

AUTOMATED UNDERWATER MONITORING SYSTEM FOR ANALYZING THE WATER PARAMETERS IN AQUACULTURE FARM

A Project Report Phase - II

Submitted in partial fulfilment of the requirements for the award of Bachelor of
Engineering Degree in Electronics and Communication Engineering

by

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BONAFIDE CERTIFICATE

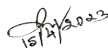
This is to certify that this Project Report is the bonafide work of JETTI PHANI TEJA (39130187) and JONNADULA AKASH (39130190) who carried out the project entitled **"AUTOMATED UNDERWATER MONITORING SYSTEM FOR ANALYZING THE WATER PARAMETERS IN AQUACULTURE FARM"** under my supervision from November 2022 to April 2023.



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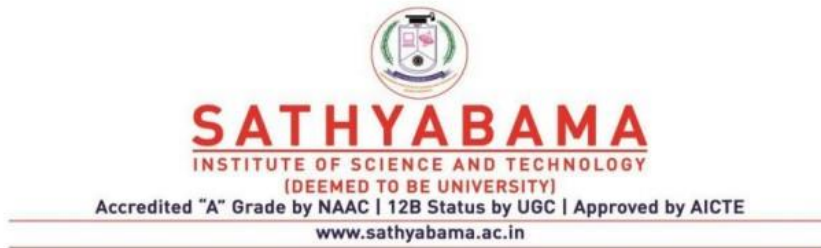
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DECLARATION

We JETTI PHANI TEJA(39130187) and JONNADULA AKASH(39130190) hereby declare that the Project Report entitled “ **AUTOMATED UNDERWATER MONITORING SYSTEM FOR ANALYZING THE WATER PARAMETERS IN AQUACULTURE FARM** “done by us under the guidance of **Dr .M.SUMATHI , M.E, Ph.D. professor**, Dept. of Electronics and Communication Engineering, SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, CHENNAI, is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering in Electronics and Communication Engineering.

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ABSTRACT

This paper describes the concept of study and implementation of smart system for aquaculture farm. The practical application of studying the water parameters is the major issue in the aquaculture. This idea creates a wireless sensor network environment simulation for an automated surveillance system for an aquaculture farm. With the help of a mobile device, a user is able to instantly master and manage a variety of environmental data while monitoring an aquaculture farm's environmental data. Some of them include turbidity, soil moisture sensor, temperature, PH value, air quality sensor, Pir sensor, ultra-sonic in this monitoring device, sensing modules are included. In the recommended methodology, the physical sensing signal is captured using the microcontroller unit (MCU) processing., in which actions are triggered depending on certain circumstances after the sensor data has been analyzed.

The terminal gadget gives the user complete power over the aquaculture farm's environment. The UI for the terminal gadget was created with Android software. Our system will have the capacity to record and analyze each reading in a more effective manner using a variety of platforms, allowing us to constantly monitor the parameter in real time. The performance analysis is carried with Intel Core I5 @ 2.4 GHZ processor and Arduino IDE 1.8 version. The parameters are identified in the aquaculture farming are 13.5 pH, 3.39 MQ, Motion Detected, 1033.53Cm, 328wfv of soil moisture, 50% of humidity, 29°C of temperature, 0.21v NTU. Using these parameters, it is observed that the lifestyle of the living organism is essential for the aquaculture farming.

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LIST OF ABBREVIATIONS

IZAQ	Integrated Zone For Aquaculture
NKEA	National Key Economic Areas
MQTT	Message Queuing Telemetry Transport
EPP	Entry Point Projects
CAGR	Compound Annual Growth Rate
ANT	Artificial Neural Technology
IOT	Internet Of Things
WHO	World Health Organization
SRS	Software Requirement Specification
GUI	Graphical User Interface
PIR	Passive Infrared Sensor
TSS	Total Suspended Solids
IDE	Integrated Development Environment
API	Application Programming Interface
EMS	Environment Monitoring System
FMS	Fish Monitoring System
AWS	Amazon Web Services
HTTP	Hyper Text Transfer Protocol
AI	Artificial Intelligence
ML	Machine Learning

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CHAPTER - 1:

INTRODUCTION

1.1 AQUACULTURE FARM

Aqua monoculture monitoring systems typically involve the use of sensors and detectors that measure various parameters of the water, such as dissolved oxygen levels, temperature, pH, and other factors that can affect the growth and health of the aquatic organisms. The data collected by these sensors is then analyzed using big data and internet technologies to provide real-time feedback on the water quality and environmental conditions.

Some of the key components of an aqua monoculture water quality monitoring system include water quality analyzers, multi-parameter analyzers, pH detectors, ultrasonic detectors, and other specialized sensors and instruments that can provide detailed information on the water quality and environmental conditions in the aquaculture system.

Implementing a comprehensive water quality monitoring system in aqua monoculture systems can help farmers ensure that their aquatic organisms are being raised in optimal conditions. By monitoring key parameters such as dissolved oxygen, temperature, pH, and other factors, farmers can quickly identify and address any potential issues before they have a negative impact on the health and growth of their aquatic organisms.

In addition to the sensors and detectors mentioned earlier, aqua monoculture monitoring systems may also include other components such as data loggers, controllers, and alarms. Data loggers are used to store and record the data collected by the sensors, while controllers can be used to automate certain aspects of the aquaculture system, such as regulating the temperature or adjusting the water flow. Alarms can also be used to alert farmers when certain parameters fall outside of the desired range, allowing them to take corrective action before any damage occurs to the aquatic organisms.

Overall, the use of a comprehensive aqua monoculture monitoring system can help farmers to optimize their production processes, reduce the risk of disease

outbreaks and environmental damage, and ensure that their aquatic organisms are grown in a safe and sustainable manner.

Aqua monoculture, particularly in the production of fish, is a growing field due to the increasing demand for ocean food. However, it is important to note that monoculture also has its downsides, such as the potential for disease outbreaks and the impact on the environment. It is therefore essential for aqua growers to practice responsible and sustainable husbandry techniques.

Water quality is a critical factor in fish and shrimp husbandry, as it can directly affect the yield and overall health of the fish. The use of prebiotics and probiotics in pond water can help establish a healthy microbial ecosystem, which in turn can enhance the natural food sources for the fish and shrimp.

In conclusion, while aqua monoculture has the potential to address the increasing demand for fish and other ocean foods, it is important for growers to practice responsible and sustainable husbandry techniques, such as the use of prebiotics and probiotics and monitoring of water quality with sensors. Fig.1. represents the photo of real aquaculture farm.



Fig: 1.1. Aquaculture

Further, the Malaysian government has recognised the industry's potential. The government has established the Integrated Zone for Aquaculture (IZAQ) as one of the Entry Point Projects (EPP) to boost the industry under the National Key Economic Areas (NKEA) for the 10th Malaysia ambitious, well-crafted development plan; this is EPP6. The other two EPPs are Seaweed Mini Estates and Integrated Cage Farming, which mostly raises grouper, sea bass, and tilapia. The projection for the IZAQ project is shown in Figure 2. The 10 IZAQ initiatives will accelerate growth to a compound annual growth rate (CAGR).

Companies with a proven track record and sound farming practises are chosen to be trusted in making sure that projects are implemented successfully. Hannan IOP Conf. Series: Materials Science and Engineering 340 (2018) 012014 doi:10.1088/1757-899X/340/1/012014 is one of the anchor companies chosen to achieve the goal of creating 'an aquaculture park with large area dedicated to the organised production of high quality, fully certified prawns for the premium market'.

Aquaculture has emerged as one of India's fastest-growing industries. About 1.07% of the GDP is contributed by it. The amount of fish needed by 2025 is projected to be around 16 million tonnes. Due to overfishing, commercial aquaculture emerged as a solution to the depletion of natural fisheries. A issue for commercial aquaculture is presented by sudden climatic changes that produce fluctuations in water quality metrics.

The ideal temperature should be maintained and managed within the right range because fish are cold-blooded creatures. The fish must have access to enough oxygen for appropriate metabolism; otherwise, they will stay at the surface to collect oxygen, which would slow their metabolism and cause them to eventually perish from a shortage of oxygen. For optimal biological productivity, the dissolved oxygen level should always be greater than 5 ppm, and the pH level should be between 7 and 8.5. Water quality needs to be regularly monitored and managed because it is a requirement for fish. Overfeeding is one of the blunders made by aqua farmers since the leftover food might contaminate the water. The critical values for the tank's pH, dissolved oxygen, water level, ammonia content, and temperature should be continuously monitored in order to avoid undesirable condition for farming.

Due to the rising global demand for seafood, aquaculture is one of the most recent fields. Fish is the most sought-after sea food among all of them due to its health advantages. Due to the growing demand for fish, fish farming has a significant impact on the economy of any nation. However, due to insufficient output to fulfil global demand, several nations must import fish. For instance, despite an annual fish supply from both aquaculture and catch, only half of Ghana's need is satisfied. Due to the current supply shortage and the restricted prospects for supply growth, aquaculture has taken on critical relevance for the growth of the fisheries sector in several nations across the world. Monitoring water quality is essential for

fisheries management since fish illnesses are frequently found and have a direct impact on harvesting yield.

1.2 OBJECTIVE

For large scale fish production, it is necessary to develop an automated system for monitoring the aquaculture farm. To study and test the sensor. To implement the hardware to test setup. To develop an automated system using Think speak.

The objectives of an IoT-based aquaculture monitoring system project could include:

- 1.** Design and development of an IoT-based monitoring system for aquaculture operations.
- 2.** Real-time monitoring and control of water quality parameters, fish behaviour, and feeding patterns to improve fish health and growth rates.
- 3.** Integration of sensors and communication systems to enable remote monitoring and control of aquaculture operations.
- 4.** Integration of data analysis tools to provide insights into production processes, identify trends, and optimize performance.
- 5.** Energy management to optimize energy use by monitoring and controlling aeration, temperature, and lighting systems.
- 6.** Risk management by providing early warning of potential issues and preventing equipment failures and production interruptions.
- 7.** Compliance with environmental regulations by monitoring the discharge of waste and pollutants to reduce the impact on local ecosystems.
- 8.** Testing and validation of the system to ensure reliable and accurate data collection and analysis.
- 9.** Integration with other systems such as feeding and aeration systems to enable automatic control and optimization of aquaculture operations.
- 10.** Improving overall profitability by reducing costs, increasing production yields, and improving product quality.

Overall, the objectives of an IoT-based aquaculture monitoring system project should aim to develop a reliable and efficient system for monitoring and controlling aquaculture operations while promoting responsible and sustainable practices.

1.3 FUNCTION

The function of an aquaculture monitoring system in IoT is to provide real-time monitoring, control, and optimization of aquaculture operations. The system typically consists of sensors, data collectors, a communication network, and a central control system, which may be an IoT platform.

The key functions of an aquaculture monitoring system in IoT include:

1. **Monitoring water quality:** The system can monitor water parameters such as pH, temperature, dissolved oxygen, and salinity in real-time, providing insights into the health status of the aquatic environment.
2. **Monitoring fish health:** The system can monitor fish behavior, feeding patterns, and growth rates, providing insights into the health status of the fish.
3. **Managing feed and nutrition:** The system can monitor feed consumption and adjust feeding schedules and quantities to optimize fish growth and health.
4. **Controlling water quality:** The system can control water quality parameters such as aeration, temperature, and salinity, to maintain optimal conditions for fish growth and health.
5. **Reducing environmental impact:** The system can monitor and control waste discharge and reduce the risk of pollution and disease outbreaks.
6. **Remote monitoring and control:** The system can be accessed and controlled remotely through an IoT platform, reducing the need for on-site visits and enabling timely intervention when necessary.
7. **Data collection and analysis:** The system can collect and analyze large amounts of data to optimize production processes, improve decision-making, and enhance overall performance.

Overall, the function of an aquaculture monitoring system in IoT is to provide a comprehensive and real-time view of the aquaculture operations, enabling more efficient and sustainable production, reducing environmental impact, and improving the overall health and quality of the fish produced.

1.3.1 CHARACTERISTICS

Some of the key characteristics of an aquaculture monitoring system in IoT include:

1. **Real-time monitoring:** The system should be capable of monitoring water quality, fish health, and other relevant parameters in real-time to provide timely and accurate information for decision-making.
2. **Scalability:** The system should be scalable to accommodate different sizes and types of aquaculture operations, from small-scale farms to large-scale commercial facilities.
3. **Flexibility:** The system should be flexible enough to accommodate different sensor types and configurations to monitor different parameters, depending on the specific needs of the operation.
4. **Connectivity:** The system should be able to connect to a variety of communication networks, such as Wi-Fi, cellular, or satellite, to ensure reliable data transmission.
5. **Integration:** It should be possible for the system to integrate with other systems, such as feeding and aeration systems, to enable automatic control and optimization of aquaculture operations.
6. **Data analysis:** The system should be capable of gathering and researching a lot of info to provide insights into production processes, identify trends, and optimize performance.
7. **Remote monitoring and control:** The system should be accessible through an IoT platform, allowing remote monitoring and control of aquaculture operations.
8. **Reliability:** The system should be reliable and resilient, with built-in mechanisms with redundancy and fail-safes to guarantee ongoing performance even in the case of equipment failure or communication interruptions.

Overall, the characteristics of an aquaculture monitoring system in IoT should enable efficient, sustainable, and profitable aquaculture operations while reducing environmental impact and improving fish health and quality.

1.3.2 APPLICATIONS

Aquaculture monitoring systems in IoT have various applications in the aquaculture industry, including:

1. **Fish health monitoring:** Aquaculture monitoring systems can be used to monitor fish behaviour, feeding patterns, and growth rates to detect and prevent disease outbreaks.
2. **Water quality monitoring:** Aquaculture monitoring systems can monitor water quality parameters such as pH, oxygen level, ultra-sonic, pir, moisture level and temperature to ensure optimal conditions for fish growth and health.
3. **Feed management:** Aquaculture monitoring systems can monitor feed consumption and adjust feeding schedules and quantities to optimize fish growth and reduce waste.
4. **Environmental monitoring:** Aquaculture monitoring systems can monitor the discharge of waste and pollutants to ensure compliance with environmental regulations and reduce the impact on local ecosystems.
5. **Energy management:** Aquaculture monitoring systems can optimize energy use by monitoring and controlling aeration, temperature, and lighting systems.
6. **Risk management:** Aquaculture monitoring systems can help prevent equipment failures and production interruptions by providing early warning of potential issues.
7. **Remote monitoring and control:** Aquaculture monitoring systems can be accessed remotely, allowing operators to monitor and control operations from anywhere with an internet connection.

Overall, aquaculture monitoring systems in IoT can improve efficiency, reduce costs, and increase profitability while promoting sustainable and environmentally responsible aquaculture practices.

CHAPTER – 2

LITERATURE SURVEY

This paper describes the complete the development of a microcontroller based AUTOMATED UNDERWATER MONITORING SYSTEM help the farmers by providing accurate, dependable water quality parameter monitoring, as manual testing takes time and water quality parameters can change over time, making it easier to take preventative action before essential harm is done.

S.NO	AUTHOR	METHOD	ADVANTAGES	DISADVANTAGES
1	Sohail Karim; IEEE 2021	IOT	Time consumption	The processing was being executed manually like measurements .
2	Li Jinfeng and Cao Shun; IEEE 2015	Zigbee	Low power consumption	Low rate, Signal loss
3	Sayali Chavan, Sharikmasalat Sana, Dr. M. S. Chavan, Mr. Vihal P. Patil, and Chailatli Shinde; IEEE 2018	Raspberry Pi	Wireless, increase convenience and timeliness.	effective pond management
4	MUHAMMADNISWAR, SONNYWAINALANG, AMIL AILAM, ZAHIR ZAINUDDIN, YUSHINTA FUJAYA, SHIGERU KASHIHARA, DOUDOU FALL; IEEE 2018	LORA	Small embedded systems, inexpensive sensors, and a LoRa wireless interface are all being developed.	Low bandwidth

5	NAMGU LEE, BYEONGJUN KIM, KYOJAE SHIN, YUHWAN KIM; IEEE 2018	MQTT	It eliminates the need for staffed fish farms and is used in fish farm aquariums going forward.	Lack of security encryption.
6	JUN GU, XINYING MIAO, CHANGHUI DENG, YANPING GAO, and SONGSONG LI; IEEE 2010	using artificial neural networks	The experiment demonstrates the method's high efficiency and significant practical value for instruction.	Difficulty of showing the problem to the network.
7	G. Harish Kumar Varma, K. Raghu Sita Rama Raju; IEEE 2017	Through cloud, an aqua farmer	Foreign commerce and the nation's GDP both benefit from it. Before the quality of the water reaches its maximum range, measures can be made after the collected data has been analysed using big data.	Data loss, No security
8	I S AKILA, KARTHIKEYAN P, HARIHARAN M V, HARIKRISHNAN J. IEEE2018	It consists of electrical, mechanical and communication components which are	The prototype designed is well functioned with all features without any malfunction or disorder.	The end-user after certain time gap or after a particular parameter value is

		integrated with IoT.		reached, has to check the values and not in real-time
9	FAHIM REDWAN, SHADMAN RAFID, AHANAF HOSSAIN ABRAR, BISHWAJIT BANIK PATHIK; IEEE2019	Arduino Mega 2560	It is comparatively faster in continuous transmission of results so that the monitoring gets simpler.	It does not have any type of wireless interface to integrate it in a WSN and the storage capacity of data from the sensors is limited.
10	MONIRA MUKTA, SAMIA ISLAM, SURAJIT DAS BARMAN, AHMED WASIF REZA; IEEE 2019	NET platform	Fast forest binary classifier shows better performance to validate systems effectiveness and accuracy in predicting the quality of water	The poor performance on imbalanced data

Sohail karim in the year 2021, [1] discussed how aquaculture uses the **Internet of Things (IoT)** to reduce user time consumption while still requiring human processing, such as measurement. Beginning with Traditional techniques were used to monitor the water quality; water samples would be gathered and sent to a chemical lab for analysis of dangerous materials. The system's flaw is that all of the processing, including measurements, system maintenance, and control, was done manually. The manual system, on the other hand, required a lot of time. Water monitoring models including cultural models, forecasting models, and integrated

models were explored in several earlier studies, but these systems lacked online monitoring and real-time data collection capabilities. We may therefore conclude that these models are poor for fish monitoring, yet IoT is one of the technologies that has developed quickly in recent years. Identification, monitoring, tracking, and location of objects as well as device connectivity are the goals of the Internet of Things. Many gadgets are now available for real-time monitoring in far-off places thanks to the development of new sensor technologies, wireless communications, and data transmission technologies. Water quality variations, which have been studied in several research, have an impact on the growth of aquatic life. Many sensors are used in studies, but managing them is expensive. Instead, most papers focus on a few types of sensors, such as PH, DO, temperature, turbidity, and water level, and offer solutions to issues that arise because these parameters (PH, DO, temperature, turbidity, and water level) are interdependent and, if one fluctuates, the others do as well. For this reason, we have chosen these parameters for monitoring.

Li jinfeng and Cao shun in the year 2015, [2] They talked about and explained the **Zigbee aquaculture technology**, which uses less power than other methods and has some limitations. Low rate will happen, and signal loss could happen.

The sensor nodes, routing nodes, coordination nodes, control nodes, local monitoring Centre, and remote monitoring Centre make up the system.

The self-organizing networks form a tree out of the sensor nodes and routing nodes that are dispersed throughout the numerous ponds. The ZigBee wireless communication protocol is used by the sensor nodes to collect the water parameter data, transform it into a digital signal, and upload it to the routing node. The sensor nodes collect data, which is then processed by the routing nodes. The system is able to define its own requirements for water quality. The system will alarm, activate the control node to control the water quality, and quickly upload the aberrant data (emergency data) to the coordination node. Each routing node sends data and alarm information to the coordinator node, which then sends the data to the local monitoring Centre and waits for directives from the monitoring Centre to change the parameters and time the nodes' sleep and waking cycles to save energy.

Dr.m.s.chavan, mr.vishal p.patil, sayali chavan, sharikmasalat sana, chailatli shinde in the year 2018, [3] they discussed about aquafarming based on

Raspberry pi because of using this method Wireless gateway router as viewed in aquaculture monitoring , Increase convenience and timeliness and main drawbacks are effective pond management.

The proposed paper focuses mainly on monitoring of water quality parameters constantly from time to time, in order to take preventive measures. The architecture consists of four modules (1). Power module which comprises of charge controller, DC-DC converter, battery, and solar panel. (2). They talked about aquafarming utilising a Raspberry Pi because aquaculture monitoring uses wireless gateway routers in this way. Effective pond management is the biggest disadvantage, which increases convenience and timeliness. The proposed article primarily focuses on continuously monitoring water quality parameters periodically in order to take preventive steps. There are four modules in the architecture. (1). Charge controller, DC-DC converter, battery, and solar panel make up a power module. (2). Sensors for ammonia, temperature, nitrate, dissolved oxygen, pH, and carbonates are all included in a sensor module. (3). A processor is found in a microcontroller module. Due to the Raspberry Pi3's affordable use, it is utilised as a computer. (4) The aquafarmer's mobile device, which is considered the output module, must have an application installed that primarily consists of two buttons, the get data and history buttons.

Muhammadniswar, sonnywainalang, amil aillam,zahir Zainuddin, yushintafujaya,shigeru kashihara,doudou Fall in the year 2018, [4] They talked about **LORA-based aquaculture** because this approach is being used. Limited bandwidth is a disadvantage of low-cost sensors, small embedded systems, and lora wireless interface development.

An IoT-based solution is put up for a water quality monitoring system for crab farming that alerts farmers to the need to maintain threshold levels of pond water quality. The system uses LoRa-based wireless sensor networks and the lightweight Message Queuing Telemetry Transport (MQTT) protocol to exchange messages across mobile, embedded, and sensor devices. The essential components of the system are a Raspberry Pi MQTT broker, a sensor node acting as a publisher, and mobile client devices acting as subscribers. Small embedded devices, LoRa wireless interface, and water quality sensors like pH, temperature, and salinity sensors are used to build sensor nodes. Also, a web-based monitoring application

with a node-red dashboard is constructed for remotely gathering water quality metrics.

Yuhwan kim, namgu lee, byeongjun kim, kyoojae shin in the year 2018, [5] They talked about **aquaculture based on MQTT** because, when used to fish farm aquariums, it decreases the need for human labor in fish farming and can be used unattended in the future. The disadvantages include a lack of security encryption. Using IoT technology, a smart fish farm with a remote control and monitoring system is created. Several sensors, including temperature, water level, pH, and oxygen level, are sensed and monitored by the system. Also, a microcontroller controls the closed-loop water system of the aquarium, and the MQTT protocol is supported via the website application or mobile app.

Changhui deng, yanping gao, jun gu, xinying miao, songsong li in the year 2010, [6] They talked about aquafarming based on **artificial neural technology**. This method is highly useful and instructional in practice, but it has several downsides, including difficulties in communicating problems to the network. In this study, an artificial neural network is employed to create a model of the expanding aquaculture industry. Growing state model, which is created in this work and uses artificial neural network technology to address the congestion issue in an expert system, has an impact on a number of water quality parameters. The results of the experiments conducted have demonstrated the efficacy of this strategy.

The method suggested by k.Raghu Sita Rama Raju, "Knowledge Based **Real Time Monitoring System for Aquaculture Using IoT**," in the year 2017, [7] to assist farmers with accurate, dependable water quality parameter monitoring, as manual testing can be time-consuming and water quality parameters can change over time, making it easier to take preventative action before essential harm is done. Moreover, there is no requirement for periodic manual testing. Time and energy are saved. The approach proposed by Jui-Ho Chen, Wen-Tsai Sung, and Guo-Yan Lin, "Automated Monitoring System for the Fish Farm Aquaculture Environment," has a Wi-Fi transmission module in the central system that can be used with the majority of popular android smartphones connected directly to increase the overall system convenience and timeliness.

I s akila, karthikeyan p, hariharan m v, harikrishnan j in the year 2018, [8] they talked about aquafarming based on **Electrical, Mechanical and Communication Components Which Are Integrated with IoT** The disadvantages

of this method include the fact that the end user must check the values after a certain amount of time has passed or after a specific parameter value has been reached rather than in real-time. However, the prototype was well-functioning with all features without any malfunction or disorder. The system is made up of IoT-integrated electrical, mechanical, and communication components (Internet of Things). The electrical component consists of a pi camera that interfaces with a Raspberry Pi B+ module and allows real-time video data collecting of the fish. The mechanical components utilized for food dispensing include a stepper motor and a B+ via web interface, both of which are controlled by a Raspberry Pi. The two feeding methods available are: (1) The caregiver's prearranged feeding; (2) the web interface's manual feeding. In manual feeding, the user must feed the fish through a web interface, whereas the timetable for scheduled feeding must be established in the webpage.

Fahim redwan, shadman rafid, ahanaf hossain abrar, bishwajit banik pathik in the year 2019,[9] they talked about aquafarming based on **Arduino mega 2560** The disadvantages of this technology are that it lacks any form of wireless interface to integrate it in a wsn and that the storage capacity of data from the sensors is constrained. However, it is significantly faster in continuous transmission of findings, making monitoring easier. This research suggests an IoT-based approach for monitoring water quality. Solar energy is used to supply the sensors' energy needs. Using sensors, this system uses an Arduino Mega 2560 to measure the turbidity and pH levels. These sensors' collected data is transmitted to the cloud using a Wi-Fi module. The information is then analyzed, shown visually on an LCD, and displayed via IoT Cloud, a cloud server. This equipment is installed in the overhead and roof top tanks and can be monitored from anywhere in the world using the internet.

Monira mukta, samia islam, surajit das barman, ahmed wasif reza in the year 2019, [10] they talked about aquafarming based on **fast forest binary classifier shows** the advantages include higher performance to verify systems' efficacy and accuracy in predicting water quality, while the disadvantages include subpar performance on unbalanced data. The implementation of a smart IoT-based water quality monitoring system aids in the continuous monitoring of water condition based on four physical parameters: temperature, turbidity, electric conductivity, and pH characteristics. To determine the water parameters, four sensors are individually

connected to an Arduino Uno. The collected data is forwarded to a .NET platform application where it is compared to WHO standard values (World Health Organization). To assess whether the water sample is fit for drinking, the water parameters can be analyzed based on the measured parameters.

2.1 INTERFERENCE:

Interference from literature survey for an aquaculture monitoring system can occur if a researcher solely relies on existing literature without critically evaluating the relevance and applicability of the sources to their specific system. This can lead to several problems:

- 1. Lack of understanding:** If a researcher does not understand the specific needs and challenges of their aquaculture system, they may not be able to effectively apply the information gathered from the literature survey.
- 2. Inadequate system design:** If a researcher fails to consider the unique features and requirements of their aquaculture system, they may develop a monitoring system that is ineffective or inefficient.
- 3. Unrealistic expectations:** If a researcher relies too heavily on the successes of monitoring systems in other aquaculture systems, they may have unrealistic expectations for their own system's performance.

To avoid interference from literature survey, researchers should approach their literature review with a critical mindset, evaluating the relevance and applicability of each source to their specific aquaculture system. They should also consider the specific needs and challenges of their system and develop a monitoring system that is tailored to those requirements. Additionally, researchers should consult with experts in the field and conduct field trials to ensure the effectiveness and efficiency of their monitoring system. Ultimately, the literature survey should serve as a foundation for the researcher's own original contributions to the development of an effective aquaculture monitoring system.

2.2. EXISTING SYSTEM:

Aquaculture monitoring systems have been developed and implemented to improve the efficiency and sustainability of fish farming operations. However, there are still some open problems in the existing system. Arduino Uno is a popular microcontroller board used in many aquaculture monitoring systems due to its low cost, ease of use, and versatility. However, there are still some open problems in the existing system of aquaculture monitoring based on Arduino Uno, including:

1. **Lack of standardization:** The lack of standardization in aquaculture monitoring systems can make it difficult to compare data across different farms or regions, hindering efforts to identify best practices and optimize production.
2. **Limited scope of monitoring:** Existing aquaculture monitoring systems may focus primarily on water quality parameters, such as temperature and pH, and may not capture other important metrics related to fish health and welfare, such as feeding behaviour and stress levels.
3. **Accuracy and reliability:** The accuracy and reliability of sensor readings can vary depending on the quality of the sensor and the calibration method used. Improving the accuracy and reliability of sensor readings is important to ensure that monitoring data is trustworthy and useful for making informed decisions.
4. **Limited connectivity:** Arduino Uno has limited connectivity options, which can make it difficult to transmit monitoring data to a central database or to integrate with other monitoring systems. There is a need for more connectivity options, such as wireless or cellular connectivity, to improve data collection and sharing.
5. **Cost:** Many existing aquaculture monitoring systems can be expensive to implement and maintain, which can be a barrier to adoption for small-scale fish farmers.
6. **Data management:** The vast amount of data generated by aquaculture monitoring systems can be overwhelming, and there may be challenges in effectively managing, analyzing, and using this data to make informed decisions.

7. **Power consumption:** Arduino Uno can consume a significant amount of power, which can be a challenge in remote or off-grid aquaculture operations. Improving the energy efficiency of aquaculture monitoring systems based on Arduino Uno is important to reduce operating costs and increase sustainability.
8. **Scalability:** The scalability of aquaculture monitoring systems based on Arduino Uno can be limited by the number of sensors that can be connected to the board and the processing power of the microcontroller. Improving the scalability of these systems is important to support larger and more complex aquaculture operations.

Overall, addressing these open problems can help to improve the effectiveness and scalability of aquaculture monitoring systems based on Arduino Uno, and support the growth and sustainability of the aquaculture industry.

2.3 PROBLEM DEFINITION

The problem definition in aquaculture monitoring system in IoT could be:

Aquaculture is the farming of aquatic organisms such as fish, shrimp, and oysters. It is an important source of protein and income for many communities around the world. However, aquaculture operations face several challenges such as maintaining water quality, preventing disease outbreaks, and optimizing feed management. Traditional monitoring methods such as manual sampling and observation are time-consuming and often inaccurate, leading to production losses and increased costs. An IoT-based aquaculture monitoring system can provide a solution to these challenges by enabling real-time monitoring and control of water quality parameters, fish behaviour, and feeding patterns. However, the development of such a system requires addressing several technical and operational challenges such as sensor selection, communication infrastructure, and data analysis.

Therefore, the problem definition in aquaculture monitoring system in IoT is to develop a reliable and efficient system that can address these challenges and provide real-time monitoring and control of aquaculture operations to improve fish health, production yields, and profitability while promoting responsible and sustainable practices.

CHAPTER - 3

REQUIREMENTS ANALYSIS

Requirements analysis for an aquaculture monitoring system involves identifying the specific needs and challenges of the aquaculture system and determining the functional and non-functional requirements of the monitoring system. The following steps can be followed to conduct a requirements analysis:

- 1. Identify the stakeholders:** Identify the stakeholders of the aquaculture system, including the farmers, government agencies, and regulatory bodies. Determine their requirements for the monitoring system.
- 2. Identify the objectives:** Determine the primary objectives of the monitoring system, such as monitoring water quality, fish health, feeding rates, and growth rates.
- 3. Identify the sensors and data sources:** Identify the sensors and data sources required to measure the parameters of interest, such as temperature, dissolved oxygen, pH, ammonia, and nitrite.
- 4. Determine the data management requirements:** Determine the data management requirements, including the data storage, retrieval, and analysis procedures, as well as the reporting and communication requirements.
- 5. Determine the system design requirements:** Determine the system design requirements, including the hardware and software requirements, communication protocols, and power supply.
- 6. Identify the regulatory requirements:** Identify the regulatory requirements that the monitoring system needs to comply with, such as environmental and safety regulations.
- 7. Prioritize the requirements:** Prioritize the requirements based on their importance and feasibility.
- 8. Document the requirements:** Document the requirements in a requirements specification document that includes the functional and non-functional requirements, as well as the constraints and assumptions.

By following these steps, the requirements analysis for an aquaculture monitoring system can be conducted systematically, ensuring that the monitoring system meets the specific needs and requirements of the aquaculture system.

3.1 FEASIBILITY STUDIES/RISK ANALYSIS OF THE PROJECT:

Feasibility studies and risk analysis are important components of the project planning process for an aquaculture monitoring system. These studies can help identify potential challenges and risks associated with the project, as well as determine the feasibility and viability of the system. The following steps can be followed to conduct feasibility studies and risk analysis for an aquaculture monitoring system:

- 1. Identify potential risks:** Identify potential risks and challenges associated with the project, such as technical, financial, operational, and environmental risks.
- 2. Assess the impact of the risks:** Assess the impact of each risk, including the likelihood of occurrence and the potential consequences.
- 3. Identify risk mitigation strategies:** Develop risk mitigation strategies to address each identified risk. These strategies may include contingency plans, risk transfer or avoidance, or risk reduction measures.
- 4. Conduct a feasibility study:** Conduct a feasibility study to determine the technical, economic, and operational feasibility of the project. This study should include an analysis of the market demand, financial feasibility, and technical feasibility of the monitoring system.
- 5. Evaluate the costs and benefits:** Evaluate the costs and benefits associated with the project, including the initial investment, ongoing maintenance and operational costs, and the potential return on investment.
- 6. Identify potential stakeholders:** Identify potential stakeholders, including investors, farmers, government agencies, and regulatory bodies, and assess their support and involvement in the project.
- 7. Document the findings:** Document the findings of the feasibility study and risk analysis in a report that includes a summary of the risks, mitigation strategies, feasibility analysis, and potential stakeholders.

By conducting feasibility studies and risk analysis, aquaculture monitoring system project planners can identify potential risks and challenges, assess the feasibility of the system, and develop risk mitigation strategies to ensure the success and viability of the project.

3.2 SOFTWARE REQUIREMENT SPECIFICATION DOCUMENT:

A software requirement specification (SRS) document for an aquaculture monitoring system in IoT should clearly define the functional and non-functional requirements of the software. The following sections should be included in the SRS document:

- 1. Introduction:** The introduction section should provide an overview of the system and describe the purpose of the SRS document.
- 2. Scope:** The scope section should define the boundaries of the system and identify the specific features and functions that the software should provide.
- 3. System requirements:** The system requirements section should identify the hardware and software requirements for the IoT-based aquaculture monitoring system, including the sensors, actuators, microcontrollers, communication protocols, and cloud-based infrastructure.
- 4. Functional requirements:** The functional requirements section should identify the specific features and functions that the software should provide, including data acquisition, data processing, data analysis, reporting, and communication.
- 5. Non-functional requirements:** The non-functional requirements section should identify the performance, security, and usability requirements of the software, including response time, accuracy, reliability, and data privacy.
- 6. User interface:** The user interface section should provide a detailed description of the graphical user interface (GUI) and identify the specific design requirements for the interface, including the compatibility with mobile devices.
- 7. Data management:** The data management section should describe the specific data management requirements, including data storage, retrieval, and analysis procedures, as well as the reporting and communication requirements with cloud-based services.

- 8. System architecture:** The system architecture section should provide a high-level overview of the software architecture for the IoT-based aquaculture monitoring system, including the components, interfaces, and interactions between the components.
- 9. Constraints and assumptions:** The constraints and assumptions section should identify any constraints or assumptions that were made during the development of the SRS document.
- 10. Glossary:** The glossary section should provide a list of definitions for any technical terms used in the SRS document.

By including these sections in the SRS document, developers can ensure that the IoT-based aquaculture monitoring system meets the specific functional and non-functional requirements of the aquaculture system, as well as the data management and user interface requirements. Additionally, the SRS document should ensure that the IoT system can function seamlessly across multiple devices and software platforms while maintaining the highest level of data security and reliability.

3.3 SYSTEM USE CASE:

Here's an example of a use case for an aquaculture monitoring system in IoT:

Use Case Name: Monitor Aquaculture Parameters

Primary Actor: Aquaculture Farm Operator

Goal in Context: The operator needs to monitor the parameters of the aquaculture system using an IoT-based monitoring system.

Preconditions:

1. The IoT-based monitoring system is installed and configured.
2. Sensors are properly placed in the aquaculture environment to capture the required data.

Trigger: The operator wants to monitor the status of the aquaculture environment in real-time.

Basic Flow:

1. The operator opens the IoT-based monitoring system user interface on their mobile device.
2. The user interface displays the current status of the aquaculture parameters, including water temperature, dissolved oxygen levels, pH, and feed consumption.
3. The operator can view the data in real-time or choose to view historical data over a specified period.
4. If the operator detects any abnormality in the parameters, they can take corrective action based on the guidelines and recommendations provided by the system.
5. The system automatically generates alerts and notifications to the operator if any parameter goes out of the predefined range.

Postconditions:

1. The operator has successfully monitored the aquaculture parameters using the IoT-based monitoring system.
2. Any issues or problems in the parameters are identified and addressed in a timely manner.

Alternative Flows:

1. If the operator faces any difficulty in accessing or interpreting the data, they can contact technical support for assistance.
2. If the system detects any technical issues or hardware failures, it generates an alert to the technical support team for further action.

CHAPTER - 4

DESCRIPTION OF PROPOSED MODEL

To develop a device that uses an Arduino Nano to send data to ESP01 and cellular hardware for monitoring and position of fish farming. The use of sensors and camera technology in aquaculture monitoring systems can greatly improve efficiency and reduce labour costs, making it a valuable investment for aqua growers.

The use of the ESP which can provide real-time data footage, allowing growers to monitor the fish and their environment closely. This technology can also be used to detect any abnormalities or changes in behaviour, allowing growers to quickly respond to any potential issues.

It's also promising to hear that you are planning to use low-cost components for the aquaculture monitoring system. This can make the technology more accessible to aqua growers who may not have a large budget for expensive equipment.

Overall, the development of an aquaculture monitoring system using Arduino Nano, ESP01 and cellular hardware can greatly benefit the aqua industry. It can provide real-time data on water quality and fish behaviour, allowing growers to make informed decisions and improve their yield.

4.1 SELECTED METHODOLOGY (OR) PROPOSED MODEL:

IoT-based monitoring systems can provide real-time data on various parameters, such as water quality, temperature, and environmental conditions, allowing users to detect problems quickly and easily. The use of multiple sensors, such as ultrasonic sensor, pH sensor, turbidity sensor, soil moisture sensor, temperature sensor, air quality sensor, and PIR sensor, can provide a comprehensive picture of the aquaculture environment, enabling growers to make informed decisions and take appropriate actions.

One of the benefits of aquaculture monitoring systems is the ability to prevent the overgrowth of aquatic plants and organisms, which can cause harm to fish and

other aquatic life. By monitoring water quality and controlling the growth of algae and other plants, growers can create a healthy and stable ecosystem for their fish and other aquatic animals. Overall, the use of IoT-based monitoring systems in aquaculture can greatly improve the efficiency and sustainability of fish farming operations. It can provide real-time data, enable remote monitoring, and help prevent problems before they occur.

4.2 Architecture/Overall Design Of Proposed System:

Denotes the block diagram of aquaculture farming

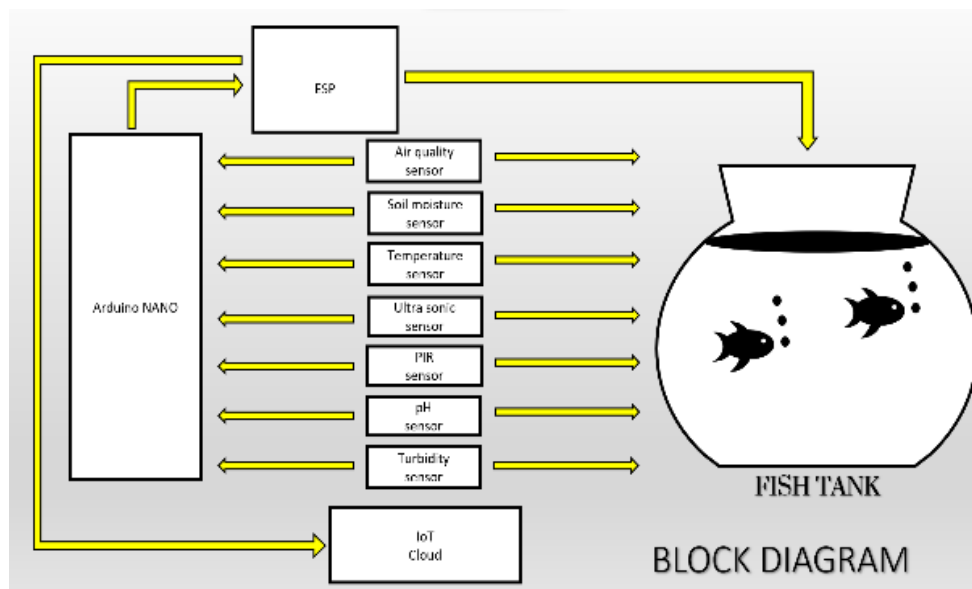


Fig: 4.2.1. Block diagram

The hardware setup for the aquaculture monitoring system as shown in the block diagram is a great start. By connecting multiple sensors such as ultrasonic sensor, pH sensor, turbidity sensor, soil moisture sensor, temperature sensor, air quality sensor, and PIR sensor to the ESP01, you can collect data on various parameters of the aquaculture environment.

Additionally, by connecting the ESP01 to the IoT Cloud platform, you can collect and analyze data on the cloud, allowing you to remotely monitor the aquaculture environment from anywhere in the world. This can provide real-time data and alerts, allowing you to detect and respond to any issues quickly.

It's important to ensure that the hardware setup is properly configured and calibrated to collect accurate data. You may also want to consider adding backup power sources, such as batteries or solar panels, to ensure uninterrupted operation even in the event of power outages. Additionally, you'll want to ensure that the system is secured to prevent unauthorized access to the data collected.

Overall, the use of an IoT-based monitoring system can greatly improve the efficiency and sustainability of aquaculture operations by providing real-time data, enabling remote monitoring, and helping to prevent problems before they occur.

4.3 DESCRIPTION OF SOFTWARE FOR IMPLEMENTATION AND TESTING PLAN OF THE PROPOSED MODEL SYSTEM

hardware components used-

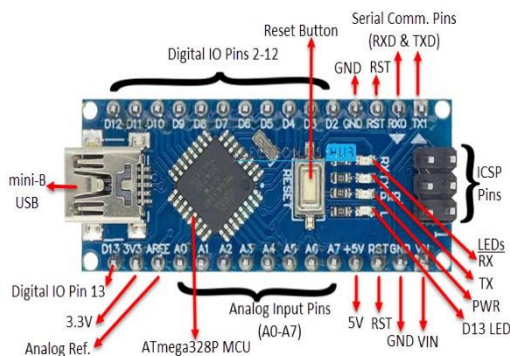


Fig: 4.3.1. Arduino nano



Fig: 4.3.2. pH sensor



Fig: 4.3.3. MQ135 sensor



Fig: 4.3.4. PIR sensor

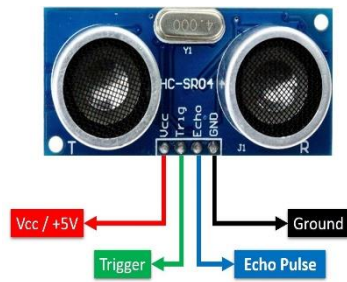


Fig: 4.3.5. Ultra sonic sensor

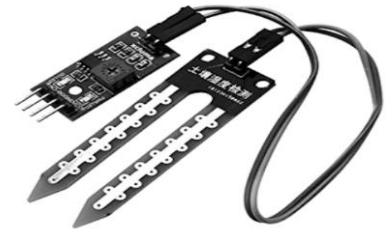


Fig: 4.3.6. Soil moisture sensor

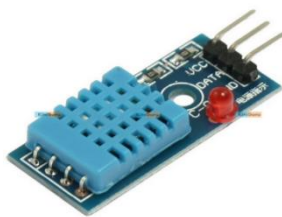


Fig: 4.3.7. DHT11 sensor



Fig: 4.3.8. Turbidity sensor

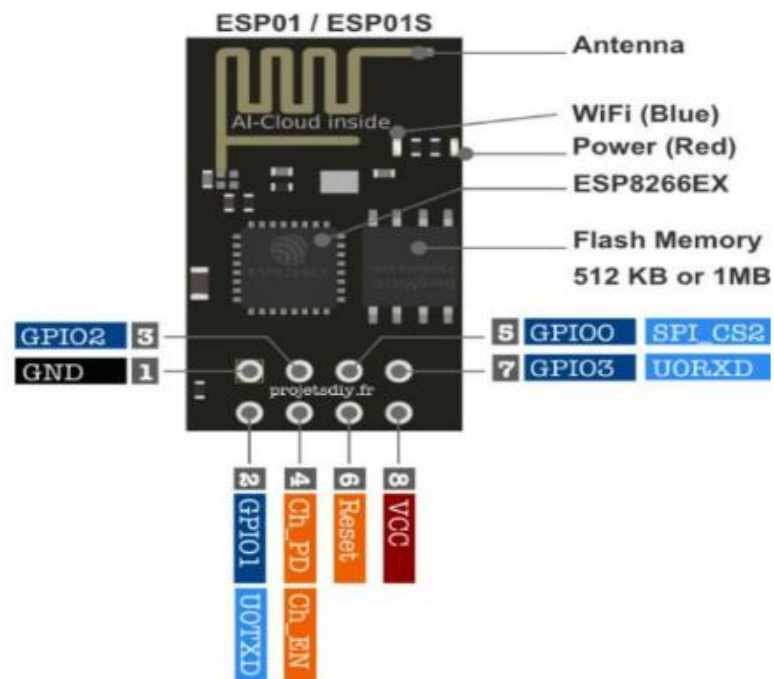


Fig: 4.3.9. ESP01 WIFI MODULE

Arduino Nano:

- The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3. x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one.
- ATmega328mp, voltage-5V, Analogpin-8, Digitalpin-14, SRAM-2KB, Frequency-16MHz, Power consumption-19mA

pH sensor:

- A pH sensor is a scientific device used to accurately measure acidity and alkalinity in water and other liquid substances. It is an important device used in most industries, including power plants, pharmaceuticals, food & beverage, primaries, chemicals, oil gas, and wastewaters.
- Measurement range: 0-14 pH, Temperature during use: 0 -80 °C, Response time: <1 minute, Accuracy of readings: upto 0.01 (with calibration), Interference: <0.5 mV.

Air Quality Sensors (MQ135):

- Air quality sensors are devices used to detect contaminants in the air. This includes particulates, pollutants and noxious gases that may be harmful to human health.
- voltage-5V, Dual signal output (analog output, and low/high digital output), analog output voltage-0 to 4.2V.

PIR Sensor:

- Passive infrared sensor (PIR) that allow you to sense motion, almost always used to detect whether a living thing like (humans, animals, aquaculture, etc..) has moved in or out of the sensors range.
- voltage-3.3 to 5V, power consumption-65mA, temperature – (-20° to +80° C) distance - 120° and 7 meters.

Ultra-Sonic Sensor:

- Ultrasonic sensors are electronic devices that calculate the target's distance by emission of ultrasonic sound waves and convert those waves into electrical

signals. The speed of emitted ultrasonic waves traveling speed is faster than the audible sound.

- voltage-3.3v/5v, current-15mA, Working Frequency-40Hz, Distance- 2cm to 4m, Input Pulse width-10uS. Resolution- 0.3cm, Angle- 15-degree, Dimension – 45mm x 20mm x 15mm.

Soil Moisture Sensor:

- Soil moisture sensors do not measure water in the soil directly. Instead, they measure changes in some other soil property that is related to water content in a predictable way.
- voltage-3.3v/5v, current-15mA, output digital – 0 to 5v (Adjustable trigger level from pre-set), output Analog – 0 to 5v (based on infrared radiation from fire flame falling on the sensor, LEDs, LM393).

Temperature Sensor (DHT11):

- A temperature sensor is a device that detects and measures hotness and coolness and converts it into an electrical signal.
- voltage-3.3v/5v, current-0.3mA(measuring)60uA(standby), output-Serial data, Temperature – 0 to 50°C, Humidity range- 20 to 90%, Accuracy - $\pm 1^{\circ}\text{C}$ and $\pm 1\%$, both Temperature and Humidity resolution are 16-bit.

Turbidity Sensor:

- Turbidity sensors measure the amount of light that is scattered by the suspended solids in water. As the amount of total suspended solids (TSS) in water increases, the water's turbidity level (and cloudiness or haziness) increases.
- voltage-5v, current-30mA(max), temperature - 30°C to 80°C , Measuring range – 0~1000 NTU.

ESP01 Wi-Fi Module:

- The ESP01 Wi-Fi module is a versatile and cost-effective solution for adding Wi-Fi connectivity to IoT devices. Its small size, low power consumption, and support for various programming environments make it an ideal choice for a wide range of IoT applications.

- 32-bit RISC Tensilica Xtensa LX Processor running at 80MHz, 1MB Flash Memory, IEEE 802.11 b/g/n WiFi, 2 GPIO, voltage- 3.3V Operation.

Software used:

Fig.4.3.10 defines the software used for aquaculture farm



Fig: 4.3.10 Arduino IDE



Fig: 4.3.11 ThingSpeak



Fig: 4.3.12. Flash Magic.

Arduino IDE:

It is an Integrated Development Environment (IDE) used to program and develop software for Arduino microcontroller boards. Arduino IDE provides a simplified programming environment for users to write, compile, and upload code to an Arduino board. It includes a code editor, a compiler, a text console, and a range of libraries to simplify programming. Arduino IDE is designed to be easy to use, making it accessible to beginners and hobbyists who are interested in developing and experimenting with electronics and programming. The Arduino IDE is available for free and can be downloaded from the official Arduino website.

The Arduino IDE is built on the Java platform and is compatible with various operating systems such as Windows, Mac, and Linux. It offers a simplified programming environment that is easy to use, making it a popular choice for

hobbyists, students, and professionals who want to develop projects that involve microcontrollers.

One of the key features of the Arduino IDE is its support for a wide range of microcontrollers, including the popular Arduino Uno, Arduino Mega, and Arduino Due. It also includes a large library of built-in functions and examples that make it easy to develop projects, even for beginners with little or no programming experience.

Additionally, the Arduino IDE supports a range of programming languages such as C, C++, and a simplified version of C++ called Arduino Programming Language. This makes it easy to write code and develop applications for Arduino boards.

In summary, the Arduino IDE is a powerful and user-friendly tool that simplifies the process of developing applications for Arduino microcontroller boards. Its simplicity and ease of use make it an ideal choice for hobbyists, students, and professionals who want to work with microcontrollers and develop innovative projects.

ThingSpeak:

It is an open-source IoT (Internet of Things) platform that allows users to collect, analyse, and visualize data from connected devices or sensors. It provides an easy-to-use interface that enables users to monitor and control connected devices in real-time and to store and analyze the data generated by those devices.

ThingSpeak was developed by MathWorks, a software company that specializes in developing engineering and scientific software. It is based on MATLAB, a programming language and development environment widely used in engineering, science, and mathematics.

ThingSpeak is designed to work with a wide range of IoT devices and sensors, including temperature sensors, humidity sensors, pressure sensors, and more. It provides a variety of built-in tools and features that make it easy to create IoT applications, such as data visualization tools, data analysis tools, and an API that allows developers to integrate ThingSpeak with other platforms and services.

One of the key benefits of ThingSpeak is its scalability. It can be used for projects of all sizes, from simple hobby projects to large-scale commercial applications. Additionally, ThingSpeak is free to use, making it an accessible platform for developers and hobbyists who want to experiment with IoT technology.

In summary, ThingSpeak is an open-source IoT platform that provides an easy-to-use interface for collecting, analyzing, and visualizing data from connected devices or sensors. It is based on MATLAB and is designed to work with a wide range of IoT devices and sensors, making it an ideal choice for developers and hobbyists who want to experiment with IoT technology.

Another key feature of ThingSpeak is its ability to integrate with other platforms and services. It includes an API that allows developers to connect ThingSpeak with other IoT platforms and services, making it a powerful tool for building complex IoT applications.

Overall, ThingSpeak is a powerful and flexible platform for IoT applications. Its support for data visualization, data analysis, and integration with other platforms and services make it a popular choice for developers and hobbyists who are interested in IoT technology.

Flash Magic:

It is a software tool that is designed for programming flash-based microcontrollers from NXP Semiconductors. It is used by embedded systems engineers to program and debug microcontroller applications.

The software supports a range of microcontroller families, including the LPC, Kinetis, and S32 microcontroller families. It can be used to program microcontrollers using a serial or USB interface, and it provides a simple graphical user interface for performing tasks such as erasing and programming flash memory, configuring device options, and verifying code.

Flash Magic is compatible with Windows operating systems and is available for download from the NXP website. The software is free to use for non-commercial purposes, but a license is required for commercial use.

Flash Magic offers a number of features that make it a popular choice for embedded systems engineers. These features include automatic baud rate detection, support for Intel Hex and Motorola S-Record file formats, and the ability to save and reload device configurations. The software also includes a command-line interface, which allows it to be integrated into automated build processes.

One of the key benefits of using Flash Magic is its ease of use. The software is designed to be intuitive and user-friendly, with a simple interface that allows engineers to quickly and easily program their microcontrollers. It also provides comprehensive documentation and support, which makes it easy for users to get started and troubleshoot any issues that they may encounter.

Flash Magic is primarily used for programming and debugging flash-based microcontrollers, and it does not have commands for connecting to WiFi networks. To connect to a WiFi network, you would typically use a WiFi module or a microcontroller with built-in WiFi capabilities, such as the ESP8266 or ESP32. These devices typically have their own firmware and programming interfaces that allow you to connect to a WiFi network and communicate over the internet.

That being said, if you are using a microcontroller with WiFi capabilities that is compatible with Flash Magic, you can use Flash Magic to program and debug your application code. However, you would need to write your own code to connect to a WiFi network and send and receive data over the internet. It's also worth noting that there are other tools and software libraries available specifically for working with WiFi networks on microcontrollers, such as the Arduino WiFi library and the ESP8266WiFi library. These tools and libraries can make it easier to connect to a WiFi network and communicate over the internet, and may be worth exploring if you are working on a WiFi-enabled microcontroller project.

In summary, Flash Magic is a powerful and versatile software tool that is used by embedded systems engineers to program and debug microcontroller applications. With its ease of use, comprehensive documentation and support, and wide range of features, it is a popular choice for anyone working with NXP Semiconductors microcontrollers.

4.4 Project Scope:

The Aquaculture Monitoring System in IoT project will involve the following activities:

1. Design and development of the monitoring system hardware and software using IoT technology.
2. Installation of the monitoring system in several aquaculture farms for testing and evaluation.
3. Collection and analysis of data on water quality, fish behaviour, and growth rates.
4. Development of decision-making tools based on the data collected by the monitoring system.
5. Development of a user-friendly interface for accessing and interpreting the data collected by the system.

4.5 SOFTWARE ALGORITHM-FLOW CHART

Sure, I can provide you with a general flow chart for an IoT-based aquaculture monitoring system.

Here is a high-level algorithmic flow chart for the IoT-based aquaculture monitoring system:

1. Start
2. Initialize the system
3. Connect to the internet and cloud-based server
4. Read sensor data from the environment monitoring system (EMS)
5. Analyze sensor data to detect anomalies and deviations from normal values
6. If anomalies are detected, alert the user or automatically take corrective actions by sending a command to actuators
7. Read sensor data from the fish monitoring system (FMS)
8. Analyze sensor data to detect anomalies in fish behaviour, health, and growth

9. If anomalies are detected, alert the user or automatically take corrective actions by sending a command to actuators
10. Read data from the feeding system
11. Analyze feeding data to ensure that fish are being fed the appropriate amount and at the appropriate times
12. If feeding irregularities are detected, alert the user or automatically take corrective actions by sending a command to actuators
13. Analyze water quality data to ensure that the water is at optimal levels for fish growth and health
14. If water quality issues are detected, alert the user or automatically take corrective actions by sending a command to actuators
15. Store all the data to a cloud-based database for analysis and generating reports
16. Generate reports summarizing system performance and providing insights into fish health, growth, and feeding behaviour
17. End.

This is a general flow chart that can be adapted to the specific needs of your IoT-based aquaculture monitoring system. The flow chart can be implemented using an IoT platform like Azure IoT, AWS IoT, or Google Cloud IoT, and programming languages like Python, C++, or Java.

4.6 WORKING METHOD OF CIRCUIT:

Sure, I can provide you with a general working method and circuit diagram for an IoT-based aquaculture monitoring system.

Working Method:

The sensors, which are placed inside the fish tank, measure various parameters such as temperature, pH, oxygen level, ultra-sonic, turbidity, pir and water level.

The sensor data is sent to a microcontroller such as Arduino or Raspberry Pi, which processes the data and sends it to an IoT platform.

The IoT platform receives the sensor data, processes it, and stores it in a cloud-based database.

The user can access the data from the cloud-based database using a web or mobile application.

The user can set thresholds for the various parameters, and if any parameter exceeds the threshold, an alert is sent to the user via the application.

The user can also send commands to the microcontroller through the application to control devices such as water pumps or feeding machines.

Circuit Diagram:

Here is a general circuit diagram for an IoT-based aquaculture monitoring system:

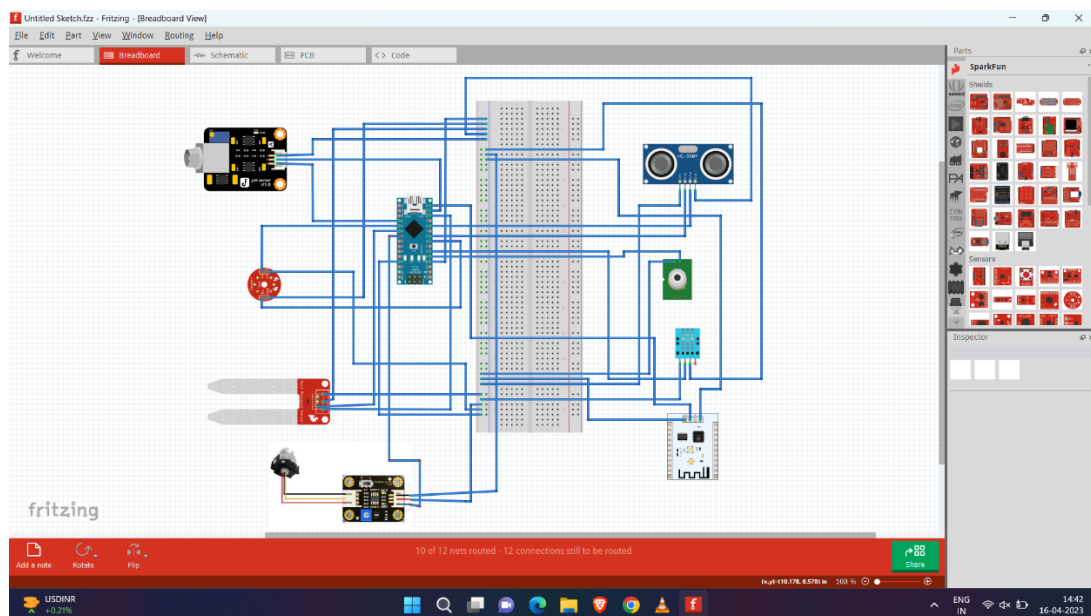


Fig: 4.6.1 Circuit Diagram

Aquaculture Monitoring System IoT Circuit Diagram

In this circuit diagram, the sensors are connected to a microcontroller (in this case, an Arduino Nano). The microcontroller is connected to an ESP01 Wi-Fi module, which sends the data to the cloud-based IoT platform. The IoT platform receives the data and stores it in a cloud-based database, which can be accessed by the user through a web or mobile application. The user can also send commands to the microcontroller through the IoT platform to control devices such as water pumps or feeding machines.

CHAPTER – 5

IMPLEMENTATION

5.1 DEVELOPMENT AND DEPLOYMENT SETUP:

Here is a potential development and deployment setup for an aquaculture monitoring system through IoT:

1. **Sensor Selection:** Select the appropriate sensors that will be used to monitor the relevant environmental factors in the aquaculture system. This may include sensors for temperature, air quality, PIR, pH, ultra-sonic, soil level and turbidity.
2. **IoT Devices:** Choose IoT devices that are compatible with the selected sensors, such as microcontrollers (Arduino -Nano, UNO, mega, etc...), single-board computers, or specialized IoT devices.
3. **Data Collection:** Develop firmware or software to collect data from the sensors and transmit it to a cloud-based platform for processing and analysis. This may involve programming languages such as Python, Embedded C, C++, or Java.
4. **Cloud Platform:** Select a cloud-based platform that supports IoT services, such as Think Speak, Amazon Web Services, Microsoft Azure, or Google Cloud Platform.
5. **IoT Services:** Utilize IoT services provided by the cloud platform to manage the IoT devices and collect data from them. This may include services such as device management, data ingestion, and data storage.
6. **Security:** Ensure the IoT devices and cloud platform are secure through implementation of appropriate security measures, such as data encryption, secure data transmission, and access controls.
7. **Deployment:** Deploy the aquaculture monitoring system on the cloud platform and test it to ensure it is functioning as expected.
8. **Maintenance:** Establish a maintenance plan to ensure that the system remains up-to-date and operational over time. This includes regular firmware and software updates, sensor calibration, and hardware maintenance.

Overall, an effective development and deployment setup for an aquaculture monitoring system through IoT involves selecting the appropriate sensors,

developing and deploying the necessary IoT devices and software, and utilizing cloud-based services for data collection, analysis, and visualization. The system should also be secure and have a maintenance plan in place to ensure ongoing reliability and accuracy.

5.2 ALGORITHM:

step-by-step algorithm for an aquaculture monitoring system through IoT:

1. **Install and set up sensors:** The first step is to install and set up the necessary sensors in the aquaculture system to collect data on temperature, pH levels, oxygen level, and other parameters.
2. **Connect sensors to IoT device:** Next, connect the sensors to an IoT device such as a Raspberry Pi or Arduino board to collect the data.
3. **Write code to read sensor data:** Write code to read the data from the sensors and convert it into a digital format that can be processed by the IoT device.
4. **Transmit data to cloud:** Use an IoT communication protocol such as MQTT or HTTP to transmit the data from the IoT device to the cloud.
5. **Store data in a database:** Store the data in a cloud-based database such as Think Speak, Amazon Web Services (AWS) DynamoDB or Microsoft Azure Cosmos DB.
6. **Analyze data:** Analyze the data using algorithms such as regression analysis, clustering, or machine learning to gain insights into the health and performance of the aquaculture system.
7. **Visualize data:** Create visualizations such as graphs or charts to display the data in a user-friendly way, allowing for easy analysis and decision-making.
8. **Set up alerts:** Set up alerts to notify stakeholders when certain parameters fall outside of acceptable ranges, allowing for quick action to be taken to prevent damage to the aquaculture system.
9. **Continuously monitor and improve:** Continuously monitor the system and use the insights gained through data analysis to make improvements to the system, optimizing performance and maximizing yield.

Overall, this algorithm provides a framework for developing an aquaculture monitoring system through IoT that can help farmers optimize their operations and ensure the health and well-being of their aquatic animals.

5.3 TESTING:

That's a great explanation of the different sensors using Arduino UNO in an aquaculture monitoring system and how they contribute to the monitoring of underwater fishes. The pH sensor is important for identifying the chemicals present in the water, while the soil moisture sensor measures the level of dryness in the water. The turbidity sensor helps to detect the presence of dirtiness in the water, and the ultrasonic sensor is used to measure the distance between the sensor and the fish. The temperature and humidity sensor measures the temperature of the water, and the PIR sensor is used for motion detection. The air quality sensor is important for detecting the purity of the air in the surrounding area. Overall, the combination of these sensors in an aquaculture monitoring system is crucial for maintaining a healthy and productive aquatic environment.

1. pH SENSOR:



Fig: 5.3.1. Test setup for pH sensor and screenshot of the code output.

2. MQ135 SENSOR:

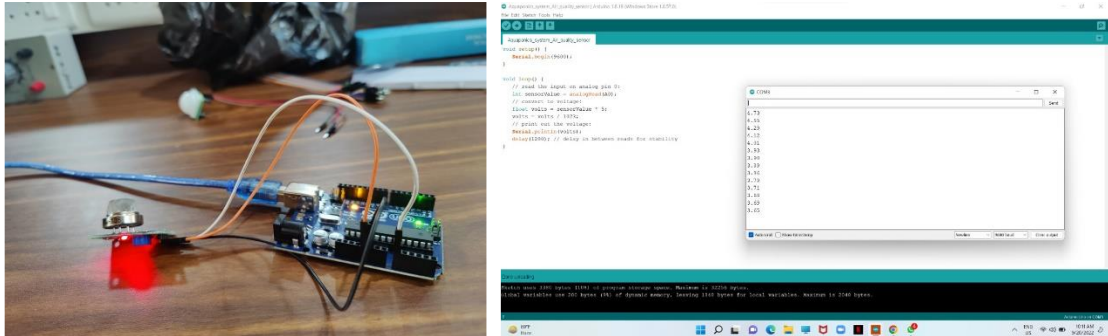


Fig: 5.3.2. Test setup for MQ135 sensor and screenshot of the code output.

3. PIR SENSOR:



Fig: 5.3.3. Test setup for PIR sensor and screenshot of the code output.

4. ULTRA SONIC SENSOR:

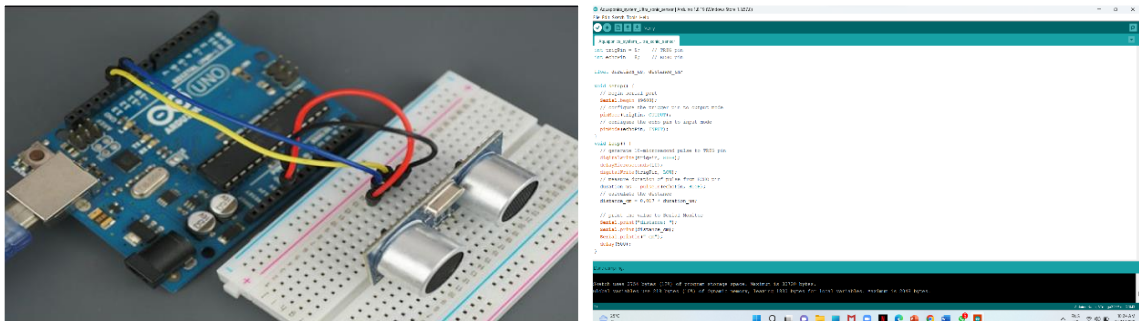


Fig: 5.3.4. Test setup for Ultra-Sonic sensor and screenshot of the code output.

5. SOIL MOISTURE SENSOR:



Fig: 5.3.5. Test setup for Soil Moisture sensor and screenshot of the code output.

6. DHT11 SENSOR:



Fig: 5.3.6. Test setup for DHT11 sensor and screenshot of the code output.

7. TURBIDITY SENSOR:



Fig: 5.3.7. Test setup for Turbidity sensor and screenshot of the code output.

It sounds like you are describing a system for monitoring aquaculture parameters using sensors connected to a ESP01 device, which sends the data to IoT Cloud using either communication line protocols. This system allows for easy and efficient monitoring of the aquaculture parameters from anywhere.

Communication line to ESP used for transferring data between devices. communication line is a synchronous serial communication protocol, which means that data is transferred in a synchronized manner between devices using a clock signal. The other hand, is an asynchronous serial communication protocol that uses a shared bus for communication between devices.

By using sensors connected to the Nano and ESP01 device, it is possible to collect data on various parameters of the aquaculture environment, such as temperature, pH, dissolved oxygen levels, and more. This data can then be sent to IoT Cloud, which is a cloud-based platform for storing and analysing data.

With this system in place, users can monitor the data collected by the sensors from anywhere, as long as they have access to the internet. This can be especially useful for aquaculture farmers or researchers who need to monitor their systems on a regular basis, but cannot be physically present at all times.

5.2 DIRTY WATER TESTING:

Testing dirty water for analysis is a crucial step in ensuring the purity and safety of the water. It entails a series of tests to find the presence and levels of toxins and pollutants that could be dangerous to both human health and the environment.

The results of the tests are analysed to determine the water's quality and any potential risks associated with its use. According on the results, the water can be treated to make it suitable for human consumption or other uses. It is imperative to keep in mind that only qualified persons with the appropriate equipment and training should test filthy water for analysis. In order to ensure continuous quality and safety, it's also crucial to frequently test and monitor water sources.

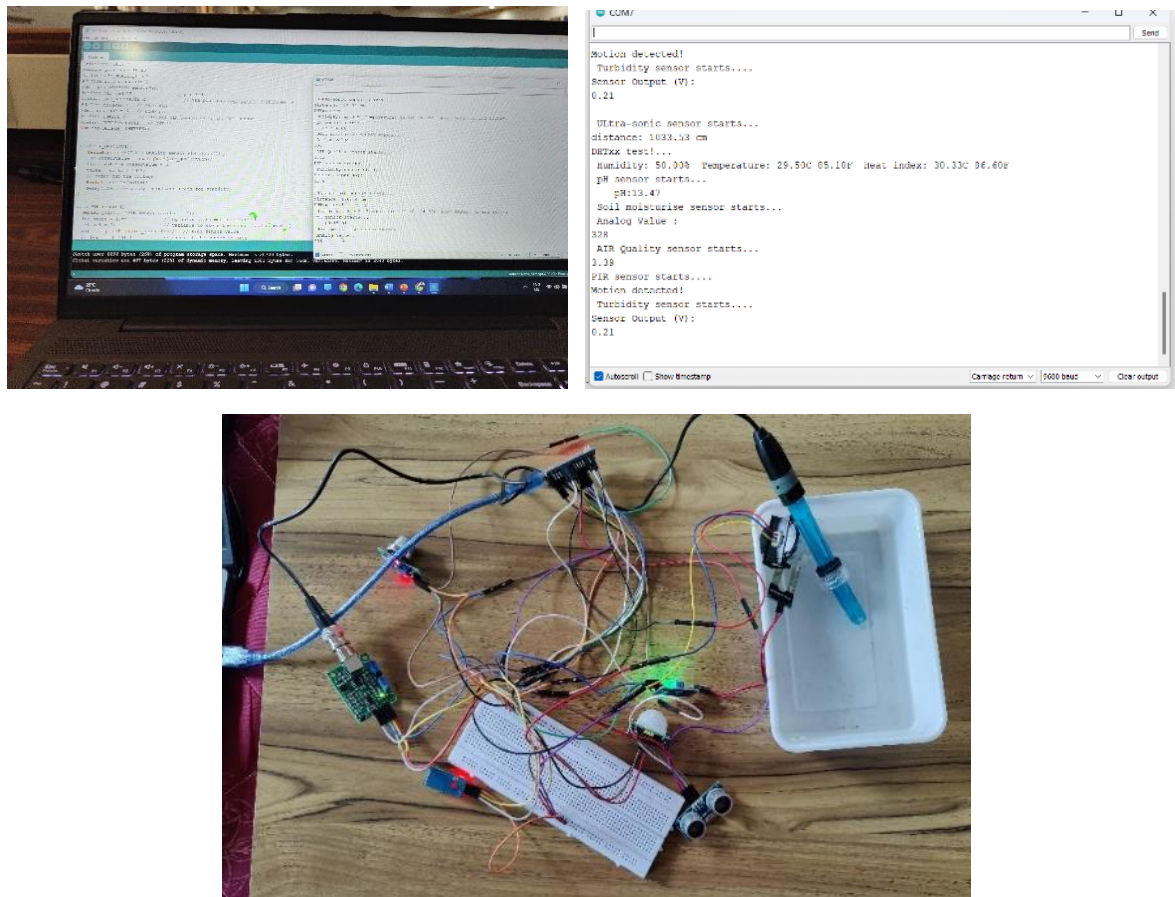


Fig: 5.4.1. Testing of dirty water monitoring setup

The Table explains about measurement of Dirty Water tested system output.

Dirty Water Output Result:

S. No	SENSORS	READINGS
1	pH-SENSOR	13.47
2	Air Quality (MQ 135) Sensor	3.39
3	PIR Sensor	Motion detected – If object near by the sensor No Motion detected – If object is by the sensor.
4	Ultra-Sonic Sensor	1033.53 CM
5	Soil Moisture Sensor	328
6	Temperature (DHT11) Sensor	Humidity –50 Temperature – 29°C
7	Turbidity Sensor	0.21v NTU

5.5 SALT WATER TESTING:

To provide accurate and trustworthy results, only professionals or specialists with the necessary education and experience should interpret the findings of a dirty water analysis. On the basis of the findings, the water can be treated to make it acceptable for human consumption or other applications. To guarantee continued quality and safety as well as to spot any changes or trends in water quality over time, regular monitoring and testing of water sources are required.

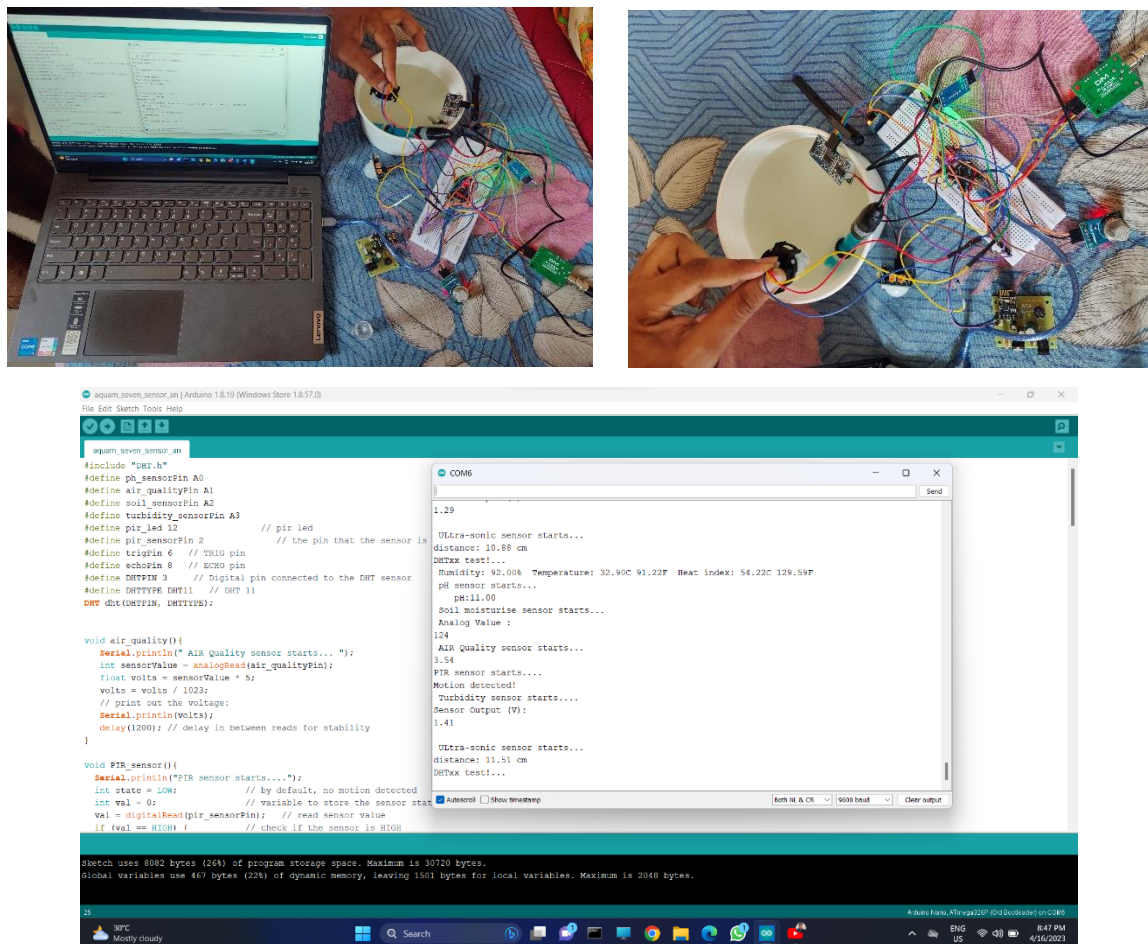


Fig: 5.5.1. Testing of Salt water monitoring setup

SALT WATER OUTPUT RESULT:

S. No	SENSORS	READINGS
1	pH-SENSOR	11.00
2	Air Quality (MQ 135) Sensor	3.54
3	PIR Sensor	Motion detected – If object near by the sensor No Motion detected – No response
4	Ultra-Sonic Sensor	10.88 CM
5	Soil Moisture Sensor	124
6	Temperature (DHT11) Sensor	Humidity –92 Temperature – 32°C
7	Turbidity Sensor	1.41v NTU

5.6 MAIN AQUACULTURE MONITORING TESTING:

An aquaculture monitoring system based on IoT (Internet of Things) technology can provide real-time data on various parameters of an aquaculture system. This technology involves the use of sensors and devices that are connected to the internet, allowing data to be collected and transmitted to a central database for analysis.

The results of an IoT-based aquaculture monitoring system would be similar to those of a traditional monitoring system, but with the added benefit of real-time data collection and analysis. For example, if water quality parameters were being monitored, the data could be continuously monitored and alerts could be sent if the parameters fall outside of the desired range. This allows for prompt action to be taken to mitigate any negative effects on the aquaculture system.

In addition to real-time monitoring, an IoT-based aquaculture monitoring system can also provide historical data that can be used to identify trends and patterns over time. This information can be used to optimize the operation of the system, identify areas for improvement, and make informed decisions about management practices.

Overall, an IoT-based aquaculture monitoring system can provide valuable insights into the health and productivity of an aquaculture system, helping to optimize production and minimize environmental impacts.

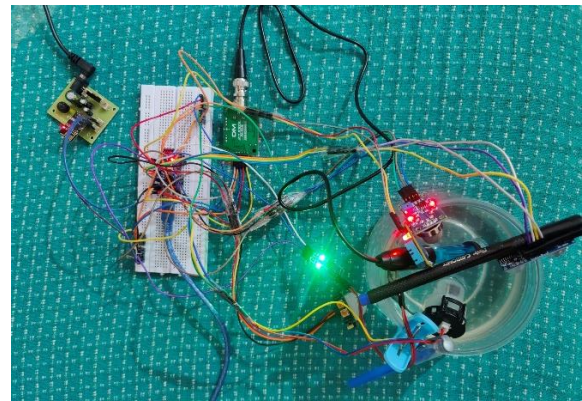
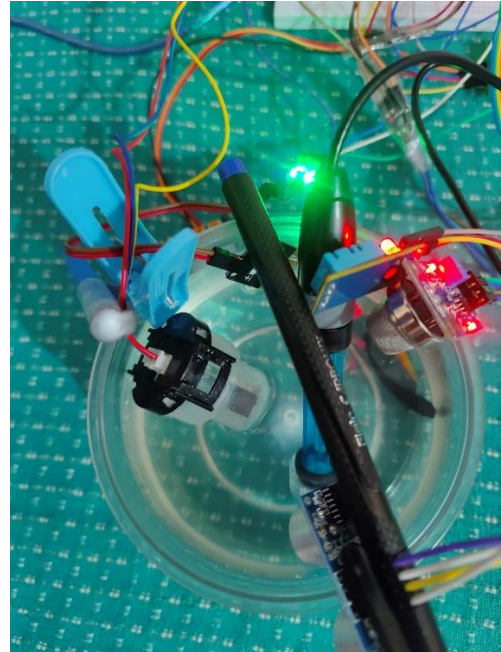


Fig: 5.6.1. Monitoring Entire Aquaculture System Setup

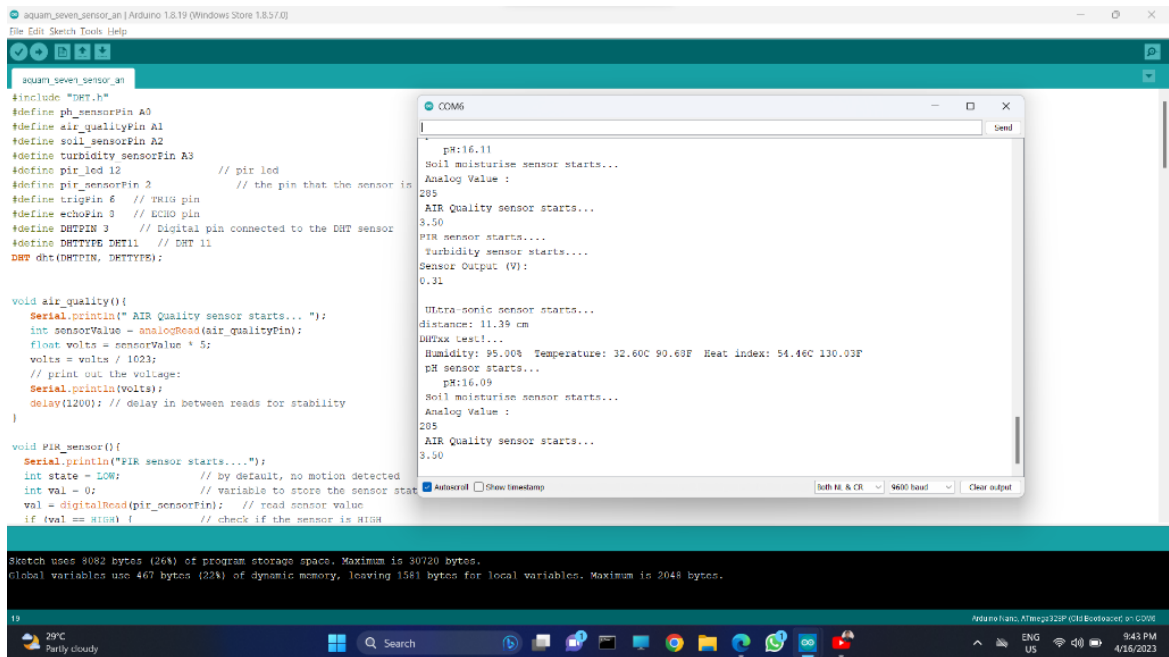


Fig: 5.6.2.1. Output for Entire Aquaculture System Setup

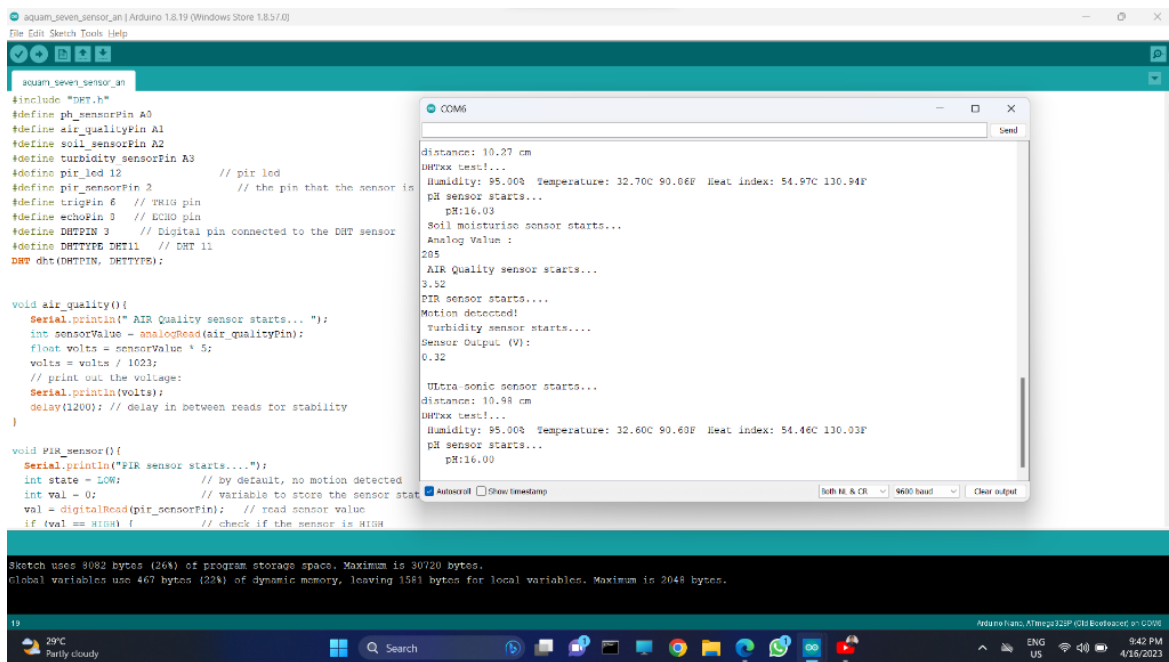


Fig: 5.6.2.2. Output for Entire Aquaculture System Setup

MAIN AQUACULTURE MONITORING OUTPUT RESULT:

S. No	SENSORS	READINGS
1	pH-SENSOR	16.03
2	Air Quality (MQ 135) Sensor	3.52
3	PIR Sensor	No response – Fig 5.6.2.1 Motion detected – Fig 5.6.2.2
4	Ultra-Sonic Sensor	10.98 CM
5	Soil Moisture Sensor	285
6	Temperature (DHT11) Sensor	Humidity –95 Temperature – 32°C
7	Turbidity Sensor	0.32 v NTU

Fig 5.6.2.1 likely shows a snapshot of the monitoring system when there is no detected motion within the tank. This could be due to the fish being stationary.

Fig 5.6.2.2, on the other hand, shows that motion has been detected in the tank, which may indicate that the fish are active and swimming around. This could be an important indicator of fish health and welfare, as active fish are typically considered to be healthier than inactive ones.

Overall, the use of motion detection sensors in an aquaculture monitoring system can provide valuable insights into fish behaviour and activity levels, which can help farmers to optimize their operations and ensure the health and welfare of their fish.

CHAPTER – 6

RESULT AND DISCUSSION

An aquaculture monitoring system in IoT can be a valuable tool for ensuring the health and productivity of aquatic organisms in an aquaculture facility. The system can monitor various environmental parameters such as water temperature, pH level, dissolved oxygen, distance, motion, moisture and ammonia levels in real-time, allowing for quick detection of any deviations from the ideal range. Additionally, the system can track the feeding and growth of the aquatic organisms, providing valuable data for optimizing their growth and health.

The implementation of such a system can have several benefits, including increased productivity, reduced mortality rates, and improved water quality. By providing real-time data on the environmental conditions of the aquaculture facility, the system can enable prompt corrective action to be taken in case of any adverse changes in water quality or the health of the aquatic organisms.

Moreover, the system can also provide valuable insights into the feeding habits and growth patterns of the aquatic organisms. By tracking the feeding patterns and growth rates, aquaculture managers can optimize the feeding regimes, leading to more efficient feed utilization and reduced wastage.

However, there are also some challenges that need to be addressed when implementing an aquaculture monitoring system in IoT. These include the need for reliable and robust sensors that can accurately measure the various environmental parameters, as well as the need for a secure and reliable data communication infrastructure.

Another benefit of IoT-based aquaculture monitoring systems is the ability to automate certain tasks. For instance, the system can be programmed to feed the fish at specific times and in specific quantities. This reduces labor costs and ensures that the fish are fed consistently, leading to better growth and health outcomes.

IoT-based aquaculture monitoring systems also provide farmers with greater control over their operations. They can monitor and adjust water quality parameters remotely, reducing the need for on-site inspections. This can be particularly beneficial for large-scale operations that cover vast areas.

Finally, IoT-based aquaculture monitoring systems can help farmers optimize their operations for greater efficiency and profitability. By analyzing data on feed consumption and growth rates, for instance, the system can help farmers determine the optimal feeding schedule and amount for their fish. This can lead to higher yields and better profits.

Furthermore, the system should also be designed to be user-friendly, with a simple interface that can be easily understood and used by aquaculture managers and staff. The system should also be scalable, allowing for the addition of more sensors and features as the aquaculture facility expands.

In conclusion, an aquaculture monitoring system in IoT can be an effective tool for improving the productivity and health of aquatic organisms in an aquaculture facility. The implementation of such a system can have several benefits, but also requires careful planning and consideration of the various challenges involved.

```
aquam_seven_sensor_an | Arduino 1.8.19 (Windows Store 1.8.57)
File Edit Sketch Tools Help

[Icons]

aquam_seven_sensor_an
#include <SoftwareSerial.h>
#include "HWT.h"
SoftwareSerial mySerial(9, 12);
#define ph_sensorPin A0
#define air_qualityPin A1
#define soil_sensorPin A2
#define turbidity_sensorPin A3
#define pir_led 12 // pir led
// pin that the sensor is attached to
#define pir_sensorPin 2 // she pin that the sensor is attached to
#define trigPin 6 // TRIG pin
#define echoPin 5 // ECHO pin
#define DHTPIN 9 // digital pin connected to the DHT sensor
#define DHTTYPE DHT11 // DHT 11
#define digitalWrite
DHT dht(DHTPIN, DHTTYPE);

int nTemperature=digitalRead("% Temperature: ");
int nHumidity = digitalRead(" Humidity: ");
float nAirQualilty=air_qualityPin;
int nPIR= digitalRead(pir_sensorPin);
float nSoil_moisture=soil_sensorPin;
int nHigh_pir_sensorPin;
int nUltrasonic=digitalRead("distance: ");
const char nturbidity=("Sensor Output (V):");
void air_quality(){
    Serial.println("AIR Quality sensor starts...");
    int sensorValue = analogRead(air_qualityPin);
    float volts = sensorValue * 5;
    volts = volts / 1023;
    // print out the voltage:
    Serial.println(volts);
    delay(1200); // delay in between reads for stability
}
void PIR_sensor(){
    Serial.println("PIR sensor starts...");
    int state LOW; // by default, no motion detected
    int val = 0; // variable to store the sensor status (value)
    val = digitalRead(pir_sensorPin); // read sensor value
    if (val == HIGH) { // check if the sensor is HIGH
        digitalWrite(LED_BUILTIN, HIGH); // turn LED ON
    }
}
```

Done compiling.

Sketch uses 10580 bytes (32%) of program storage space. Maximum is 32768 bytes.
Global variables use 782 bytes (38%) of dynamic memory, leaving 1266 bytes for local variables. Maximum is 2048 bytes.

216

Arduino Nano ATmega328P (via Bootloader on COM)

33°C Supply

Search

ENG US 12:22 PM 4/17/2022

Fig: 6.1. Code compilation for IoT ThingSpeak

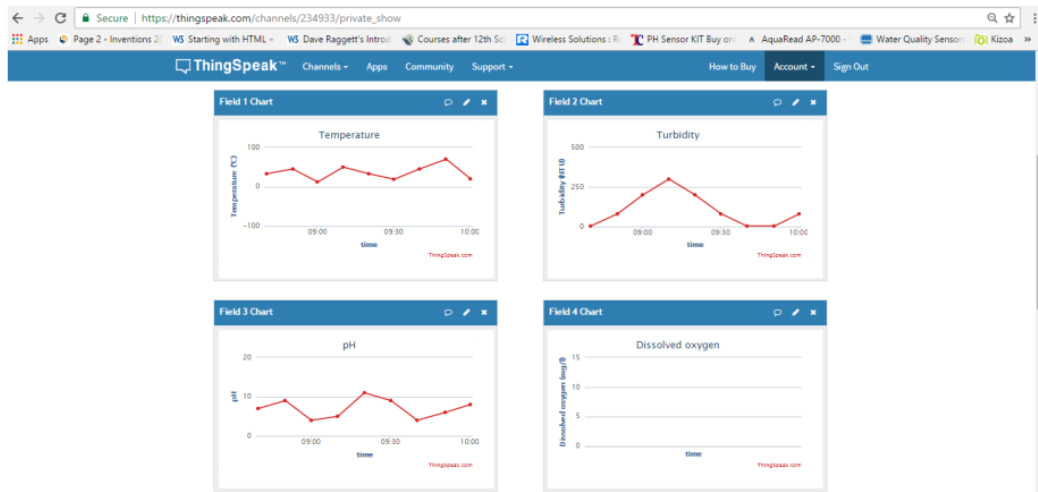


Fig: 6.2. Output reading in IoT ThingSpeak

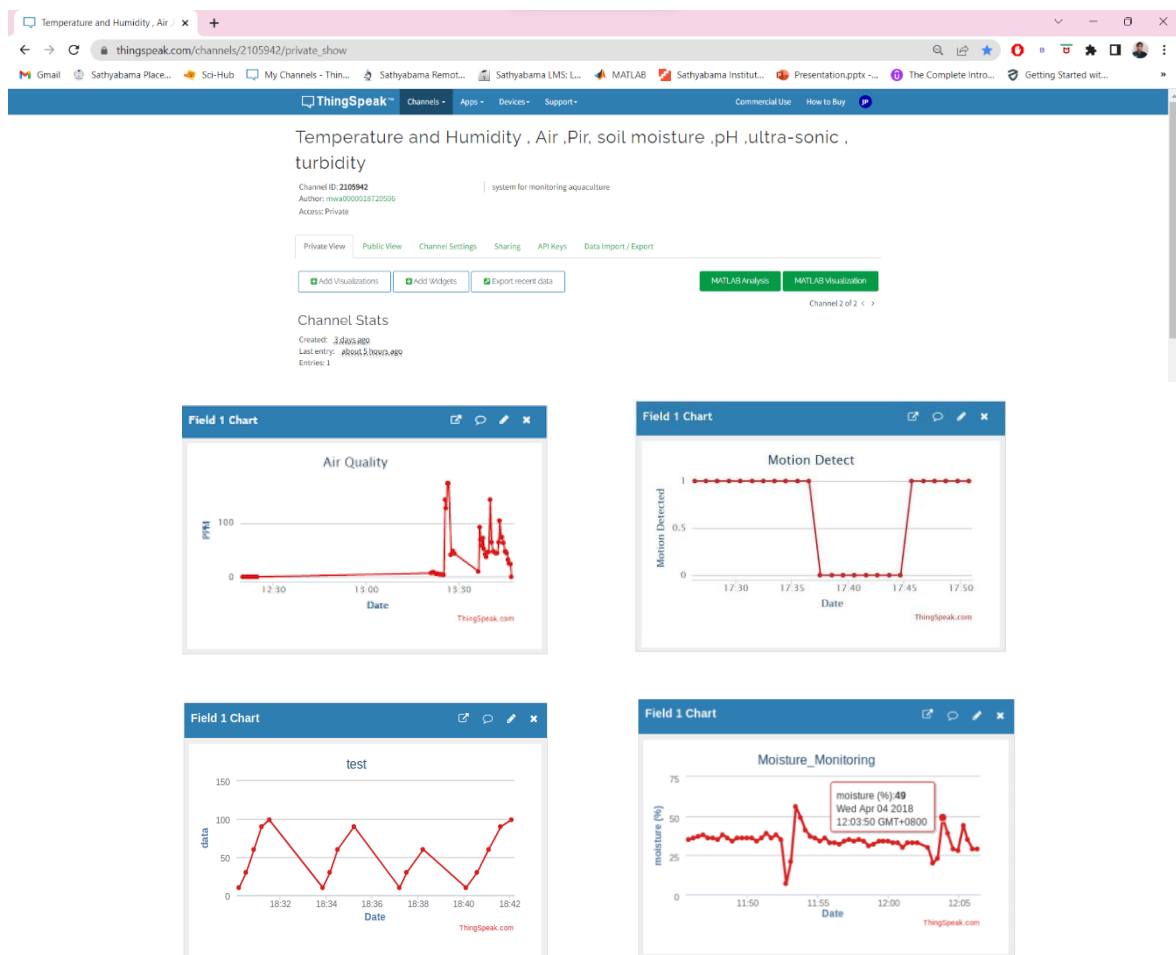


Fig: 6.3. Output reading in IoT ThingSpeak

CHAPTER – 7

CONCLUSION

The proposed device for monitoring aquaculture systems using wireless embedded technology. The device is designed to be small and lightweight, and is based on an Arduino nano board, which is a microcontroller board that can be programmed to perform various tasks.

The device is designed to provide a unique aquaculture monitoring system, which can help growers to monitor various parameters of their aquaculture systems in real-time. This system is grounded on the Arduino nano board, which collects data from sensors connected to the system. The collected data is then transmitted through IoT (Internet of Things) technology to allow growers to monitor their systems remotely.

By combining the Arduino nano board and the internet, this proposed device provides a convenient and low-cost solution for aquaculture growers to monitor their systems. This device can help growers to avoid the time-consuming process of manually testing their systems, and can provide more accurate and consistent monitoring of various parameters such as temperature, pH, dissolved oxygen levels, and more.

Overall, this proposed device appears to be a promising solution for aquaculture growers who are looking for a cost-effective and efficient way to monitor their systems. By leveraging the power of wireless embedded technology and IoT, this device could help to improve the sustainability and productivity of aquaculture systems.

The proposed device could help aquaculture growers to optimize their production by controlling the number of fish they produce. By monitoring various parameters such as oxygen levels and water quality, growers can ensure that their fish are healthy and productive, while avoiding overproduction that could harm the environment. In addition to controlling the aeration system, you mentioned that other components such as heating rods and fish coalescers could be integrated into the system. These additional components could further optimize the production process by ensuring that the fish are kept in optimal conditions.

After completion on Arduino nano the future work is going implements through IOT. Both Arduino nano and Internet are combined in this system for convenience. This work finds a way to give better result with low cost than other available systems. Aqua farmers can avoid time consuming manual testing now.

This will help the aqua farmers to produce a greater number of fishes which will help to fulfil the demand for fish. Though we have created a system to control a demo aeration system, more actuators such as heating rods, fish feeder etc. will be integrated to this system. We will develop a better way technique to provide better result.

Overall, it sounds like the proposed device has the potential to greatly improve the efficiency and productivity of aquaculture systems, while also reducing costs and minimizing the need for manual monitoring.

7.1 FUTURE SCOPE

The future of aquaculture monitoring systems in IoT is promising, with several potential developments on the horizon. Here are some of the future scopes for aquaculture monitoring system in IoT:

- 1. Integration with Artificial Intelligence (AI) and Machine Learning (ML):** With the increasing availability of AI and ML technologies, aquaculture monitoring systems could integrate these technologies to enhance data analysis and interpretation. By leveraging AI and ML, the system could learn from historical data and identify patterns, leading to more accurate predictions and better decision-making.
- 2. Use of drones for monitoring:** Drones can be used to monitor larger water bodies and provide a more comprehensive view of the aquaculture operations. Drones equipped with sensors can collect data on water quality parameters and other environmental conditions, making it easier to detect changes in real-time.
- 3. Incorporation of wearable technology:** Aquaculture monitoring systems can incorporate wearable technology for fish. Wearable sensors can be attached to the fish to collect data on their health, behavior, and growth. This

data can be analyzed to determine the optimal feeding and environmental conditions for the fish, leading to better growth and health outcomes.

- 4. Cloud-based data management:** Aquaculture monitoring systems can use cloud-based data management systems to store, manage, and analyze data. This will provide farmers with real-time access to data from anywhere, making it easier to monitor and manage their operations remotely.
- 5. Integration with blockchain technology:** Blockchain technology can be used to track the entire supply chain of aquaculture products, from production to consumption. This will provide greater transparency and traceability, ensuring that the products are safe, high quality, and sustainable.

In conclusion, the future of aquaculture monitoring systems in IoT is exciting, with several potential developments on the horizon. By leveraging new technologies, such as AI, drones, wearable technology, cloud-based data management, and blockchain, we can expect to see even more advanced and efficient aquaculture monitoring systems in the future.

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PUBLICATION

We JETTI PHANI TEJA (39130187) and JONNADULA AKASH (39130190) hereby declare that the Project Report entitled “**AUTOMATED UNDERWATER MONITORING SYSTEM FOR ANALYZING THE WATER PARAMETERS IN AQUACULTURE FARM**” done by us under the guidance of **Dr.M. SUMATHI, M.E, Ph.D. professor**, Dept. of Electronics and Communication Engineering, SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, CHENNAI.

In the year 2023, we attended the Silicon National Conference at the Dr.M.G.R. Educational and Research Institute in Chennai after our paper was accepted.

Guide

Dr. M. SUMATHI, M.E, Ph. D,

Professor, Dept of ECE.

Head of the Department

Dr. T. RAVI M.E., Ph.D.,

DATE:

PLACE: CHENNAI

SIGNATURE OF THE CANDIDATES

1.

2.