still open questions and areas that may use more investigation. The goal of the current project is to close these gaps by creating an all-inclusive solution that combines an ultrasonic sensor, an ESP8266 microcontroller, and a cloud platform. The project aims to provide an effective and affordable solution for water level monitoring and management by utilizing wireless connectivity, cloud storage, and real-time data processing.

Overall, the literature study demonstrates the development and promise of IoT-based water level monitoring systems and serves as a foundation for the proposed research. The project aims to advance the current body of knowledge, add to the developing

body of knowledge in this area, and provide useful advice for efficient use of water resources.

Other systems

1. Stream Gauges: Stream gauges are devices installed in rivers to measure water levels and flow rates. These gauges typically consist of a water level sensor and a data collection unit. The collected data helps monitor river water levels and provides crucial information for flood forecasting and water resource management.
2. Satellite Remote Sensing: Satellite remote sensing technology allows for the monitoring of large river systems and their water levels from space. Satellites equipped with radar or laser altimeters can measure water levels by bouncing signals off the Earth's surface. This data helps monitor river dynamics, flood extent, and changes in water levels over time
3. Telemetry Systems: Telemetry systems involve the use of sensors placed in rivers that wirelessly transmit real-time water level data to a central monitoring station. These systems often use radio, cellular, or satellite communication to transmit the data. Telemetry systems enable continuous monitoring and rapid data collection from multiple locations, aiding in flood prediction and early warning systems.
4. Flood Forecasting Models: Many countries employ sophisticated flood forecasting models that utilize inputs such as rainfall data, river flow measurements, and topographic information. These models simulate the behavior of river systems and predict water

levels and flood extents based on current conditions and future weather forecasts. Flood forecasting models help authorities issue timely warnings and implement appropriate flood management strategies.

5. Automatic Weather Stations: Automatic weather stations positioned near rivers can provide valuable data on rainfall patterns and atmospheric conditions. This information, combined with river flow measurements, assists in understanding the factors contributing to changes in water levels. Automatic weather stations contribute to flood monitoring efforts by providing comprehensive meteorological data.

Advantageous

1. Affordability: Sri Lanka, like many developing countries, faces budget constraints when it comes to implementing extensive flood monitoring systems. This project offers a cost-effective solution by utilizing affordable components such as the ESP8266 microcontroller and ultrasonic sensor. The low cost makes it feasible to deploy multiple monitoring stations across the country, enhancing coverage and accuracy of water level measurements.
2. Ease of Implementation: The project's simplicity in terms of hardware setup and software development makes it accessible for implementation in Sri Lanka. It does not require complex infrastructure or specialized technical expertise, enabling local communities to adopt and deploy the system with relative ease. This ease of implementation facilitates quicker deployment and wider coverage, ultimately enhancing flood monitoring capabilities across the country.

3. Real-Time Data: The project's focus on real-time data collection and transmission is crucial for effective flood management in Sri Lanka. By providing real-time water level information, the system enables authorities to monitor and respond promptly to changing flood conditions. This timely data empowers decision-makers to issue accurate warnings, mobilize resources efficiently, and implement targeted mitigation measures, thus reducing the impact of flooding on vulnerable communities.
4. Community Empowerment: The low cost and simplicity of the project also make it conducive to community involvement. Local communities can actively participate in the installation and maintenance of the monitoring system, fostering a sense of ownership and empowerment. This participatory approach strengthens community resilience, as individuals become actively engaged in flood monitoring and response efforts.
5. Wi-Fi mesh: Extended Coverage, Wi-Fi mesh networks can cover a larger area compared to traditional single-router setups. By placing multiple nodes throughout a space, the network can provide consistent and reliable Wi-Fi coverage in every corner. Seamless Roaming, with a Wi-Fi mesh network, devices can seamlessly roam between different nodes without experiencing any interruptions or drops in connection. This is particularly useful in environments where mobility is required, such as homes or offices. Improved Performance, Mesh networks distribute the network load across multiple nodes, resulting in better performance and reduced congestion. This enables devices to connect to the nearest and strongest signal, ensuring faster and more stable connections. Easy Setup and Management, Setting up a Wi-Fi mesh network is typically straightforward, often involving a simple app-based configuration process. Additionally, most mesh

systems offer centralized management, allowing users to monitor and control the network from a single interface

6. Using MQTT: MQTT is designed to be lightweight and efficient, making it suitable for resource-constrained devices and networks. The protocol uses a minimal amount of bandwidth and has a small code footprint, enabling it to run on devices with limited processing power and memory. MQTT follows a publish-subscribe messaging pattern, where publishers send messages to specific topics, and subscribers receive messages based on their subscriptions to those topics. This decoupling allows for flexible and scalable communication between multiple devices and applications. MQTT supports different levels of message delivery assurance. There are three QoS levels: QoS 0 (at most once), QoS 1 (at least once), and QoS 2 (exactly once). The QoS level chosen determines the reliability and guarantees of message delivery. MQTT allows asynchronous communication, meaning that publishers and subscribers do not need to be actively connected at the same time. Messages are stored in the broker's queue until the intended recipient becomes available, ensuring reliable message delivery even in intermittent network conditions MQTT uses topic-based filtering to determine which messages are sent to which subscribers. Subscribers can use wildcard characters to subscribe to multiple topics or specific subsets of topics, allowing for efficient message routing and filtering based on application needs.

Method Of Approach

Achieving this is not an easy target but understanding the problems and what is the suitable way we can plan the project with more details.

1. Data Collecting

- By reading news papers and finding new from media and meeting people who work as emergency service and people who know about the water stream. Able to understand how much time service team take to respond and how water stream cost flooding.
- Stakeholder Consultations: Organizing meetings and consultations with relevant stakeholders, such as government officials, local authorities, disaster management agencies, and NGOs working on flood-related initiatives, can provide valuable insights. These discussions can shed light on ongoing efforts, current policies, and the feasibility of integrating the proposed project into existing frameworks
- Site Visits and Case Studies: Visiting areas prone to flooding and documenting specific instances and their impacts can help gather on-ground data. Examining infrastructure projects designed to mitigate flooding, such as dams, embankments, and drainage systems, can provide insights into their effectiveness and identify areas for improvement.
- Reviewing Research and Academic Studies: Conducting a comprehensive review of existing research papers, academic

studies, and technical reports on flood management and disaster response can provide a wealth of information. Analyzing these sources can help identify gaps in knowledge, best practices, and potential opportunities for innovation.

- Collaborating with Research Institutions: Collaborating with research institutions, universities, or organizations working on flood-related research can provide access to specialized knowledge and expertise. Building partnerships can facilitate data sharing, technical guidance, and access to resources that support the development and validation of the project

2. System design

- Component Identification: The first step in system design involved identifying the key components required for the project, including the ESP8266 microcontroller, ultrasonic sensor, and cloud platform. Each one of them were selected knowing how they work together.
- Architecture Design: The system's overall architecture was designed, outlining how the components would interact and function together. This included defining the roles and responsibilities of each component like the role of the ESP8266 acting as a Wi-Fi hotspot and repeater, the ultrasonic sensor measuring water levels, and the cloud platform storing and showing the dat to the user in real time
- Data Flow and Communication: The data flow and communication between the components were established. This involved determining how the ESP8266 would collect data from the

ultrasonic sensor and then process it and transfer the data to the cloud platform. The communication protocols and interfaces

- User Interface: user interface is provided by the cloud. The different widget can be added base on user like and on the supported data type.

3. Hardware Setup

- Connecting the components: The ultrasonic sensor and ESP8266 microcontroller were connected during the hardware setup. The correct pins on both components had to be located, and the needed electrical connections had to be made. To avoid any loose wiring or defective connections, great care was taken to ensure perfect alignment and tight connections.
- Power Supply: The hardware setup included providing a stable and appropriate power supply to both the ESP8266 and the ultrasonic sensor. This involved connecting the microcontroller to a reliable power source, such as a USB cable or an external power supply, and ensuring the voltage and current requirements of the components were met. Adequate power supply is essential for the proper functioning of the system.
- Architecture Design: The system's overall architecture was designed, outlining how the components would interact and function together. This included defining the roles and responsibilities of each component, such as the ESP8266 acting as a Wi-Fi hotspot and repeater, the ultrasonic sensor measuring water levels, and the cloud platform storing and analyzing the data.

- Mounting and Positioning: For precise water level readings, the mounting and positioning of the hardware components were essential. The ultrasonic sensor was put in an appropriate spot so that it could accurately and unhindered measure the water level. The ESP8266 microcontroller's placement was chosen to maintain a solid Wi-Fi connection and ensure accessibility for setup and maintenance.
- Enclosure and Protection: As part of the hardware setup, proper enclosures and protection were offered in order to guarantee the system's lifetime and endurance. In order to protect the components from environmental elements like moisture and dust, enclosures or casings were used. Additionally, precautions were taken to shield the parts from physical harm or unintentional damage.

4. Software Development

- selecting the Program Language: Choosing the right programming language for the ESP8266 microcontroller was a step in the software development process. The microcontroller's capabilities and the availability of the libraries and frameworks, and the simplicity of development were all considered. To ensure effective and efficient implementation of the specified functionalities, the programming language was chosen.

- Connecting and working with Cloud Platform: During the software development phase, the program was also integrated with the selected cloud platform. This requires setting up the needed APIs or MQTT protocols for data exchange, configuring the necessary credentials and endpoints for data transfer, and guaranteeing seamless integration between the microcontroller and the cloud platform. The program was created to make it easier to move data securely and effectively to the cloud for archiving and analysis.

5. Testing and Validation

- Functional Testing/Program it self: Functional testing involved confirming that the system works properly and satisfies the required specifications. The ESP8266 microcontroller and ultrasonic sensor were tested individually to make sure they accurately carried out their intended functions. To ensure smooth communication and data flow, the integration between the components was also tested. The features were validated using a variety of test cases, including analyzing the accuracy of water level readings, verifying data transmission to the cloud, and testing the system's responsiveness.
- Validation with Real-world Scenarios: Validation with real-world scenarios aimed to assess the system's performance and reliability in practical conditions. This involved conducting tests in different environmental conditions, such as variations in water levels, temperature, and humidity. The system's ability to provide

accurate and consistent measurements in these scenarios was evaluated. Additionally, the system's long-term stability and durability were assessed by running the system continuously over an extended period to ensure it can sustain reliable operation

Requirements

- ESP8266 Microcontroller: The project requires an ESP8266 microcontroller as the central processing unit to collect and process data from the ultrasonic sensor, establish a Wi-Fi connection, and facilitate communication with the cloud platform. The microcontroller should have sufficient processing power, memory, and connectivity capabilities to handle the required tasks.
- Ultrasonic Sensor: An ultrasonic sensor is a critical component for measuring water level. The sensor should be compatible with the ESP8266 microcontroller and capable of accurately measuring distances. It should have appropriate range and resolution to capture the water level readings effectively. Male to female cables are used to establish the necessary connections between the sensor and the microcontroller.
- Wi-Fi Connectivity: The project relies on Wi-Fi connectivity to transmit data from the microcontroller to the cloud platform. Therefore, a stable and reliable Wi-Fi connection is essential. The ESP8266 microcontroller should support Wi-Fi connectivity and have the necessary capabilities to connect to the local network or act as a Wi-Fi hotspot/repeater to enable data transmission.
- Cloud Platform: The project requires a cloud platform for storing and analyzing the collected water level data. The cloud platform

should support data storage, provide APIs or MQTT protocols for data transmission, and offer data visualization and analysis capabilities. Integration with the chosen cloud platform should be feasible and well-documented

- Power Supply: A reliable and appropriate power supply is necessary to ensure the continuous operation of the system. The power supply should meet the voltage and current requirements of the microcontroller and other connected components. This can be achieved using a USB cable connected to a power source or an external power supply, depending on the project's specific needs.
- Male to Female Cables: Male to female cables are used to establish the connections between the ultrasonic sensor and the ESP8266 microcontroller. These cables should be of suitable length and provide secure and reliable connections to ensure data transmission without interference or signal loss
- Buck Converter: have used to control the power input just in case if a high voltage came without harming the ESP and the sensor only the buck converter will be damaged .

End Project Report

After the successful implementation of this project, the monitoring system for water levels during flooding scenarios will bring numerous advantages to people, communities, and authorities. The utilization of cutting-edge technology, including an ESP8266 microcontroller, an ultrasonic sensor, and cloud connectivity, will provide real-time data on water levels, enabling prompt responses and proactive measures to mitigate the impact of floods.

During a flooding event, the system will continuously measure water levels and transmit the data to a secure cloud platform. This real-time information can be easily accessed by individuals, emergency responders, and local authorities through a user-friendly interface. By having accurate and up-to-date water level readings, decision-makers can assess the severity of the flooding, anticipate potential risks, and allocate resources effectively to respond to the situation.

One of the notable advantages of this system is its ability to act as a Wi-Fi hotspot or repeater. This feature allows nearby nodes and devices to connect to the network and share their own measurements with the cloud. By creating a network of interconnected devices, a broader and more comprehensive view of the flooding situation can be obtained. This collaborative approach enhances the precision and coverage of data collection, resulting in more informed decision-making and improved flood management strategies.

The availability of real-time water level data empowers individuals and communities to make informed decisions regarding their safety and well-being. Residents in flood-prone areas can access the data through mobile applications or web platforms, enabling them to monitor water levels and take necessary precautions to protect their properties and evacuate if required. This increased situational awareness can significantly reduce potential risks associated with flooding and minimize property damage, saving lives and resources.

Furthermore, the data collected from the system's deployment will contribute to a better understanding of flood patterns and behavior over time. Researchers and urban planners can analyze historical data to identify flood risk areas, uncover patterns, and develop effective mitigation plans. This knowledge can inform the construction of early warning systems, urban planning projects, and infrastructure upgrades, improving the overall resilience of flood-prone areas and enhancing the ability to respond to future flooding events.

Another advantage of this project is its low-cost nature, making it accessible and easily deployable in various locations. In case of any node failures, the system can be quickly repaired or replaced with minimal disruption. This scalability and flexibility ensure the long-term sustainability and effectiveness of the project, even in challenging environments.

In conclusion, the implementation of this monitoring system for water levels during flooding scenarios brings numerous benefits to Sri Lanka. It provides real-time data, enhances situational awareness, supports informed decision-making, and contributes to long-term flood management strategies. The low-cost and simplicity of implementation make this project a valuable asset in mitigating the adverse effects of flooding, protecting lives, and preserving critical infrastructure.

In conclusion, the deployment of this project will revolutionize flood monitoring and response mechanisms. The integration of an ESP8266 microcontroller, ultrasonic sensor, and cloud connectivity offers real-time water level data, facilitating proactive decision-making and effective resource allocation. Individuals, communities, and authorities

will benefit from enhanced situational awareness, improved preparedness, and the ability to implement targeted flood mitigation measures. By leveraging technology and collaborative data collection, this project contributes to building resilient communities and mitigating the devastating impacts of flooding.

Conclusion

In conclusion, the implementation of this project, which involves monitoring water levels during flooding scenarios using an ESP8266 microcontroller, an ultrasonic sensor, and cloud connectivity, offers significant advantages and holds great promise for addressing the challenges posed by flooding.

By providing real-time data on water levels, the system empowers individuals, communities, and authorities to make informed decisions and take proactive measures to mitigate the impact of floods. The availability of accurate and up-to-date information enhances situational awareness, enabling prompt responses and resource allocation. This can result in more effective evacuation plans, property protection measures, and overall risk reduction.

The system's ability to function as a Wi-Fi hotspot or repeater is a valuable feature, as it facilitates the establishment of a network of

connected devices. This collaborative approach enhances the precision and coverage of data collection, enabling a comprehensive view of the flooding situation. By leveraging this network, decision-makers can obtain a better understanding of flood patterns, behavior, and risks, leading to improved flood management strategies and more resilient urban planning.

Moreover, the accessibility and low cost of implementing this project make it an attractive solution, particularly in flood-prone areas like Sri Lanka. The simplicity of the hardware setup, including the use of male-to-female cables, ensures ease of deployment and maintenance, while the scalability of the system allows for expansion and adaptation to different locations and scenarios.

The benefits of this project extend beyond immediate flood response and management. The data collected over time can contribute to valuable insights for researchers, urban planners, and policymakers. Analysis of historical data can inform the development of early warning systems, effective mitigation plans, and infrastructure improvements, enhancing the long-term resilience of flood-prone areas.

Overall, the successful deployment of this project holds the potential to significantly improve flood monitoring and management in Sri Lanka. It offers a cost-effective and efficient solution that can save lives, protect properties, and enhance the overall resilience of communities in the face of flooding. With ongoing development and refinement, this system can be a valuable tool in mitigating the adverse effects of floods and contributing to a safer and more sustainable future.

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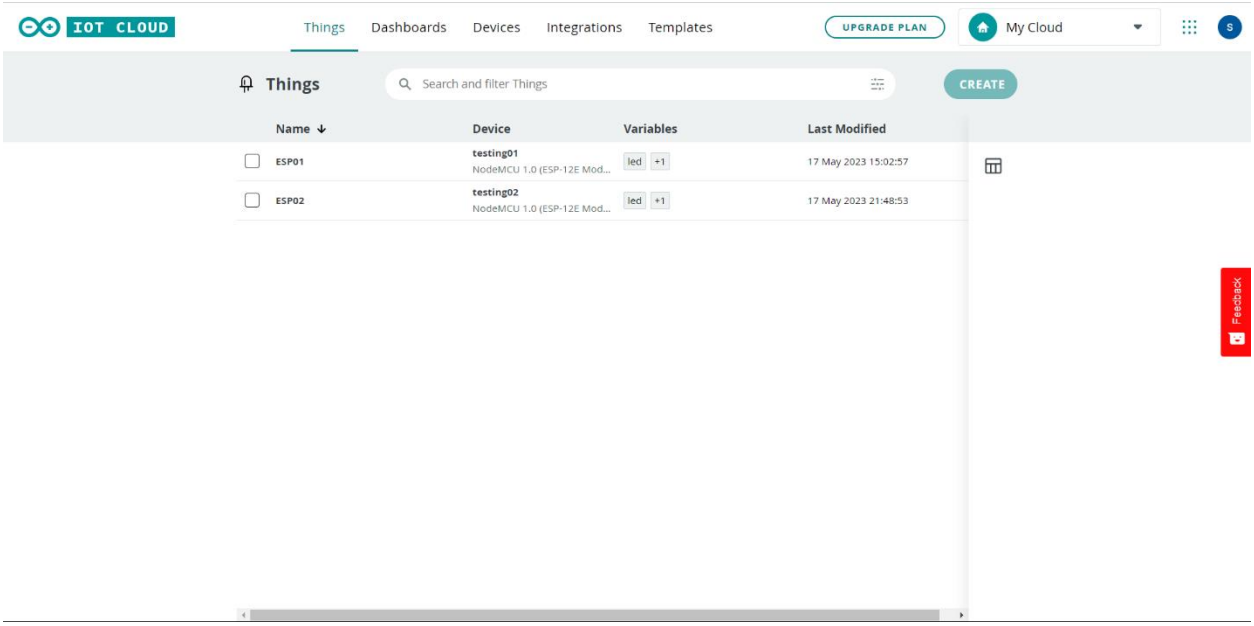
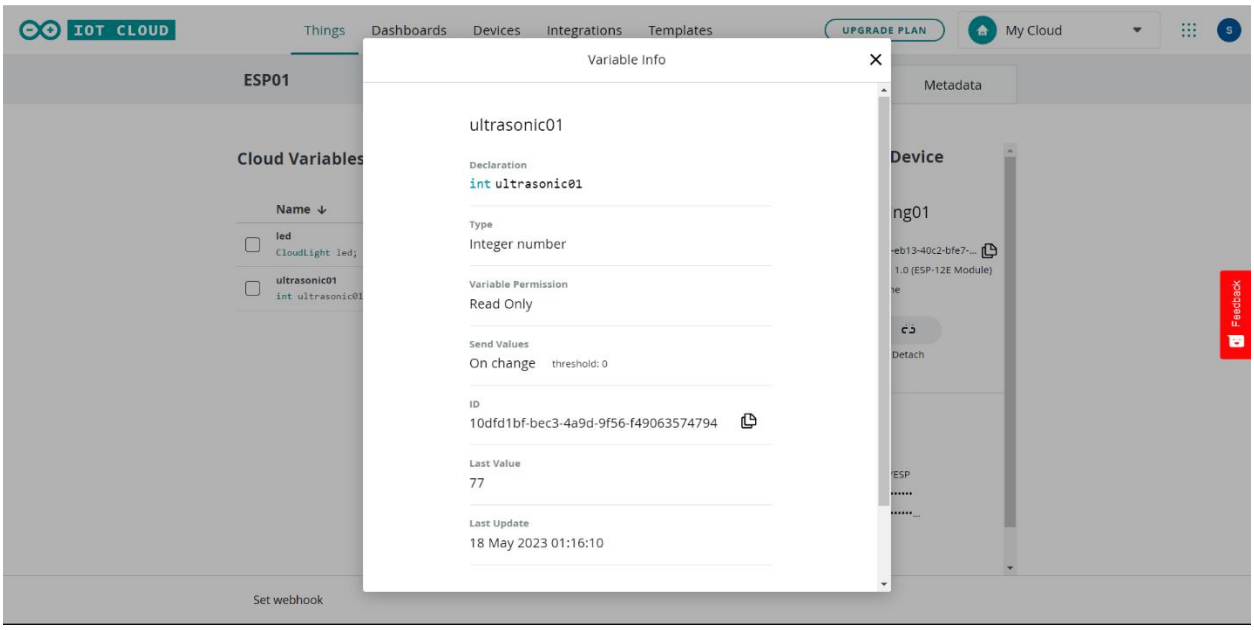
Flooding in Sri Lanka 2018 (no date) JBA. Available at: https://www.jbarisk.com/products-services/event-response/flooding-in-sri-lanka-2018/#:~:text=The%20economic%20damage%20to%20households,year%20later%20(May%202017). (Accessed: 18 May 2023).

Appendices

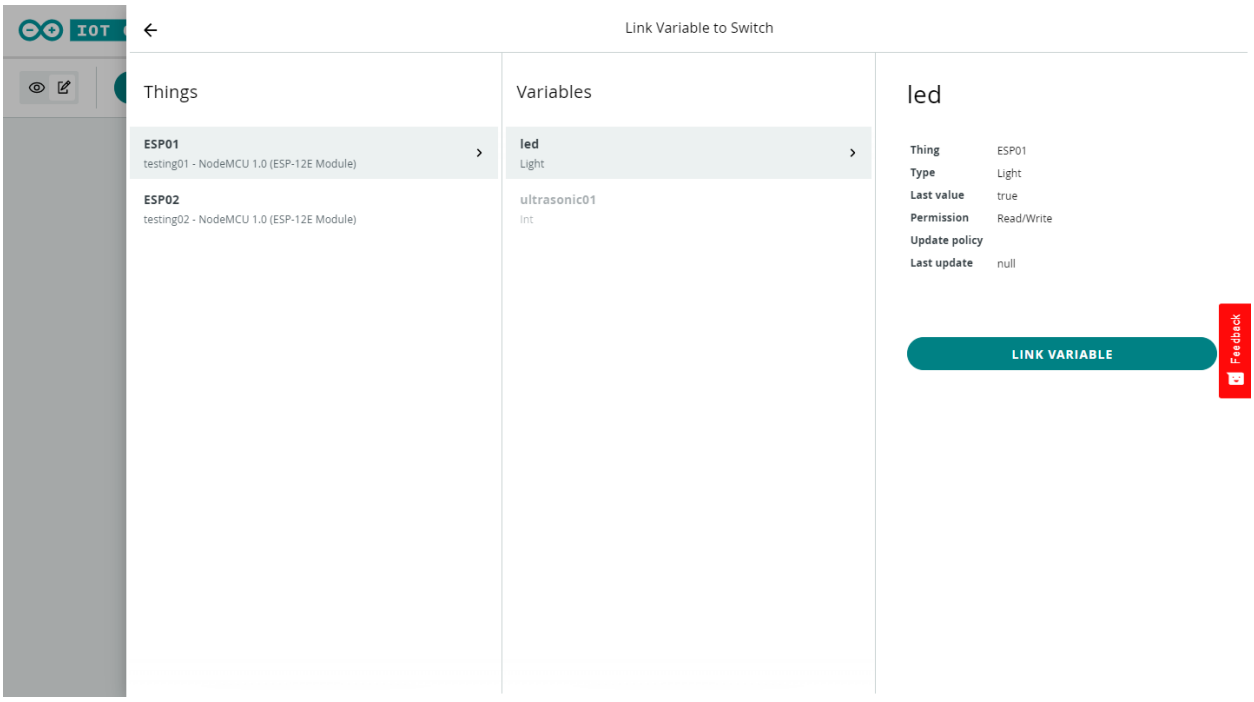
Creating things on the Arduino IOT Cloud. It simply mean that you chose the device you are going to connect and provide the version. And cloud will assign a device id and a key. Those must be same in your code as well



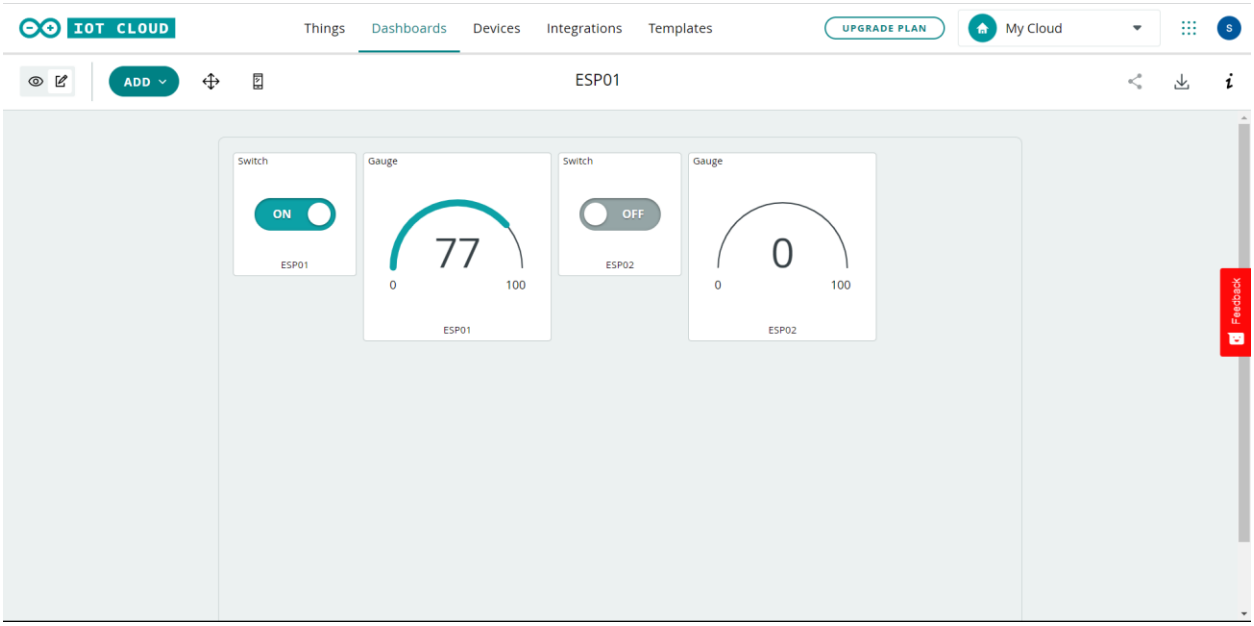
In this step we create a veriable that our data is get stored and then tranfer to the cloud. In the code it must be the same.



And then we navigate to the dashboard and link the variable we have created



This is the dashboard where the user will be able to monitor the data from nodes.



User Guide

- Users need to log in to the Arduino IOT Cloud account.
- Then the user have to click on the IOT Cloud
- Then navigated to Dashboard
- Click on the Dashboard and monitor the data using widget

Faced Obstacles and Challenges

Due to the inflation problem currently faced by Sri Lanka, I encountered significant challenges related to the shortage of money and the unavailability of certain items required for my project. The economic instability and rising prices have made it difficult to procure the necessary components and materials for the implementation of the project.

The inflation issue has resulted in an increase in the cost of goods and services, including electronic components and hardware required for the project. The limited availability of foreign exchange and the depreciation of the national currency have contributed to the soaring prices of imported items. As a result, the affordability and accessibility of these components have been greatly impacted, posing financial constraints for individuals like myself who are working on projects with limited budgets.

In such circumstances, I had to explore alternative options, such as seeking local substitutes or second-hand components, in order to

proceed with the project within the available resources. Creative problem-solving and resourcefulness became essential to overcome the challenges posed by the money shortage and scarcity of items.

Despite the obstacles faced, the project was able to progress with the support of local suppliers, fellow enthusiasts, and the friends of the IOT community. Collaboration and sharing of resources and knowledge became crucial in finding viable solutions and workarounds.

The experience of navigating the financial constraints and scarcity of items due to the inflation problem has provided valuable insights into the realities of working on projects in challenging economic conditions. It has fostered adaptability, resourcefulness, and an appreciation for the importance of sustainable and self-reliant approaches to overcome such hurdles.

After that I had a problem with the platform I was going to use. First the Cayenne MyDevice which was not accepting ESP to there platform. Then my next solution was Google IOT platform. I finished my project and after one-two week the platform had trouble connecting device . it was not about the free trial I was having it was platform not working well all the people including me had look for another platform. I had to start my project over again.

Then I moved to using Arduino IOT Cloud which is free and easy to use but the problem was when coding you have to code in the cloud and then upload your code to the board. But the painless mesh I was using

before had trouble because in cloud IDE it ask for LittleFS library which only support for esp32.

I found away to code in Arduino desktop IDE and use the sketch fine that cloud IDE use to connect to the cloud. Even Tho

The painless mesh was not compatible with the cloud. So I used a wifi that now allow me to communicate with the cloud.

Summery

This project aims to develop a flood monitoring system using an ESP8266 microcontroller and an ultrasonic sensor. The system enables real-time measurement of water levels and data transmission to the cloud for further analysis and monitoring.

The ESP8266 microcontroller serves as the central processing unit, responsible for controlling the sensor and data transmission. It is a low-cost and easily programmable device, making it ideal for this application. The ultrasonic sensor is used to measure the distance between the sensor and the water surface, allowing for accurate determination of water levels. This sensor operates by emitting ultrasonic waves and measuring the time taken for the waves to bounce back after hitting the water surface.

The project incorporates a comprehensive research design, including a literature review to understand the existing flood monitoring systems and their limitations. The hardware setup involves connecting the ultrasonic sensor to the microcontroller, which acts as a Wi-Fi hotspot and data repeater. The software development encompasses designing the user interface, implementing data processing algorithms, and establishing cloud connectivity.

Testing and validation are essential stages to ensure the accuracy and reliability of the system. The project undergoes rigorous testing to verify the sensor readings and the successful transmission of data to the cloud. The system is evaluated in various scenarios to validate its functionality and performance.

During the testing phase, the sensor readings are thoroughly evaluated to validate their accuracy and consistency. This involves conducting controlled experiments where the water levels are manually adjusted and compared with the sensor measurements. By analyzing the data collected during these tests, any discrepancies or deviations can be identified and addressed.

The transmission of data to the cloud platform is also subjected to rigorous testing. This includes evaluating the reliability of the data transfer process, ensuring that the system can consistently and securely transmit the sensor data to the cloud without any loss or corruption. Various network conditions and scenarios are simulated to assess the system's resilience and performance under different circumstances.

Validation is conducted to assess the system's overall functionality and performance in real-world scenarios. The system is deployed in areas prone to flooding, and its operation is monitored and evaluated during actual flood events. This validation process helps to ensure that the system performs as intended, providing accurate and timely water level information during critical situations.

After deployment, the flood monitoring system will provide real-time water level information to assist individuals, emergency responders, and authorities in making informed decisions. By proactively monitoring water levels, it helps mitigate the impact of flooding, reducing property damage and potential loss of life. The system's cloud integration allows for data storage and analysis, enabling long-term trend analysis and informing flood management strategies.

In conclusion, this project presents a feasible and practical solution for flood monitoring. It leverages readily available components, combines hardware and software expertise, and integrates cloud technology to provide real-time data and enhance flood preparedness. By implementing this system, communities can benefit from improved flood monitoring capabilities and better decision-making in flood-prone areas.

PID

Introduction

Introduction

- There has been many deaths and property damage over the years cost by flooding, but research shows that it’s not only because of the flood instead it because of not knowing, not have warn before the flood happened. After the flood happen people of that particular region or area has to face another big problem which is spreading disease so even after the flood over there can be civilian casualties such as in the most case death of children under age 10. and then the country's economy will take a big impact because they held responsibility to help the citizens. Much research has suggested that there is a urgent need of a flood warning system to warn responsible of the government.

Current Situation and the problem

- Currently there are no Automated system to warn people. Someone has go to certain place Build near the river that have a measurement stick and see what the water level of the river is. This brings few problems delay of the information, unavailability, not getting accurate data. Because of this many public and private property damage and death have happened. Recent case was 2022/11/15 because of the high rain in the higher land 3 kids lost their life due to the sudden increase of water level.

Solution

- The solution I'm suggesting here is to build a system to warn before a flood happen. It will not say that a flood will happen, but it will send data to responsible people such as Naturel Disaster Management Department or Department of Irrigation from then on, they be able to warn people. This IOT device will be able to detect, measure the water level of the river and send that data to the cloud where the people can monitor using a Dashboard.

Current water measuring method.

Business Case

Impotency of having a Resilience Network for general flood forecast information / flood warning system

Why is this important

- Most importantly people's life will be saved by this and for long term damage done by flood to the private and public properties will be minimum. Not to mention that the Viruses and many illnesses that spreading can be avoided because for this reason country health care system will be ready to deploy and start their health

care system and other forces also will be ready for save people in trouble.

Why this system needed

- Having a Resilience Network for general flood forecast information is essential for communities to effectively prepare and respond to potential flooding events. Without access to accurate and up-to-date information, individuals and communities are left vulnerable and unable to make informed decisions about their safety and wellbeing. Furthermore, a lack of a Resilience Network can lead to confusion and misinformation, hindering effective communication and coordination among emergency response teams and hindering the ability to provide timely and appropriate assistance to those in need. In short, the impotency of not having a Resilience Network for general flood forecast information can have serious consequences for individuals, communities, and emergency response efforts. **(Dennis Parker, 2005)** Most of the flood disaster data which that FHRC publishes in its publications represents the greatest conceivable property loss, neglecting the repercussions of efforts taken to minimize damage in response for flood warnings. Nevertheless, the impacts of flood warnings are considered into certain data sets and so allow flood warning benefits to be evaluated. Existing research on the destruction reducing impacts of flood warnings in England started gathering in the 1970s (e.g. Penning- Rowsell et. al., 1978) and was summarized by Parker (1991). Flood risk reduction is assessed for flood forecasting lead times and for five flood levels and is available with two flood durations (short and long, but differences in reductions are negligible) (short and long, although differences in savings are small). More limited data are available for non-residential properties.

Impact of this system

Having a resilience network for general flood forecast information can have a number of positive impacts. For example, such a network can help to improve the accuracy of flood forecasts, which can help people to better prepare for and respond to potential flooding events. This can reduce the potential for damage to property and infrastructure, as well as the risk of injury or loss of life. In addition, a resilience network can help to coordinate the efforts of different organizations and agencies involved in responding to flooding, which can improve the overall effectiveness of the response and help to ensure that resources are used in the most efficient and effective way possible. By this way as I have mention before many lives will be saved and a economy of a country will not be badly impacted. Government will be able to help people more. repair cost and property damage, can be kept to minimum for both government and private sector also the health of people specially when in comes to spreading diseases.

Project Objectives

Final Deliverables

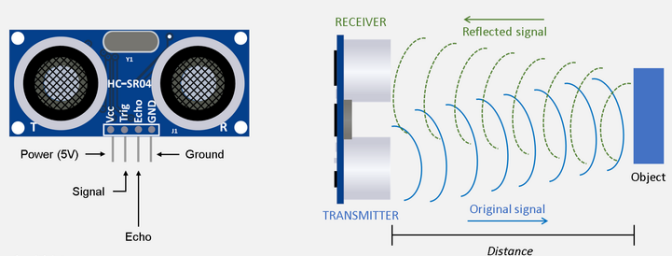
- To measure the water level as for I have 2 methods. First, I have the **ultrasonic sensor** which measure the water level using sing ultrasonic waves.
- For second method is measure the water level using a **potentiometer** that attach to an arm place on a server level witch defiance by the Department of Irrigation for that specific river.
- **Node MUC** will be used to create the **network mesh**. It will gather the raw data from the sensers and transfer it to the cloud over the internet. If one sensor failed Via Node MCU data stream will be keep happened
- For raw data processing and monitoring I'm currently using **Cayanne** IOT dashboard. It will have friendly user interface and user will be able to navigate through the dashboard easily

deliverable with technologies

- ### Ultrasonic sensors

An ultrasonic sensor is a type of device that uses high-frequency sound waves to measure the distance to an object. In the case of measuring the water level of a river, the ultrasonic sensor would be mounted on a fixed structure such as a bridge or a pier that extends over the river. The sensor would emit a pulse of ultrasonic sound waves, which would travel through the air to the surface of the water and then reflect back to the sensor. By measuring the time it takes for the sound waves to travel from the sensor to the water and back, the sensor can calculate the distance to the water's surface and thus determine the current water level in the river.

One advantage of using an ultrasonic sensor to measure the water level of a river is that it does not require any physical contact with the water, so it can be used in rivers with strong currents or other conditions that might be hazardous to a device with moving parts. In addition, ultrasonic sensors are typically quite accurate and can provide real-time data on the water level, making them a valuable tool for monitoring and predicting potential flooding events.



Ultrasonic sensors: Applications for the Internet of Things (no date). Available at: https://blog.seebo.com/iot-ultrasonic-sensors/ (Accessed: 7 December 2022).

- **Potentiometer**

A potentiometer, or pot for short, is a type of electrical device that is commonly used to measure the level of water in a tank or other container. In this application, the potentiometer is typically mounted on the outside of the tank, and a float or other type of buoyant device is attached to the wiper arm of the potentiometer.

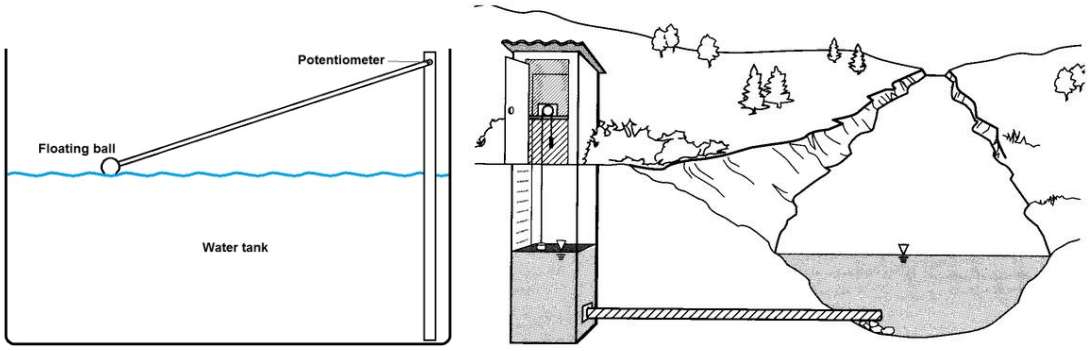
As the water level in the tank rises or falls, the float moves up or down along with the water level, causing the wiper arm of the potentiometer to move as well. This movement is translated into a change in the electrical resistance of the potentiometer, which can be measured and used to determine the current water level in the tank. Potentiometers are often used in conjunction with other types of sensors and monitoring equipment to provide a more complete picture of the water level in a given area.

Measuring the water level of a river using a potentiometer can be somewhat more challenging than measuring the water level in a tank or other stationary container. One common approach is to use a floating device that is attached to the wiper arm of the potentiometer, similar to the approach used in measuring the water level of a tank. In this case, the floating device would be designed to move up and down with the water level in the river, causing the wiper arm of the potentiometer to move and change the electrical resistance accordingly.

Alternatively, the potentiometer could be mounted on a bridge or other fixed structure that spans the river, with the wiper arm of the potentiometer contacting a fixed reference point on the bottom of the river. As the water level in the river rises or falls, it would cause the reference point to move up or down, which in turn would cause the wiper arm of the potentiometer to move and change the electrical resistance. This approach would require a more complex and robust design than the first approach, but it would have the advantage of being able to measure the water level at a specific point in the river rather than at a specific point in the water column.

- Warsito *et al.* (2012) *Design and characterization of water level detector using MW22B multi-turn potentiometer*, *AIP Publishing*. American Institute of PhysicsAIP. Available at: https://aip.scitation.org/doi/abs/10.1063/1.4730714?journalCode=apc#:~:text=The%20water%20level%20detector%20based,about%201.5m%20measurement%20range. (Accessed: December 8, 2022).

- *(554) Level measurement through potentiometeric tracking - YouTube (no date). Available at: https://www.youtube.com/watch?v=RWVGLimrLZI (Accessed: 7 December 2022).*

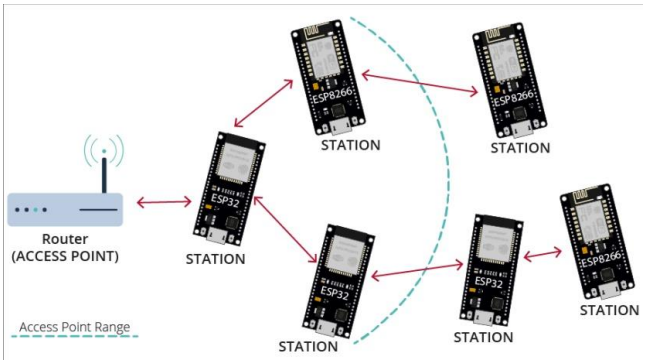


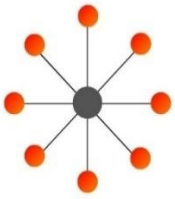
- **Node MCU & Network Mesh**

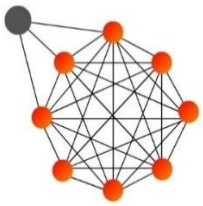
A resilience network for general flood forecast information can be a valuable tool for improving the accuracy and effectiveness of flood response efforts. Such a network can bring together different organizations and agencies involved in flood forecasting and response, allowing them to share information and coordinate their efforts. This can help to improve the accuracy of flood forecasts, as well as the overall effectiveness of the response.

One study found that the implementation of a resilience network for general flood forecast information in a specific region led to a significant reduction in the number of flood-related incidents and a corresponding decrease in the economic and social costs associated with flooding. The study also found that the resilience network helped to improve communication and coordination among different organizations and agencies involved in flood response, leading to a more efficient and effective use of resources.

Overall, the literature suggests that a resilience network for general flood forecast information can be a valuable tool for improving the accuracy and effectiveness of flood response efforts, and can help to reduce the potential impact of flooding on communities and individuals.




Star Topology


Mesh Topology

Feasibility of each deliverable

If one of the sensors brock the data stream will keep happened by another method and if the direct link brock between main node, the data stream will keep happens trough another node which will be connected to the main node. Even there is a very low chance if somehow a object for example a coconut is in the way of ultrasonic sensor the measurement it will give will be wrong but the potentiometer will always give the accurate data. But if potentiometer mechanism somehow brock or stuck the user will be able to get measurement through Ultrasonic sensor.

As a weakness for this if there were bad internet connection the data stream will be interrupted since this system is for live data streaming

Literature Revive

Literature Revive , Summarize and related thing to this project

There has been few research, test project and current projects that helping people.Multistep Flood Inundation Forecasts with Resilient Backpropagation Neural Networks

(et al., 2020). They have taken few steps further and trained AI to alert before the flood happened very early. 120 flood event and test each one with 60 second time frame. And other ways to detect flooding events.

This was the main source of my information come from. I tweak it to simple but effective project that suitable for my knowledge with adding more into it. They have analyzed many flood events and gather data that what happened after the flood to people, health problems with spreading diseases, property damage both government and private and economy of the country also how cloud this have prevented if there was a flood detecting system.

Many of the Research have suggest ways warn before an even happened but most of them have done is predicting what will happened. As for this project doing that kind of project is costing over the limits and many new Areas to learn which will not have the enough time.

But all of those projects do lack one thing that is a backup system. They have placed their device or mechanism in the river but the proper way of doing it should be placing the device in a Biso Fort. It’s an ancient

technology that use by Lankan people that helped them to safety please the extra amount of water without harming the damp. even measuring the water in a river, we now steak start into the ground inside the Biso Fort get help to get a near to the accurate Measuring good when you're measuring the water the level. By placing the mechanism older device side, in the middle of the river will damage it when flood happened, when boats travels , by animals or by people who break devices like this and sell it. there be no use if this mistake kept repeating so in my project have taken action for it.

- Qing L Lin, J. Leandro and Markus Disse (2020) *Multistep flood inundation forecasts with resilient backpropagation ...* ResearchGame. Available at: https://www.researchgate.net/publication/347513400_Multistep_Flood_Inundation_Forecasts_with_Resilient_Backpropagation_Neural_Networks_Kulmbach_Case_Study (Accessed: December 8, 2022).
- Warsito *et al.* (2012) *Design and characterization of water level detector using MW22B multi-turn potentiometer*, *AIP Publishing*. American Institute of PhysicsAIP. Available at: https://aip.scitation.org/doi/abs/10.1063/1.4730714?journalCode=apc#:~:text=The%20water%20level%20detector%20based,about%201.5m%20measurement%20range. (Accessed: December 8, 2022).
- Parker, D., Tunstall, S. and Wilson, T., 2005, October. Socio-economic benefits of flood forecasting and warning. In *International conference on innovation advances and implementation of flood forecasting technology* (Vol. 17).

Method Of Approach

Ask for now I have finished the background research and gather the data I need for this. since this is a new area I'm learning Arduino, python, mesh networking and network using LinkedIn and UoM, Freecodecamp.org, GitHub. I'm also gathering fuds parts that I need for this.

I'm currently leaning network mesh and how they work as well as finding suitable IOT Parts for my project since most of them not imported to my country anymore. First I'm going try build the network mesh using Node MCU to practice network mesh and as well as get to familiar with Arduino language. Then I will try to get a Ultrasonic so can program it to measure the water level. doing some research to try adding another method just in case if both Ultrasonic sensor and potentiometer fails. I'm hoping to

Initial Project plan

Research

In this time period I will do research about project ideas that I have found suitable of doing

Project Proposal

In this time period I will precent my idea and few project that I think I may able to do and start background researching looking in to thing more deep and trying to build a prototype.

PID

I will chose the project I'm going to do after trying prototypes and research. It may or my not the same project that submitted to the project proposal but The project in the IPD will be my final project that I'm going to continue and finish.

Learning new skills

By this what I have mean is that I'm leaning new thing related to my project

Finding IOT parts

I be buying parts for my project and testing them.

Interim Document 01

I will report my current progress to my supervisor and find vulnerabilities of my project

Testing01

I will test my project with the current progress I have at this time

Interim document02

I will meet my supervisors and show my progress with the devices that I have build this time with giving them a report of any challenges I face while doing Testing01

Testing01

With the help of testing 01 and advices from my supervisors on meetings I will make my project work without a problem and start enhancing It

Full project deployment

I will deploy my project to my supervisors for further more venerability analysis

Final Report

In this I will give my final report of the full project and how I able to complete this

Risk Analysis

Since this project involve IOT which mean physical devices will be in use and considering the current situation in my county there is a good chance the items that I'm looking for might be not available. Also, there is very good chance shops will be close due to the protesting even visiting University will be not available sometime if the situation get more Dangerous so getting advice on my architecture and getting information in practice won't be effective as much as physical interaction.

To manage this rink I have I am already getting advice from my supervisors and I'm thinking to order extra node MCU online by this why

I will be bale to build my prototype. And then the finishing product without the those risks.

Any Further sections you wish to add

If I can improve this even after I left university I wish to add the device that measure the rain and also calculate ‘ if this much rain falls for this much hours the flood will be occurred ‘ and a warning system with some lighting and sound that warn low land people.

Reference

- Warsito *et al.* (2012) *Design and characterization of water level detector using MW22B multi-turn potentiometer, AIP Publishing*. American Institute of PhysicsAIP. Available at: https://aip.scitation.org/doi/abs/10.1063/1.4730714?journalCode=apc#:~:text=The%20water%20level%20detector%20based,about%201.5m%20measurement%20range. (Accessed: December 8, 2022).

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ter%20level%20detector%20based,about%201.5m%20measurement%20range. (Accessed: December 8, 2022).

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Interim

Introduction

Introduction

This project I've been working on which is a water low cost monitoring system that can help reduce the risk of flooding, Millions of people around the world are affected by flooding, which is a serious issue.

Overflowing rivers and lakes can harm buildings, commercial establishments, and infrastructure when it rains excessively. According to estimates, floods cause more than 6,000 fatalities and billions of dollars' worth of damages annually.

In my nation, where it frequently rains heavily during the monsoon season, the flooding is a very serious problem that mess people lifes. Homes, companies, and agriculture may face serious damage as a result of floods. after our paddy field get overflow with water country have no rice and it cost milions to import from other countries fact, recent studies indicate that flooding is to blame for a sizable portion of agricultural losses in my nation.

Floods do not just cause short-term harm; they can also have long-term consequences. People may become ill from contaminated water after a

flood, and their houses and towns may be damaged. Their daily lives may be greatly affected, and recovery may take years. In addition, flooding can significantly affect a

nation's economy since it damages or completely destroys infrastructure and companies.

Our water measurement system comes into play here. We've created a system that measures the water levels in rivers and other bodies of water using specialized sensors. Knowing the height of the water allows us to alert people to potential floods and lessen damage.

The information we gather can also be used to assist individuals living in water-scarce locations, enabling them to get potable water and cultivate food for their families.

This is the project is the first of its sort in my country is what makes it so amazing! It's a huge issue because we don't have any other initiatives like this. its being many years that the technology have com long way but yet my country at stone age not solving problems that cost many thing country so I think it's crucial to use technology to assist individuals and improve the planet. This initiative could potentially save lives, safeguard localities, and enhance people's quality of life.

Two ESP devices with ultrasonic sensors are used n this project to take water level

measurement. system estimate the depth of rivers and compare the water leveling ricing . Mesh networking is used to connect the devices, enabling communication between them and a router. currently using ESP now protocol but soon will change to another method. The router then transmits the data to a dashboard so that an expert may monitor it. An notice is given to residents in the affected region so they may take precautions if the water level climbs above a specific mark.

This projects is technically feasible, and we have successfully tested our water measurement system at various sites. We are currently striving to improve the system's effectiveness and efficiency. Also, we are looking into how to connect our system with the current flood warning systems to expand our audience and limit damage.

In summary, I think this project will success and it got more attention and then better resources and I or we will put much effort to improve people's lives.Technology have come long way in past few decade but my country still in stone age not trying new things and not improving people’s lifes. I think it's critical to apply technology to address problems in the

real world, and I'm glad to be a member of a team that is doing precisely that. I appreciate your interest in our project and will make sure to keep you informed of its development.

Problem Definition

My country frequently floods when it rains, but sadly we don't have a good flood warning system to let people know ahead of time. The lack of a flood warning system has had disastrous effects on the economy and the lives of people. Floods can cause significant economic losses by destroying crops, infrastructure, and houses. Moreover, infections associated with flooding can spread quickly, making it difficult for emergency response personnel to get to afflicted communities in time. Significant loss of life and property damage may result from this.

Moreover, a lack of preparation among people may result from the absence of flood warning systems. They might not take the appropriate safety measures or leave in time, which could result in more casualties and damage to property. Lack of a warning mechanism also makes it difficult for emergency response teams to control the situation, which exacerbates chaos and uncertainty.

The EM-DAT database maintained by the Centre for Research on the Epidemiology of Disasters (CRED) estimates that flood-related losses in Asia were over 280 billion US dollars between 2000 and 2019.

Between 2000 and 2019, the cost of flood-related damages in Europe was almost 43 billion US dollars. It is crucial to keep in mind that these numbers are probably an underestimate because not all flood episodes may have been recorded in the data.

Nonetheless, a properly built flood warning system can greatly lessen the effects of floods. People can be forewarned by the system, allowing them time to get ready and leave if necessary. Also, it can aid in better resource deployment and preparation for disaster response teams.

Also, it helps lessen economic losses by enabling governments and corporations to take preemptive actions. Ultimately, putting in place a flood warning system can save lives, stop property damage, and enhance the stability of the nation's economy.

Project Objectives

Having a flood warning system in place can provide numerous benefits to both a country and its citizens. With such a system, people can be alerted before a

flood occurs, allowing them to take necessary precautions such as evacuating, moving valuable possessions to higher ground, and preparing emergency kits. This can help minimize loss of life and property damage.

By minimizing flood damage, a flood warning system can benefit a nation's economy. Homes and infrastructure, including roads, bridges, and electricity systems, can be destroyed by flooding. Businesses may experience disruptions as a result, which could cost them money and productivity. A flood warning system help for better preparation and preventative action, which may lessen the severity of flooding and its negative economic effects. so people and government can act fast to save and avoided many, many more damaged

A flood warning system can also aid in disaster relief efforts. Before a flood occurs, emergency management teams can be activated, which will improve their readiness and response time. To do this, it may be necessary to send emergency workers, pumps, and sandbags to potential disaster zones.

Ultimately, having a flood warning system can assist a nation and its citizens in a number of ways. It can save

lives, lessen property damage, lessen economic effects, and promote more efficient disaster response activities by enabling early warning and greater planning.

UNIVERSITY OF PLYMOUTH | NSBM GREEN UNIVERSITY TOWN

PUSL3119 Computer Individual Project
Student Progression Report

01. Student Name ...S.D.I.P siriwardhana.....
02. Plymouth Index Number ...10747901.....
03. Degree Program ...BSc (Hons) computer Networking.....
04. Supervisor Name ...Mr. Isuru Sri Bandara.....
05. Project Title ...Resilience Network for general flood forcast information/flood warning system

Meeting Number	Meeting 01	Meeting 02	Meeting 03	Meeting 04	Meeting 05	Meeting 06	Meeting 07
Date	22/10/18	12/10/31	22/11/1	22/11/18	22/12/2	23/4/24	23/5/17
Student Signature							
Supervisor Signature							

Meeting Number	Meeting 08	Meeting 09	Meeting 10	Meeting 11	Meeting 12	Meeting 13	Meeting 14
Date	23/5/17						
Student Signature							
Supervisor Signature							

System Analysis

Facts Gathering Techniques

To gather the information, I need for this project I have use mostly use YouTube and locals. Because my problem with naturel disaster flooding mostly damage the life of local people who sitting on the bottom of the society but carries the challenging work.

From locals I found what kind of problems that they face even after the flood happen. I found that that sometime water level increase with in ten to fifteen seconds when the upper area is receiving the rain.

Also found how poorly the government treatment for those people that lost there home. Because they don't know a flood is going to happen their food, close, books, money and many other stuff get destroys and how they have drag the lowest point of there life by the flooding. Almost every locals said what " if we had known something like will happen we will be still okay without much problems"

After knowing the information, I tried to find a solution that can be done with current situation, practical and with a low cost.For finding a solution I have done my research using mostly YouTube and google which I finally found a that planting a warning system will allow us to avoid and prepare for the for worst.

I have seen what other countries use to monitor water of there rivers like how is the device or mechanism look like. But most of them was

high cost and for student it was over expensive and finding devices and sensors they use was completely out of my capabilities.

Currently there is no system like this in my country. because IOT is in its fiist few ages, government not trying solve problems if its low cost, and not much people know about technology stay in country mostly all go abroad for to live. Only real time water measuring system available is in damp where is it must to monitor but not on rivers that occasionally flood the surrounding areas and low lands. So because of this problem this project is suitable for measuring the water of river system that occasionally get flooded.

But what was in my head was the thing every local said that " if we had known something like will happen we will be still okay without much problems" so that's how this all got stared to build something that warns

them before it happens. Low cost, suitable yet do the job well and save life's

Existing system

For now my country don’t have a one but how ever there few best in the world how ever they are very advance as country their project have being completed not a one student like me. But yes they very good existing systems in the world even they are old still work well.

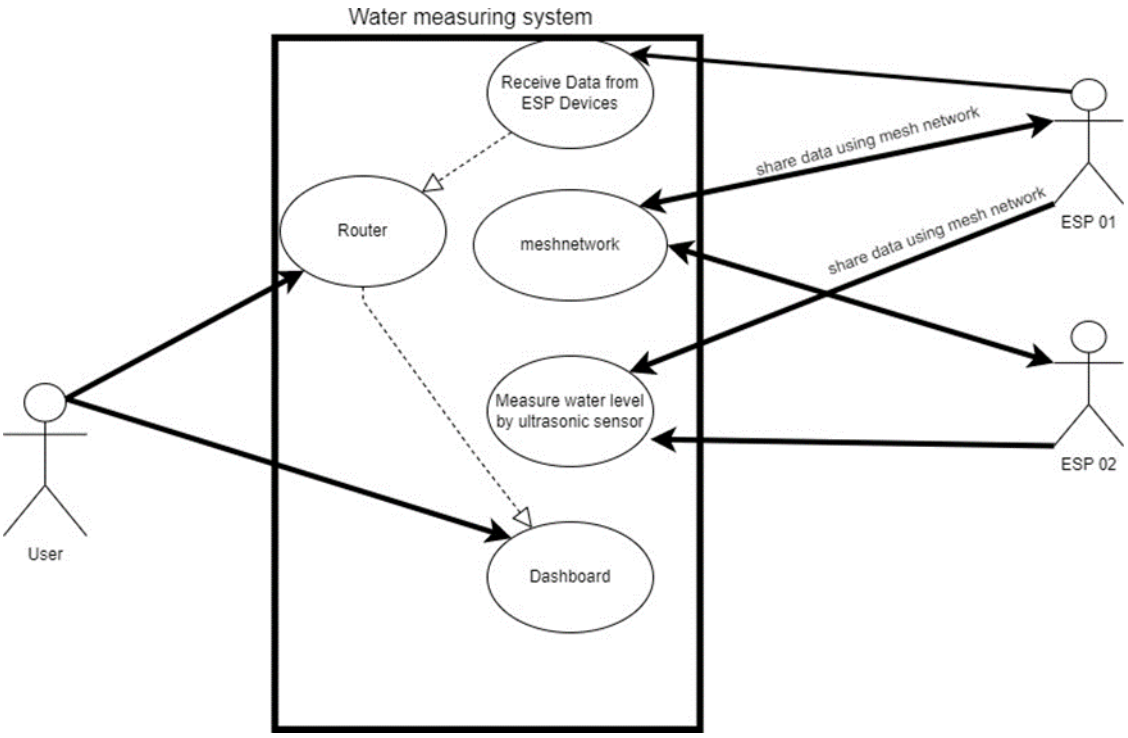
1. The Joint Research Centre of the European Commission manages the European Flood Awareness System (EU-FAS), which offers flood forecasts and alerts for the entire European Union. It offers precise and early information on probable floods by combining satellite data, meteorological models, and ground observations.

2. Japan Meteorological Agency (JMA) - The JMA operates a comprehensive flood warning system that covers the entire country of Japan. The system includes a network of river gauges, weather radars, and rainfall sensors that feed into a centralized forecasting system. The JMA issues

warnings for both river flooding and flash flooding caused by heavy rain.

3. The National Flood Warning Centre (NFWC), a system run by the Environment Agency of the United Kingdom, issues flood warnings for England and Wales. The NFWC delivers flood alerts by text message, email, and social media and uses a network of river gauges and weather stations to monitor water levels and meteorological conditions. The technology has received accolades for its precision and ability to effectively reduce damage and fatalities caused by flooding.

Use case diagram. Of water measuring



The ESP device with ultrasonic sensor measures the water level of the river at its location.

ESP Devices will triggers the "Measure Water Level" use case to measure the water level at its location.

The mesh network connects the two ESP devices together to share data.

The router receives data from both ESP devices and forwards it to the dashboard.

Dashboard receives and displays water level data received from the router. The user will be able to interact with shown data as well as control over the router

Drawbacks of the existing system

In my country currently do not have any system to measure the water level. But in other countries have but not publicly available information. But I did found some information back when I'm looking for solutions that a failed attempt in uk . I failed because they was going to mount the device on a metal plat form when

decayed over time as well as when there is high water flow it also get damaged.

And there are few more because they always tried to plant it on the water without a platform

There have been instances where water measuring systems implemented by certain countries have failed to deliver expected results. For example, in India, the Automated Meter Reading (AMR) system installed in Bangalore was unsuccessful due to technical issues such as battery failures, communication problems, and software bugs.

Additionally, the system was not properly integrated with the billing system, leading to inaccurate billing.

Similarly, in the United Kingdom, the roll-out of smart water meters was met with challenges such as technical glitches, poor data management, and higher than expected costs. The system was also criticized for being too complex for customers to use, resulting in low uptake rate

Requirements Specification

Functional Requirements

We would need sustainable power connection and internet access. Also this devices need to be mount on a Biso Kotuwa so it won't be damaged by the rain, high water flow, animals, thief's.

Non-Functional Requirements

As for nonfunctional requirements we won't be need a human assist always but occasionally to check in the device. Won't be needing high speed internet connection.

Hardware / Software Requirements

As well as this system must use mesh network to communicate with each other because instead of all the nodes connecting to a one router node will be connected to each other. project is still in the working and testing process where I am trying different way of mesh, such as ESP now, Master and slave and custom code that can get by GitHub and as well as well as code with Codex.

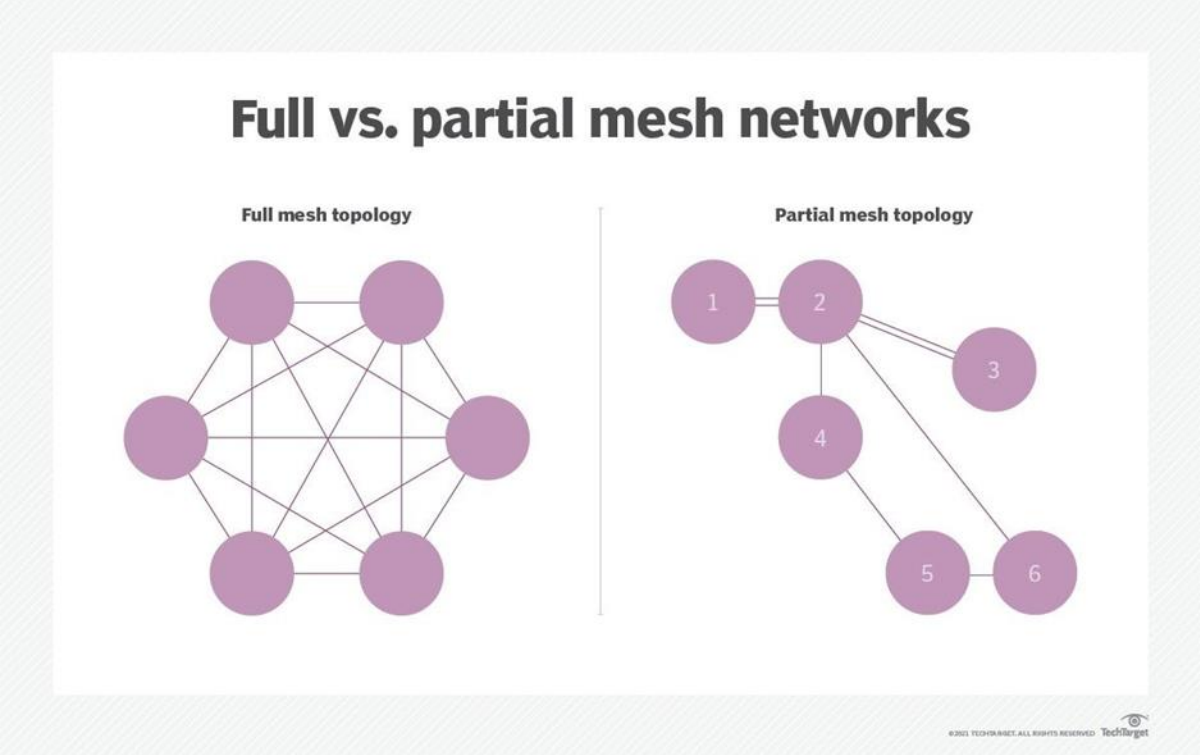
- To make this project work well we will need ESP32/82, ultra-sonic sensor, power adapter, jumper cables, project bord. How ever there are few ultra-sonic sensors out in the market. In testing you can use a sensor that very cheap which is HC-SR04 since you are mounting on top of a platform water damage will be minimum. But if want to go with water proof ultra-sonic sensor we need to have JSN-SRT04T or the A0YYUWave

As you can see up there the sensor which I am using is not waterproof but with current prices I am not able to

afford to those 2 other sensors. JSN-SR04T is not good to measure the water because its minimum range is 20 cm which mean if the water level rice up and distance between the sensor and water level pass and go above 20 cm sensor won't be able to measure the water level any longer also it cost round 3200 RP and not available in Sri Lanka. As for other sensor it was not listed or available in Sri Lanka as well. So I have to do this project with HC-SR04 ultra-sonic sensor. Since it will me mounted and placed on a platform and measuring the water using the biso kotuwa water level will not disturb with waves and water surfers will not be cover with some water plants or waste on the river.

Given the maximum distance 100M and if we able to put 5 or 10 ESP devices that connected to each other placing one router for each 500 miters or placing one router for each one kilometer will be good. Since this

can’t be done by a full mesh or start shape mesh every node will be not connected to every other node. This will be partial mesh network so one node will be connected to the router and another node will have go through one or few nodes to send, receive data to the internet.



If there is a one router and node A to J are going to connected to the internet using Node A. So this is patina mesh network, In a partial mesh architecture, additional nodes in the network that are connected through Node A would be cut off from the internet if Node A fails or is destroyed. Comparing this to a full mesh structure, which is often more durable, can be disadvantageous. Node A turns into a single point of failure for the network when it is the only node that is directly linked to the router. Unless backup routers are available, other nodes in the network would be unable to communicate with the internet or other nodes if

Node A failed. It is advised to establish more connections to the router from other network nodes in order to increase the network's resilience. The other nodes linked to Node A would lose connection to the router and the internet if Node A failed. The other nodes might still be able to connect to the internet through Node J, though, if Node J is also linked to a router and the network is set up to allow other nodes to access that router through Node J. by doing this we can increase network resilience and fault tolerance.

The code is still building because I have to use a platform to monitor the out puts and most of them are paid to work. Free ones have their own code for our devices, so I am working on it. One you got the code it cant me customized. For example Cayenne My device Dashboard they have their own code which you only can variables. Those code can be upload and run and monitor just by giving a link and ID.

Networking Requirements

- For the two ESP devices to wirelessly connect with one another and provide the information about the water level to the internet, the water measuring system needs a mesh networking protocol.

- To be able to communicate wirelessly, the router and ESP devices must both have wireless connectivity. Wi-Fi and other wireless protocols like Bluetooth and Zigbee are both capable of providing the necessary wireless communication. In this case we will be using Wi-Fi. Because it be better to gain internet access and other ESP devices to connected to the router.

- For the reason of sending the water level information to the dashboard for monitoring, the router must have internet access. An Ethernet cable or wireless network to a modem or router with internet access can be used to connect to the internet.

- To avoid hacking or unauthorized access, the water level data that is transferred between the ESP devices, network, and dashboard must be secure. Encryption, authentication, and other security mechanisms can accomplish this. the internet.

Feasibility Study

Operational Feasibility

- Operational feasibility means the capacity of a proposed system or solution to fulfill the operational needs of its users and participants. It is a measure of a system or solution's applicability and practicality.

- Maintenance and support of the system: The water measurement system ought to be made simple to maintain and support. The system should provide tools and capabilities for support and troubleshooting, and the hardware and software components should be simple to replace and upgrade. To ensure that users can properly utilize and maintain the system, the system should also offer user training and assistance.

Technical Feasibility

- The selected sensors, mesh networking protocol, and wireless communications must all operate together for the water measuring system to be technically feasible, which means it must be able to detect and communicate water level data accurately and dependably. Considerations like the

following can be used to assess the technical feasibility.

- Accuracy and stability of the sensors deployed in the water measuring system are essential to the system's performance. The accuracy of ultrasonic sensors, which are frequently used to measure water levels, can be impacted by variables like temperature, humidity, and environmental circumstances. It is crucial to choose high-quality sensors that are built for precise and dependable measurements in aquatic situations.

- Communication between the ESP devices and the router should be dependable and effective thanks to the mesh networking protocol employed in the water monitoring system. Large volumes of data should be manageable by the mesh protocol, and the sensors should have adequate coverage and range.

- The water measuring system's communication methods must be dependable and secure. The system may transfer the water level information to the dashboard using Wi-Fi, cellular networks, as well as other communication methods . Choosing communication methods that work with the

sensors, the mesh networking protocol, and the overall system architecture is crucial.

- Large amounts of data produced by the sensors should be manageable and processable by the water measurement system. To analyze and store the data, the system needs have enough processing power and storage space. It is crucial to choose hardware and software elements capable of handling the data.

- For continuous operation and data transmission about the water level, the router and ESP devices require a dependable power source. Battery power, AC power, or a combination of both can be used to do this.

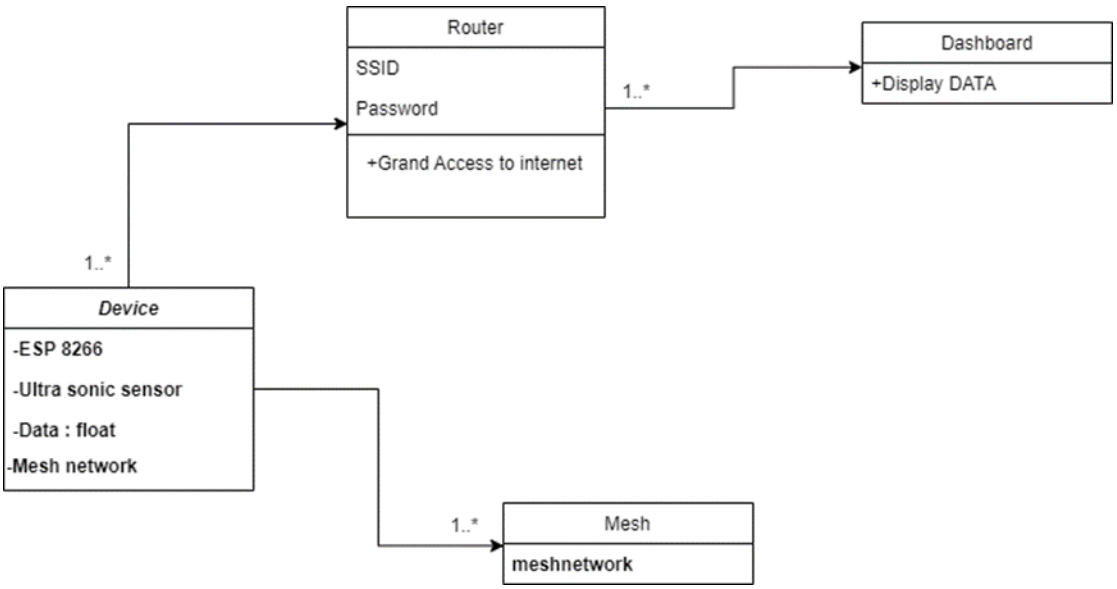
Outline Budget

- The outline budget for this is 10,000/ but items and devices keep getting unavailable and price going up. Because of this reason I was not able to get the waterproof ultra-sonic sensor. But both having the same performance features I believe it a good to go with HC-SR04 since demo or test project. I also have tried to order parts online but

it cost me around 75 to 92 USD which is not an amount that I cant spend. I also have tried reaching other students it was not helpful either. So as I mention before I believe going with HC-SR- 04 sensor will be good for the presentation but water proof ultrasonic sensor will be the most suitable one in the real life working.

System Architecture

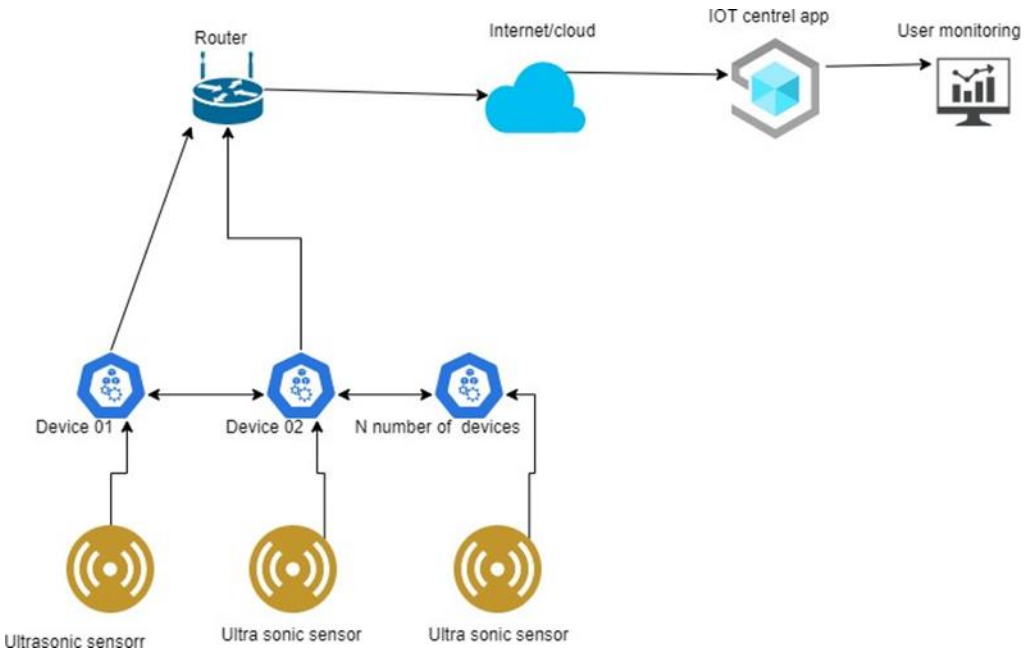
Class Diagram



- The ultra sonic sensor is connected to an ESP device, which sends the data to the Router using Wi-Fi/ESP now protocol. Only the ESP device next to the router will do this . rest will be transmit data to the next node.

- The ESP devices that use mesh networking to connect to each ESP device other ESP device and form a partial or complete mesh topology.
- The “Router” is responsible for granting internet access to the ESP devices so that they can send data to the Dashboard so the user can monitor the water of the river.

Architecture Diagram

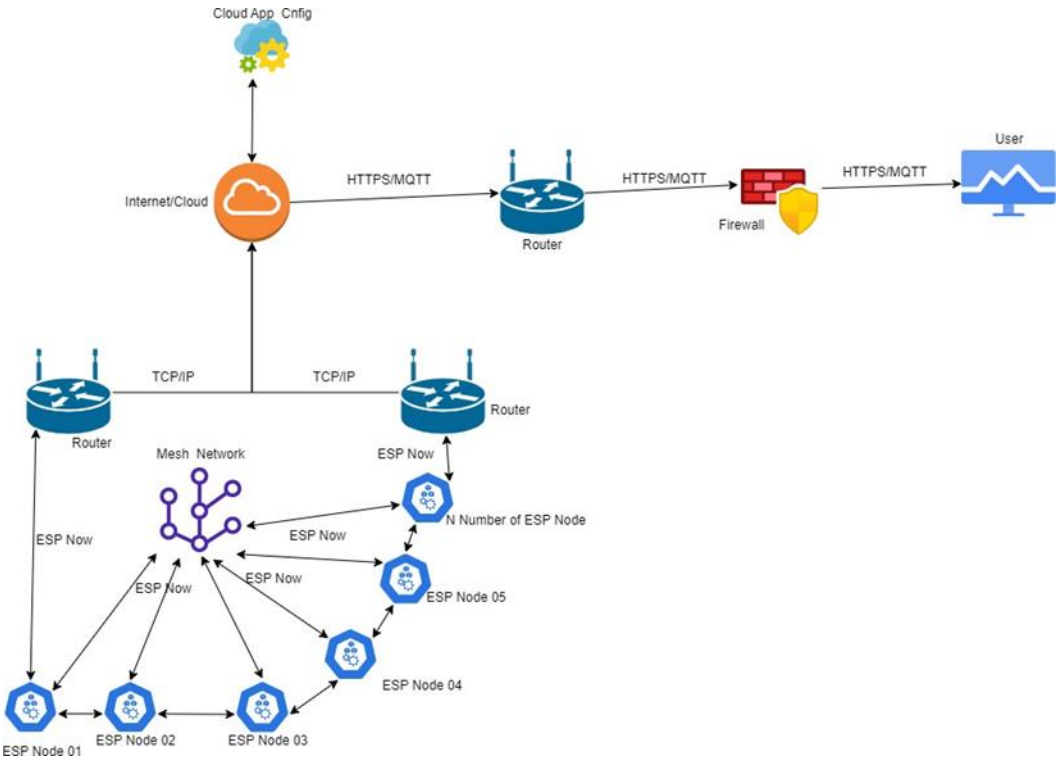


As Nodes 1 and 2 in the diagram illustrate, the system is made up of several nodes. An ESP8266 ultrasonic sensor is present in each node. To assess water level, the nodes are placed at various points along the river. One node (the one nearest to the router) acts as a gateway to the internet, allowing the nodes to

communicate with one another in a partial mesh network.

Data is collected from the nodes by the router and sent to the dashboard for real-time monitoring. The dashboard offers a user interface for tracking water levels and has a warning mechanism to let users know when water levels go above certain limits.

Network Diagram



Using the appropriate protocol, each device or component is connected to the network. The router connects to the internet and sends information to the cloud application using TCP/IP. MQTT is used by the nodes and ESP-8266 modules to connect with one another and relay information to the router. To determine the water level and transmit the information to the ESP-8266 modules, the ultrasonic sensors use a unique protocol.

To interact with the router and show the user the data, the dashboard can use either HTTP or MQTT. Overall, this network architecture is built to assure reliable and timely data transmission to the cloud application for monitoring and analysis, as well as to enable effective communication between all the devices and system components.

Note

An critical element of the network design of the system mentioned above is a mesh network. It offers various advantages that make it an appealing choice for this kind of system.

The ability of a mesh network to effectively manage numerous nodes is one of its main advantages. Each node in a conventional network must speak directly with the main router. In contrast, every node in a mesh network can talk to any other node that is nearby. This makes communication more effective and lightens the burden on the main router.

The power of a mesh network to offer resilience is an additional advantage. In a communication system, if the main connection fails, the entire network fails.

With a mesh network, however, the remaining nodes can still communicate with one another, avoiding the fallen node. i have tried best to ilustrate the mesh networking in the network digram.This means that even if one or more nodes fail, the network will still function. this mean even one of my devices got damaged other devices will be able to communicate and send data so user will be able to monitor

Development Tools and Technologies

Development Methodology

According what I have done and how the process went from 0 to now where I am it most likely a Agile methodology because I always run test on the step that I am currently in when doing a project. Agile methodology is flexible and iterative. method to software development that places a strong emphasis on customer happiness, cooperation, and flexibility. So I my case if something I need change hardware pat or a code it will be okay. Yes in this project there things that need to be changed but unfortunately I am unable to changed them.

Here is why I think it good to follow Agile methodology for my project

- My project requires the development of hardware and software elements both of which may have complex and changing specifications. Such projects benefit from the agile methodology's ability to handle changes and the evolution of requirements. So if something happen even after I completed or in the final step I be able to apply the changes
- The produced components for your project need to be tested and validated on a regular basis. Because we can find the flow in my project through testing only .Continuous testing and integration are prioritized by the agile methodology, which can assist you in swiftly identifying and resolving problems as they arise.
- For an good example when I am using the HC-Sr04 ultra sonic sensor it stared with a problem that its not water proof . this device will be use to measure the water level which mean it will get exposed to water and then it will get damaged but I was able to cover it with a waterproof box and able to measure the water level without my devise getting water damaged.

Programming Languages and Tools

I have use mostly C++ because C++ is the language that use in Arduino. Also, it is a high level language. But I also have to use google plug in because when using IOT dashboard in google you have to use despite what your code is. Mostly they have codes for everything’s and code are not changeable only can change is variables. Are using AI they generate code for your need.

Are for now only tools I use is Arduino IDE for coding, ESP with ultra sonic sensor to measure and project board to connect them.

Third Party Components and Libraries

I have use a third party libraries because they provide full code my project as they come with many default codes sketch. And ask for component everything I use is many time used item because most items are unavailable, very expensive which I am unable to afford also people who have them don't give them to student because its harder them get there parts from the devise after it al over.

Algorithms

As for now I haven't use any but codes from google may have them but I can't tell them fore use because it just a like plug in that only take and send data to be processed in the cloud like edge computing technology.

Discussion

Overview of the Interim Report

I have explains

What does this project do, how it help people and what is the problems that leads me to this and how my project word and things that it need to work

Summary of the Report

I have explained and organized how this project stared what are reasons that I stared this project, the benefits and other projects like this as well as a run down on my device and the process

Challenges Faced

I have faced only two unavoidable challenge that more like wall because I can't win it over like the other challenges I have faced in my life. Availability of the devices and the price of the devices.

Future plans / Upcoming Work

I will do this project even after I am out of the university as the service to my country. For now i do have an idea to improve the distance yet keep a good signal strength.

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