DEVELOPMENT OF AN IOT BASED FISH FARMING, REMOTE MONITORING AND ALERT SYSTEM

A project report is submitted in partial fulfillment of the requirements for the award of Degree of Bachelor of Science in Electrical and Electronic Engineering.

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DECLARATION

We, hereby declare that this project "**Development of an IoT Based Fish Farming, Remote Monitoring and Alert System**" represents our own work which has been done in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering, and has not been previously included in a thesis or dissertation submitted to this or any other institution for a degree, diploma or other qualifications. I have attempted to identify all the risks related to this research that may arise in conducting this research, obtained the relevant ethical and/or safety approval (where applicable), and acknowledged my obligations and the rights of the participants.

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APPROVAL

The project entitled **“Development of an IoT Based Fish Farming, Remote Monitoring and Alert System”** submitted by **Khursad Mahammud (ID: 201-33-1114), Rezuon Ahmed Sourav (ID: 201-33-1203), and Tonmoy Biswas (ID: 201-33-1220)** has been done by the direct supervision of the undersigned personnel and accepted as satisfactory in partial filament other requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering in **February, 2024**.

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Dedicated to Our Parents & Teacher

With love & Respect

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ABBREVIATIONS

IoT	Internet of Things
PC	Personal Computer.
NodeMCU	Open-source electronics Platform.
LED	Light Emitting Diode.
USB	Universal Serial Bus.
APK	Android Application Package
BT	Bluetooth Module
TDS	Total Dissolved Solids
pH	Potential of Hydrogen
IP	Internet Protocol
NO	Normally Open
NC	Normally Closed
Wi-Fi	Wireless Fidelity
LiPo	Lithium-Polymer

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ABSTRACT

The Internet of Things (IoT) is a rapidly evolving technology, and the field of IoT is expanding its wings in all fields today. With the advancement of computers such as Arduino, innovation is reaching the ground level with its application in farming and aquaculture. In this work, we designed and implemented aquaculture water quality monitoring using Arduino. A smartphone, different sensors (Temperature, pH, TDS etc.) and IP camera are used in this work. Arduino is in charge of sensor acquisition. It also serves as a data processing device and a server. Microcontroller also does photo acquisition with the help of the ESP32 camera to detect and ensure security. A user can monitor the water condition using an android app via BT Module and Wi-Fi connectivity. The three parameter values are analyzed to ascertain the overall estimated state of the water and the necessary action. Every function of this testing device is authentic and simple to use

Keywords: water quality, wireless technology, TDS sensors, remote monitoring, IoT.

CHAPTER I

INTRODUCTION

1.1: Background

The Internet of Things has taken the world by storm. From smart automobiles to smart cities to smart homes, technologies are assuming full charge of sensing environmental characteristics in order to provide greater monitoring and controlling capabilities to always connected people. Connected individuals can afford a better lifestyle with better decision making if they have more control over their daily lives.

The aquaculture business is one of the main industries that need technological advancement because it is envisioned as an alternate source of income to boost employment by various state governments across Bangladesh.

Our Pond Monitoring System was created with the substantial dangers involved with aquaculture production in mind. Our Pond monitoring system, with its real-time monitoring capabilities, significantly increases the production and productivity of aquaculture farming.

A fish farming pond is an artificial man-made eco-system, and on the most basic level, we can distinguish two sorts of ponds: ponds that raise tropical fish for pets, generally referred to as aquariums instead of ponds, and ponds that breed fish for food. The ponds that bread fish for food are often built and maintained in distant eco-clean places near water springs, and any outside environmental stress will have a severe influence on fish output. This is because fish are cold-blooded animals that regulate their temperature directly through their surroundings. As a result, temperature is one of the many crucial characteristics that must be checked, along with other important elements such as light intensity, pond water level, and so on.

1.2: Proposed Solution

1.2.1 Fishpond maintained using a controller

The sensors are used to manage the proposed system of microcontroller-based fish ponds. TDS meters and PH sensors are installed in the pond system to monitor water level and quality. A TDS meter is a compact hand-held instrument that measures the Total Dissolved Solids (TDS) in a solution, often water. Because dissolved ionized solids, such as salts and minerals, increase a solution's conductivity, a TDS meter analyzes the solution's conductivity and estimates the TDS from that reading. The PH sensor detects the level of water in a pond system. The microcontroller is used to operate the entire system's circuit. Mobile applications are linked to the microcontroller, and any faults or issues will be displayed. The method is discussed, but water flowing into fish lakes has the possibility to be examined every day, and its quality is ensured by the regulation of characteristics such as hydrogen particle fixation, temperature, smelling salts, and so on.

1.3: Objective

This project aims

- To develop a smart water sensor network system that monitors water quality
- To help fish farmers in producing healthy and abundant fishes
- To integrate image surveillance system in prevents fish diseases and environmental damage.
- To find cost effective solution for the module and its components

1.4: Technologies

An IoT-based smart monitoring system for fish farms is a system that uses sensors, wireless communication, and Mobile Application to collect and analyze data related to the fish and water quality. Some of the technologies that are involved in such a system are.

1.4.1: Sensors:

These are devices that measure physical or chemical properties of the fish and water, such as temperature, pH, water quality. Sensors can be attached to the fish ponds, or embedded in the fish themselves. Sensors can also capture images data of the fish behavior and environment.

1.4.2: Wireless communication:

This is the technology that enables the transmission of data from the sensors to a central server (Mobile application). Wireless communication can use different protocols and standards, such as Wi-Fi, Bluetooth, 5G, etc. Wireless communication can also provide remote control and feedback to the fish farmers through mobile devices or web applications.

1.5: Gantt Chart

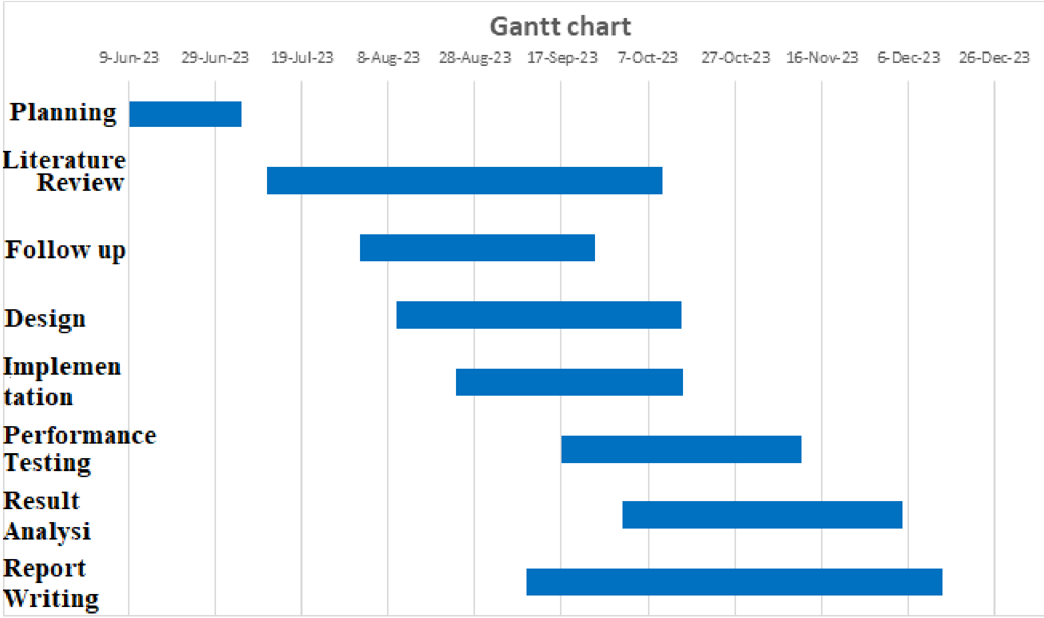

Figure 1.1: Gantt chart

1.6: Structure of the Report

1. INTRODUCTION
2. LITERATURE REVIEWS
3. DESIGN PROCEDURE,
4. RESULTS AND DISCUSSION
5. PROJECT MANAGEMENT
6. IMPACT ASSESSMENT OF THE PROJECT
7. CONCLUSIONS AND RECOMMENDATIONS

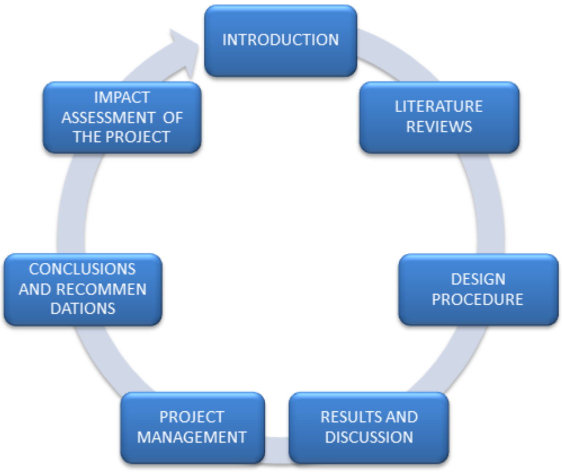

Figure 1.2: Structure of the Report

CHAPTER 2
LITERATURE REVIEWS

2.1: Introduction

Aquaculture, the cultivation of aquatic organisms, is an emerging field that can leverage the Internet of Things (IoT) to address its challenges. IoT is a network of physical devices, sensors, actuators, and software that can communicate and exchange data over the internet. IoT has various applications in domains such as agriculture, healthcare, manufacturing, and transportation. In aquaculture, IoT can enable smart monitoring and management systems that can collect and analyze real-time data on water quality, fish growth, feed consumption, and environmental conditions. These systems can also facilitate remote control and automation of fish farming operations through web or mobile interfaces. Thus, IoT can enhance the efficiency, productivity, and sustainability of aquaculture.

2.2: Related research:

Here has some illustration and Study of An IoT Solution for Fish Farming, Remote Monitoring, and Alert using Wireless Sensors and Mobile Application. Discussion is going to review those papers.

In this report (Ahmed Abu-Khadrah) [1] have given a statement that is, developed an IoT based smart fish-feeder and monitoring system that consisted of two components: one for fish eating and one for water feature and level monitoring. The first component included electrical parts that were connected to the internet to allow fish to be fed on a schedule or remotely through a web interface. The second component included microcontrollers with pH sensors that measured the water quality in the aquariums.

In this report (Maria Gemel B. Palconit) [2] have given a statement that is, introduced a development of a fish tank monitoring system using IoT modules with four subsystems: water quality monitoring, video surveillance of the fish tank, on-demand feeding machine, and cloud data storage. The system used Arduino Uno boards to connect various sensors and actuators to the internet. The system also used Google Cloud Platform to store and analyze the data collected from the sensors.

In this report (Embedded-DIY-Tech) [3] have given a statement that is, presented an IoT based smart aquaculture model that measured water quality parameters such as pH, water level, temperature, turbidity, and motion detection of fish using low-cost and short-range wireless sensor network modules. The model also provided live streaming and cloud data storage features.

In this report (Yasmine Afifah) [4] have given a statement that is, described a smart monitoring and automation control system for a fish aquarium using IoT modules. The prototype applied temperature and turbidity sensors, automatic water drains, and live stream features. The system also allowed users to adjust the fish needs remotely anywhere and anytime.

In these papers, they use many sensors, but not a Total Dissolved Solids (TDS) Sensor, and they do not ensure the security of the fish and the farm.

2.3: Compare and Contrast:

The aim of this study is to use a Total Dissolved Solids (TDS) Sensor to measure the concentration of dissolved salts, minerals, and metals in water. TDS is a key factor that influences the physiological and ecological processes of fish, as it regulates the osmotic pressure across their cell membranes. Deviations from the optimal TDS range can induce stress, impair growth, or cause mortality in fish. The recommended TDS level for most freshwater fish is below 400 ppm, but some species may have different preferences depending on their origin and adaptation. Hence, it is essential to investigate the specific requirements of the fish species before establishing an aquarium and to monitor and adjust the water quality using a TDS meter on a regular basis. TDS is a valuable indicator for fish production, fish health, and aquaculture. Secondly, to ensure the security of the fish farm, we used various kinds of security sensors, such as Motion sensor, Limit switch, Alarm and notification light, buzzer, and ESP32 camera. These sensors will help us detect any kind of object moving towards the pond and protect the fish.

2.4: Summary:

The chapter provides an overview of the applications and implications of the Internet of Things (IoT) in fish farming. It explains how IoT devices can collect and process data from various parameters of fish farming, such as water quality, fish behavior, temperature, salts, minerals, and metals in water, and ensure the security of the fish with various sensors. It also describes how IoT devices can provide feedback and control mechanisms to optimize the fish farming process. The chapter analyzes the benefits and challenges of implementing IoT in fish farming, such as enhancing productivity, reducing costs, improving sustainability, and ensuring food security. The chapter illustrates some examples of IoT-based fish farming systems, such as a low-cost ideal fish farm using IoT, an automated fish farm aquaculture monitoring system, and a smart aquaculture model that measures water quality. The chapter also reviews some existing research on IoT and AI in fisheries and aquaculture.

CHAPTER 3
DESIGN PROCEDURE

3.1: Introduction

Fish farming or aquaculture is essential for meeting the growing seafood demand. To ensure optimal fish growth, health, and sustainability [5], fish farms need efficient management. IoT technology can improve fish farming practices by enabling real-time data monitoring and automation. This design procedure shows how to create an IoT-based smart monitoring system for fish farming. The system collects and analyzes data on water quality, feeding, environment, and fish behavior. Using IoT, fish farmers can make informed decisions, optimize resources, and enhance fish productivity and welfare.

This design procedure guides the development of an IoT-based smart monitoring system for fish farming [7]. It covers the project's objectives, technology selection, and critical parameters. The system aims to improve fish farm management, support sustainability, and provide useful insights for fish farmers.

Aquaculture meets the rising seafood demand. Fish farms need efficient management for optimal fish growth, health, and sustainability. IoT technology can improve fish farming by real-time data monitoring and automation [8].

This design procedure shows how to make an IoT-based smart monitoring system for fish farming. The system collects and analyzes data on water, feeding, environment, and fish. Using IoT, fish farmers can decide, optimize, and improve fish productivity and welfare [10]. This design procedure guides the IoT-based smart monitoring system for fish farming. It covers the objectives, technology, and parameters. The system improves fish farm management, supports sustainability, and gives insights for fish farmers [14].

3.2 Proposed system block diagram

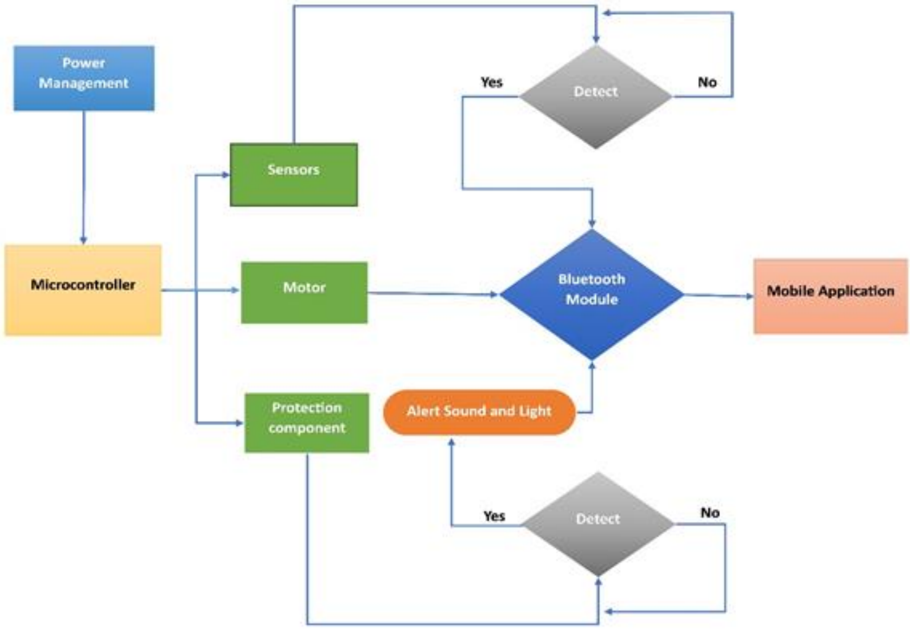

Figure 3.1: Proposed system block diagram

This figure shows how the overall system works. A power management system powers up the microcontroller. We implement sensor, motor, and protection components in the microcontroller. The sensors are programmed to measure some parameters or conditions in the environment. For example - temperature, pH, or TDS. The ESP32 Camera module is used for protecting the fish farm [10]. The camera is implemented in the motor. The motor is used to perform some physical action if any human or object is detected by the camera to protect the fish farm. These sensors, motor, and protection components transfer the data to the mobile app via Bluetooth.

3.2 Construction

Arduino is a microcontroller that can be programmed to collect data from sensors, process it, and send it to a server or a smartphone via the Internet of Things (IoT) network [11].

To measure the status of the water, pH sensor, Temperature sensor and TDS meter had been used. The pH sensor measures the acidic or basic nature of the water in the pond. In this project, power offer of 5V and 12V area unit needed.

To measure the electrical conductivity of water quality and the purity of water remotely

[13], a TDS meter alerts the user if the water has high levels of dissolved solids.

The power supply/ Solar cell gives the input supply interface to the microcontroller.

Temperature sensor can monitor the temperature of the water, and adjust the thermal energy management system to maintain the optimal temperature for the fish.

A Motion sensor with a camera can work by detecting the movement of fish in the pond, and capturing their images or videos that can be transmitted to the cloud or a mobile device for remote observation and analysis [19].

A limit switch works to detect the presence of unauthorized intruders in the fish pond, and sends an alert to the owner or the authorities

A Bluetooth module can transmit the water quality parameters, such as pH, temperature, and Water quality, from the sensors in the fish tank to a smartphone app, where the user can monitor and control the fish farm remotely

3.3: Major Components

3.3.1: Arduino UNO:

Uno is an 8-bit ATmega328P microcontroller-based microcontroller board [6]. To support the microcontroller, it includes various components such as a crystal oscillator, serial communication, a voltage regulator, and so on.

The Arduino Uno includes a USB interface, 6 analog input pins, and 14 I/O digital ports for connecting to external electronic devices. Six of the 14 I/O ports can be used for PWM output. It enables designers to control and perceive external electronic devices in real time.

The Arduino Uno has been a tremendous hit with electronics enthusiasts ranging from novice hobbyists to experienced programmers since its initial release. It is an open-source platform, which means that the boards and software are easily accessible, and anybody can alter and optimize the boards for improved functionality. The software used for Arduino devices is known as IDE (Integrated Development Environment), and it is free to use. It does, however, require some fundamental skills to master. C and C++ programming languages are supported.

Figure 3.2: Arduino Uno

3.3.2: Motion Sensor:

A motion sensor (or motion detector) is the heart of your security system since it recognizes when someone is in your home who should not be there. A motion sensor detects movement in an area by utilizing one or more technologies.

When a sensor detects motion, it sends a signal to the control panel of your security system, which is linked to your monitoring center. This notifies you and the monitoring center that there is a potential threat in your home.

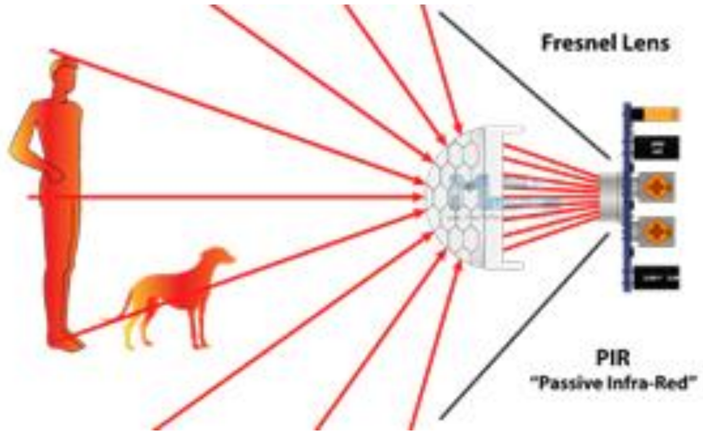

Figure 3.3: Motion sensor

3.3.3: DS18B20 Temperature Sensor:

The DS18B20 is a temperature sensor that provides 9-bit to 12-bit temperature data. These figures represent the temperature of a certain gadget. This sensor communicates via a one-wire bus protocol, which employs a single data line to interface with an internal microprocessor. Furthermore, this sensor receives power directly from the data line, eliminating the need for an external power supply. The DS18B20 temperature sensor has applications in industrial systems, consumer items, thermally sensitive systems, thermostatic controls, and thermometers.

Figure 3.4: DS18B20 Temperature Sensor

3.3.4: pH sensor:

A pH sensor kit detects hydrogen ions (H+) in a solution by using a specific glass electrode. When immersed, the electrode produces an electrochemical potential proportional to the concentration of hydrogen ions, which is translated into a pH value by a pH meter or transmitter [20]. Calibration with known pH buffer solutions and temperature adjustment improve accuracy, allowing for applications in domains as diverse as water quality monitoring and industrial operations. Regular maintenance, including cleaning and calibration, ensures that pH measurements are accurate and exact over time.

Figure 3.5: pH sensor

3.3.5: Limit switch:

A limit switch is a mechanical device that requires physical contact between an object and the switch's actuator to change the state of the contact (open/closed).

As the object or target makes contact with the switch's operator, it finally moves the actuator to the "limit" where the contacts change states.

This mechanical motion opens the electrical contacts in a normally closed (NC) circuit and closes them in a normally open (NO) circuit. The contacts then start or stop current flow in the electrical circuit.

Figure 3.6: limit switch

3.3.6: Bluetooth Modules:

Bluetooth is a wireless technology that sends and receives data between devices by using low-energy radio waves. A Bluetooth module, in particular, is a chip that uses low-energy waves to connect two compatible devices remotely [22]. Your devices will be unable to connect without a Bluetooth module board, and some may even be inoperable.

Because of its design and lack of dependency on wires, Bluetooth is great for music streaming. This is how it grew to be so well-known and pervasive. However, new internet of things (IoT) applications for the technology, such as tracking and monitoring, have emerged.

Bluetooth modules are classified into two types: classic and low energy. Bluetooth Classic is used to send bigger amounts of data, such as music or voice, than Bluetooth. The Bluetooth Low Energy Module is designed for solutions that require less data, such as location pings and sensor data transmission.

Figure 3.7: Bluetooth Modules

3.3.7: ESP32

The ESP32 is a powerful microcontroller and wireless module designed by Espressif Systems. It features a dual-core Xtensa LX6 microcontroller, allowing for efficient multitasking and increased processing capabilities. With built-in Wi-Fi and Bluetooth connectivity, the ESP32 enables seamless communication with other devices and networks, making it a popular choice for Internet of Things (IoT) projects.

Programmers can develop applications for the ESP32 using the Arduino IDE, PlatformIO, or the Espressif IDF, supporting programming languages like C and C++. The board comes with a variety of GPIO pins and peripherals, such as SPI, I2C, and UART, providing flexibility for interfacing with sensors, actuators, and other components.

The ESP32 includes power management features, allowing it to operate in different power modes, making it suitable for battery-powered applications with an emphasis on energy efficiency. It also supports a real-time operating system (RTOS), enhancing multitasking capabilities for handling complex applications.

Security is a priority with the ESP32, featuring hardware-based encryption and secure boot capabilities. This makes it suitable for applications where data security is crucial. The ESP32 has gained popularity in a wide range of applications, including IoT, home automation, robotics, and smart devices, thanks to its compact design, wireless capabilities, and rich set of features that cater to diverse development needs.

Figure 3.8: ESP32

3.3.8: Servo Motor:

A servo motor operates as a closed-loop system designed for precise control of angular position. It consists of a DC motor, a feedback device (commonly a potentiometer or an encoder), and a control circuit. The feedback device continuously monitors the motor's shaft position, providing information to the control circuit. The control circuit compares the desired position with the actual position, generating an error signal that indicates the necessary adjustment.

This error signal is then amplified by the control circuit, which drives the motor with the appropriate power to correct any deviation from the target position. Servo motors use pulse width modulation (PWM) signals for control, where the width of the pulses determines the position of the motor shaft. The closed-loop nature of the system ensures accurate and controlled movement, making servo motors suitable for applications requiring precise positioning, such as robotics, automation, and aerospace.

One notable characteristic of servo motors is their ability to maintain a specific position even under external force or load changes. The feedback loop constantly updates the control circuit, allowing the motor to adapt to varying conditions. Servo motors find widespread use in scenarios where accuracy and reliability are paramount, and their versatility makes them integral components in various electromechanical systems.

Figure 3.9: Servo Motor

3.3.9: Solar panel:

Solar energy works through the photovoltaic effect in solar panels, which are composed of semiconductor materials like silicon. When sunlight hits the solar cells, it releases electrons, generating a flow of direct current (DC) electricity. To make this electricity compatible with most electrical systems, an inverter converts it into alternating current (AC). This AC electricity can then be used to power homes and businesses directly.

In grid-tied solar systems, excess electricity can be fed back into the power grid, often earning credits for the system owner through net metering. During periods of low sunlight, electricity can be drawn from the grid as needed. Off-grid solar systems use battery storage to store excess energy generated during sunny periods for use when sunlight is scarce, providing a reliable power source in remote areas or during power outages.

Solar energy is a renewable resource, reducing dependence on traditional fossil fuels and lowering carbon emissions. The technology is versatile, finding applications in various sectors, including residential, commercial, and industrial settings. As solar technology continues to advance, the efficiency of solar panels increases, making solar energy an increasingly viable and sustainable option for meeting our electricity needs. The decentralized nature of solar power empowers individuals and communities to generate their own clean energy, contributing to a more resilient and environmentally friendly energy landscape.

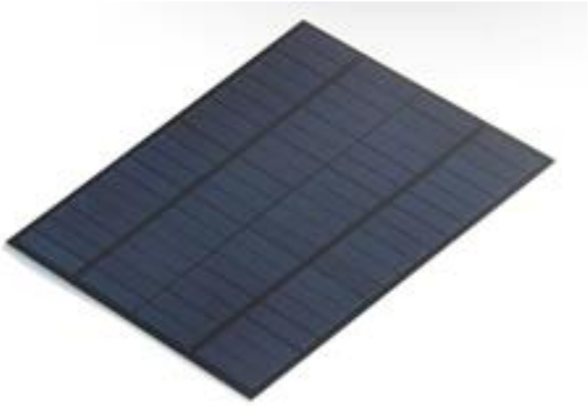

Figure 3.10: Solar panel

3.3.10: Relay module:

It operates on the electromagnetic attraction concept. When the relay circuit detects a fault current, it energizes the electromagnetic field, creating a transient magnetic field. Relay This magnetic field causes the relay armature to move, allowing the connections to be opened or closed. The small power relay has only one contact for opening the switch, but the high-power relay has two contacts for activating the switch.

The image below depicts the inner segment of the relay. It has a control coil twisted around an iron core. The coil receives electricity via the connections of the load and the control switch. The magnetic field that surrounds the coil is created by the current flowing through it.

The higher arm of the magnet draws the lower arm due to the magnetic field. As a result, close the circuit, allowing current to pass through the load. If the contact is already closed, it advances in the other direction, opening the contacts.

Figure 3.11: Relay module

3.3.11: 12v High Discharge LiPo Battery

A 12V high-discharge lithium-polymer (LiPo) battery functions by utilizing electrochemical reactions within multiple cells connected in series. Each cell contains a positive and negative electrode immersed in an electrolyte. During discharge, lithium ions move from the anode to the cathode, creating an electric current that flows through the external circuit, delivering high-power output. The term "high-discharge" indicates the battery's ability to release a substantial amount of current rapidly, making it suitable for applications like RC vehicles and power tools.

The total voltage of a 12V LiPo battery is achieved by connecting multiple cells in series, where each cell typically has a nominal voltage of around 3.7 volts. Charging involves a specific process, including a constant current phase followed by a constant voltage phase, with many LiPo batteries incorporating a protection circuit for safety.

Capacity, measured in ampere-hours, determines the energy storage capacity of the battery. Proper storage and handling, along with adherence to charging guidelines, are essential to maintain the safety and longevity of the battery. With applications ranging from drones to electric tools, high-discharge 12V LiPo batteries offer a compact, lightweight, and powerful energy source for diverse electronic devices.

Figure 3.12: 12v High Discharge LiPo Battery

3.3.12: TDS Meter:

TDS meters work by measuring water's electrical conductivity. Because dissolved solids in water may conduct electricity, the TDS meter can measure the concentration of dissolved solids by measuring the conductivity of the water. TDS meters typically employ two electrodes immersed in water. An electrical current is passed between the electrodes, and the resistance to the current is measured by the meter. The higher the resistance, the higher the dissolved solids concentration in the water.

TDS meters come in both digital and analog varieties. Digital TDS meters are more accurate and easier to read, but analog TDS meters are less expensive but require interpretation.

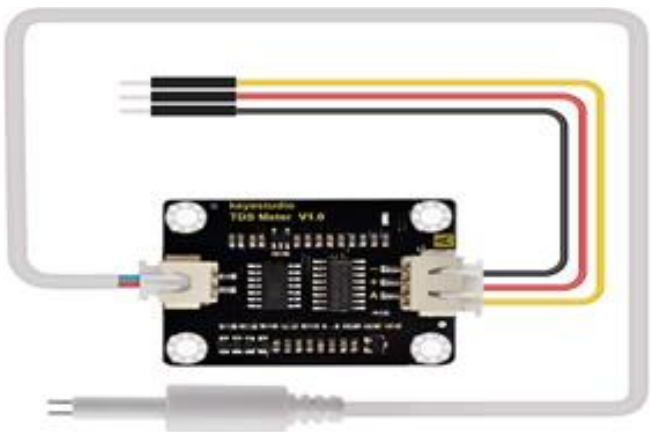

Figure 3.13: TDS Meter

3.4: System Design and Components

<u>Sensors and Data Acquisition:</u> Water Quality Sensors

1. pH sensors
2. Temperature sensors
3. TDS sensors

1. pH sensors

Arduino is a microcontroller that can be programmed to collect data from sensors and process it, in figure 3.1 To connect a pH sensor to an Arduino, we need to use three pins. Connect the VCC (RED Wire) pin of the sensor to the 5V pin of the Arduino, and the GND (BLACK Wire) pin of the sensor to the GND pin of the Arduino. Then, connect the P0(Yellow wire) pin of the sensor to the analog pin A0 of the Arduino.

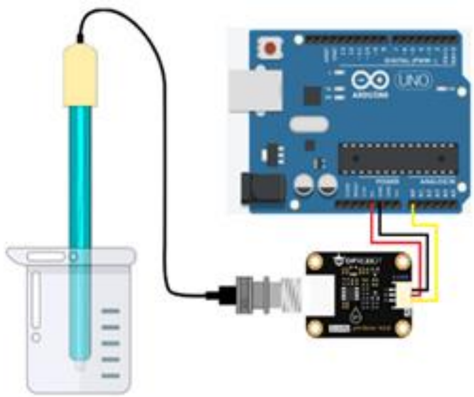

Figure 3.14: pH sensor connection for Arduino

2. Temperature sensors

A temperature sensor is a device that detects the thermal energy of its environment and transforms it into an electrical output. An Arduino is a microcontroller that can process this output and transmit the temperature data to a mobile phone application through a wireless connection. In figure 3.2 To connect a Temperature sensor to an Arduino, we need to use three pins. Connect the VCC (RED Wire) pin of the sensor to the 5V pin of the Arduino, and the GND (BLACK Wire) pin of the sensor to the GND pin of the Arduino. Then, connect the Yellow Data pin of the sensor to the pin 4 of the Arduino.

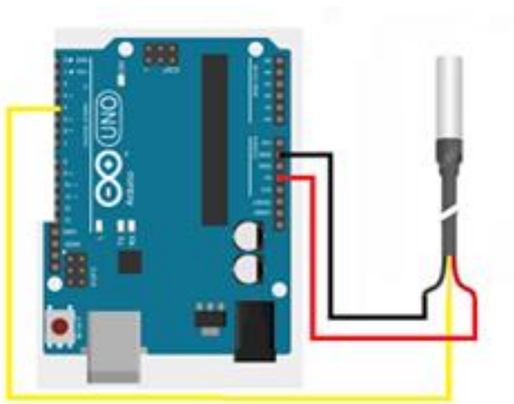

Figure 3.15: Temperature sensors connection for Arduino

3.TDS sensors

To check how clean water is, a TDS sensor finds the number of solids that are dissolved in it. It sends a signal that changes depending on the TDS level. An Arduino can use one of its pins to read this signal. In figure 3.3 To connect a TDS sensor to an Arduino, we need to use three pins. Connect the VCC (RED Wire) pin of the sensor to the 5V pin of the Arduino, and the GND (BLACK Wire) pin of the sensor to the GND pin of the Arduino. Then, connect the Data pin (BLUE Wire) of the sensor to the pin 8 of the Arduino

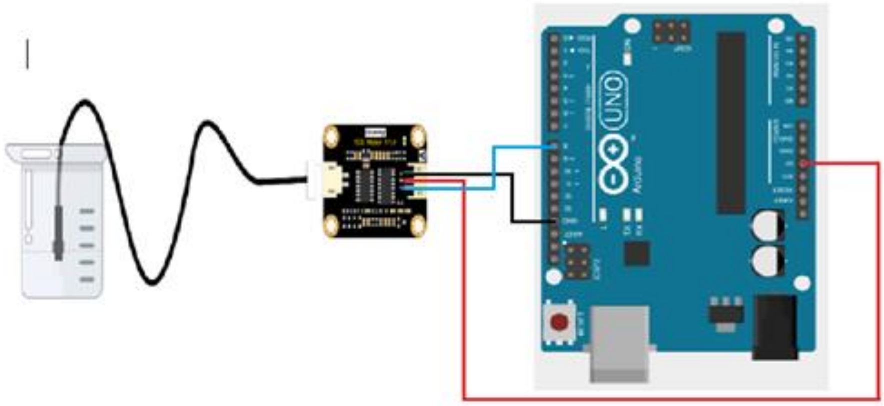

Figure 3.16: TDS sensors connection for Arduino

<u>Sensors and Data Acquisition:</u> Security sensor and Wireless Devices

1. ESP32
2. Motion Sensor
3. Limit switch
4. Bluetooth Module

1.ESP32

With a camera and an ESP32 chip on the ESP32-CAM board, Arduino IDE can code it. In figure 3.4 To connect a ESP32 to an Arduino, we need to use four pins. Connect the VCC (RED Wire) pin of the sensor to the 5V pin of the Arduino, and the GND (BLUE Wire) pin of the sensor to the GND pin of the Arduino. Then, connect the UOR (BLUE Wire) and UOT (BLACK Wire) Data pin of the sensor to the pin Rx and TX of the Arduino. And short GND pin and RES of Arduino.

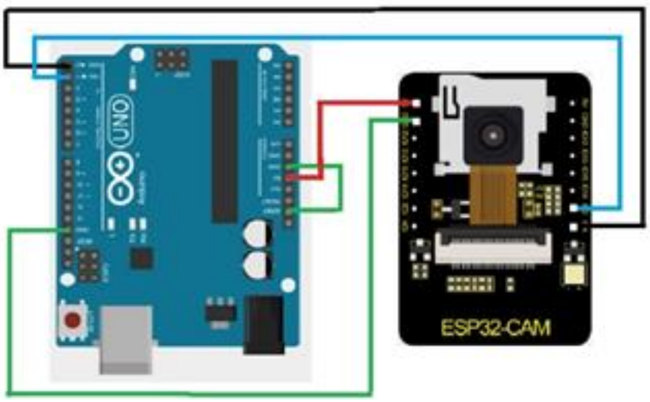

Figure 3.17: ESP32 connection for Arduino

2.Motion Sensor

When objects that give off infrared, such as people or pets, move, a motion sensor senses it. It tells an Arduino pin by sending a signal. The Arduino can use the signal to act when there is or isn't motion. In figure 3.5 To connect a Motion Sensor to an Arduino, we need to use three pins. Connect the VCC (RED Wire) pin of the sensor to the 5V pin of the Arduino, and the GND (GREEN Wire) pin of the sensor to the GND pin of the Arduino. Then, connect the Data pin (YELLOW Wire) of the sensor to the pin 2of the Arduino.

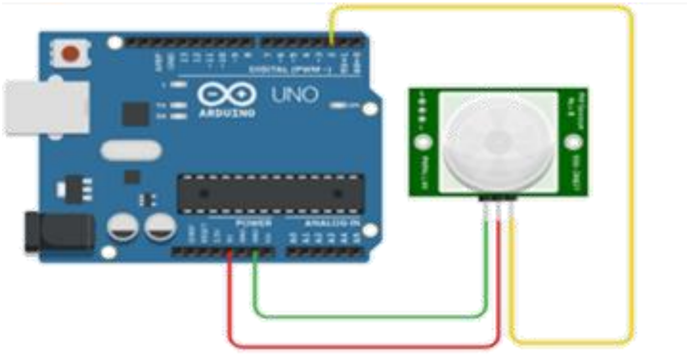

Figure 3.18: Motion Sensor connection for Arduino

3.Limit switch

A limit switch is an electromechanical device that determines the presence or absence of an object at a certain location. It can interface with an Arduino pin through a digital signal that changes state when the switch is activated or deactivated. The Arduino can utilize the signal to regulate the operation of a LED. . In figure 3.6 To connect a Limit switch to an Arduino, we need to use two pins. Connect the GND(BLACK Wire) pin of the sensor to the GND pin of the Arduino. Then, connect the Data pin (RED Wire) of the sensor to the pin 7 of the Arduino.

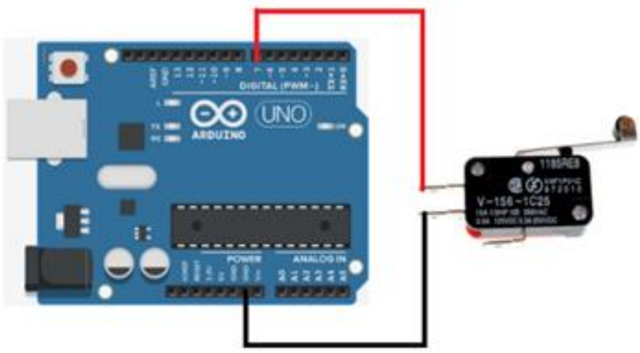

Figure 3.19: Limit switch connection for Arduino

4.Bluetooth Module

A Bluetooth module enables Arduino to establish wireless communication with other devices using radio frequency signals. It interfaces with Arduino’s serial pins and implements a protocol known as Serial Port Profile. Arduino can transmit and receive data via Bluetooth using Serial commands. In figure 3.7 To connect a BT Module to an Arduino, we need to use four pins. Connect the VCC (RED Wire) pin of the sensor to the 5V pin of the Arduino, and the GND (BLACK Wire) pin of the sensor to the GND pin of the Arduino. Then, connect the Data pin 10 (BLUE Wire) and 11 (YELLOW Wire) of the sensor to the pin Tx and Rx of the Arduino

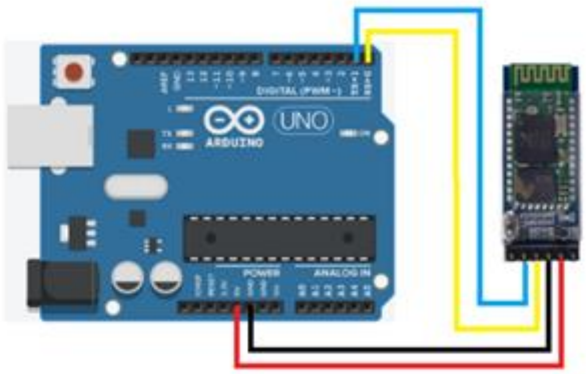

Figure 3.20: Bluetooth Module connection for Arduino

Microcontrollers (Arduino UNO & Arduino Mini) to interface with sensors Communication modules (Bluetooth, Wi-Fi) for data transmission

3.3: Data Analytics and Visualization:

1. Data Analytics
2. Dashboard and Visualization

3.3.1: Data Analytics:

Implement algorithms for real-time analysis of sensor data to derive actionable insights. Use machine learning models for anomaly detection, predictive analysis.

Figure 3.21: Temp Value

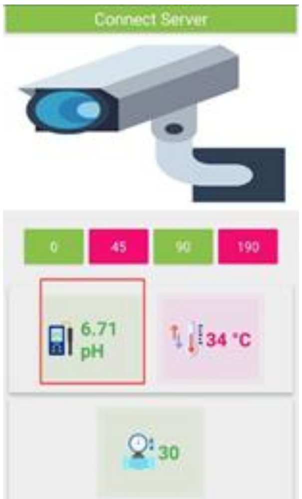

Figure 3.22: pH Value

Figure 3.23: TDS Value

The figures 3.21, 3.22, and 3.23, marked by a red square, show the temperature, pH, and TDS values of the water, respectively.

3.3.2: Dashboard and Visualization:

Figure 3.24: Dashboard-1

Figure 3.25: Dashboard-2

Figure 3.26: Dashboard-3

Developed user interface accessible via web or mobile applications to visualize real-time and historical data. Display trends, alerts, and recommendations based on analytics.

3.4: Automation and Control:

Alerts and Notifications and Power Sources

1.Alerts and Notifications:

Configure the system to send alerts and notifications (e.g., SMS, email) to the farmer in case of critical deviations in monitored parameters.

Figure 3.27: Notification Dashboard

2.Power Sources:

Utilize a combination of mains power, batteries, and renewable energy sources like solar panels to power the system.

Implement energy-efficient components and power management algorithms to optimize power consumption.

3.5: Design Analysis

Security Components and Sensors:

1. Surveillance Cameras
2. Motion Sensors and Limit switch

Surveillance Cameras: High-resolution cameras for monitoring critical areas of the fish farm, such as entry points, tanks, and equipment storage areas.

Motion Sensors and Limit switch: Infrared motion sensors to detect unauthorized movement within the premises and trigger alerts.

3.6: Data Processing and Analysis:

1. **Edge Computing**

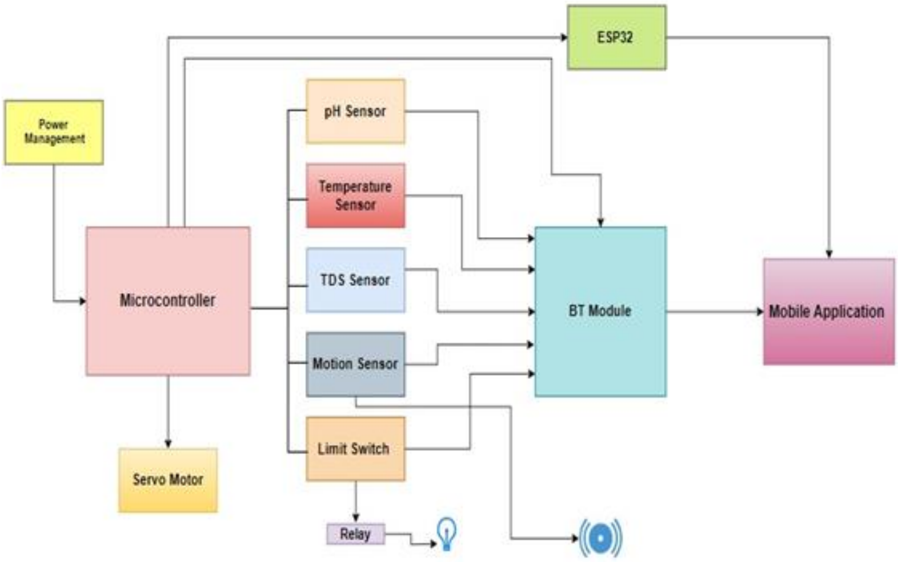

Figure 3.28: Data Processing Block Diagram

Implement edge computing for real-time processing and analysis of security-related data directly at the sensor level to reduce latency and improve responsiveness.
Machine Learning Algorithms:
Utilize machine learning algorithms for advanced analysis of camera feeds, enabling the system to distinguish between normal activities and potential threats.

2. Integration with Cloud:

Send processed security data to the cloud for further analysis, storage, and integration with the overall monitoring system.

3. Alerts and Notifications:

This Figure 3.16 is a flowchart of an alarm system. It shows how the system detects a human or any object and activates or deactivates the alarm and light accordingly. The arrows indicate the possible outcomes and actions. The figure is a simple representation of an automated system

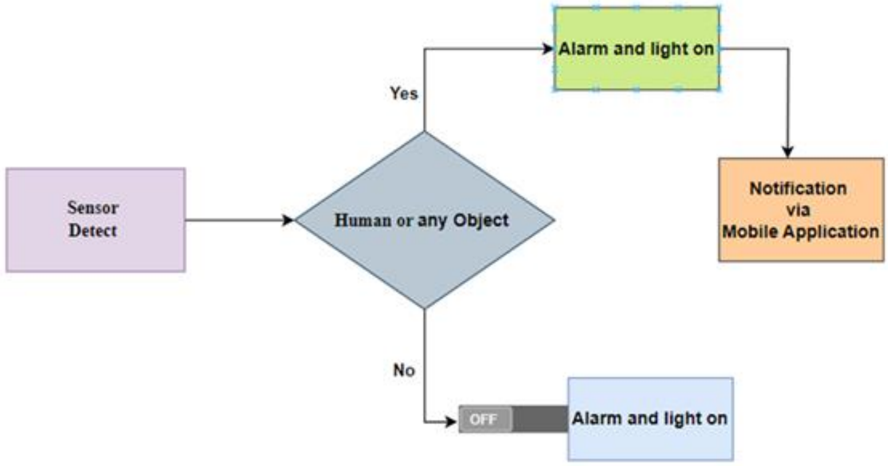

Figure 3.29: Alerts and Notifications Diagram

1. Immediate Alerts:

Send real-time alerts to designated contacts or a security monitoring center in case of a security breach, providing instant notification of potential threats.

3.7: Remote Monitoring and Control

1. Mobile Application:

This figure 3.17 is a block diagram of data transmission. A microcontroller processes data from a sensor and sends it wirelessly via Bluetooth or Wi-Fi. The arrows show the data flow direction.

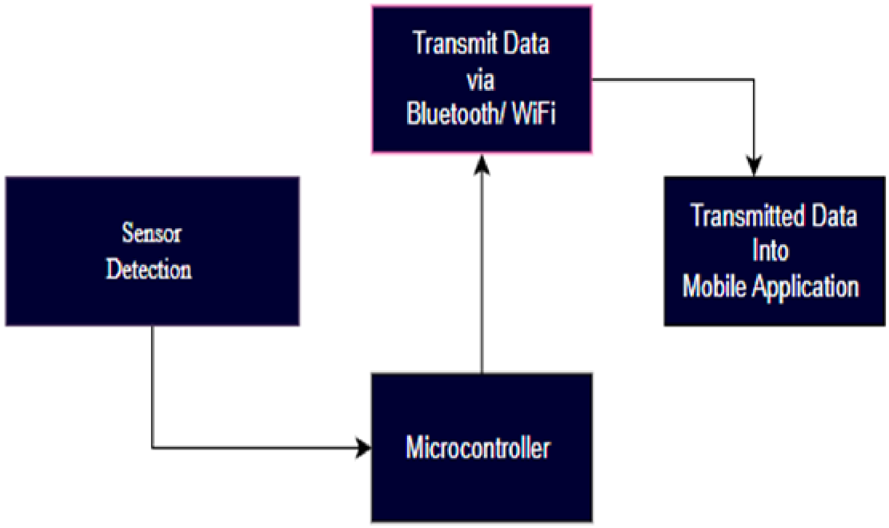

Figure 3.30: Mobile Application Diagram

Develop a user-friendly mobile application for farmers to remotely monitor the security status of their fish farm, view camera feeds, and receive alerts.
Enable farmers to remotely arm/disarm the security system and adjust settings via the mobile application.

3.8: Power Management

Include a reliable battery backup system to ensure uninterrupted operation during power outages.

1.Low Power Consumption:

Optimize the power consumption of security components to prolong battery life and reduce energy costs.

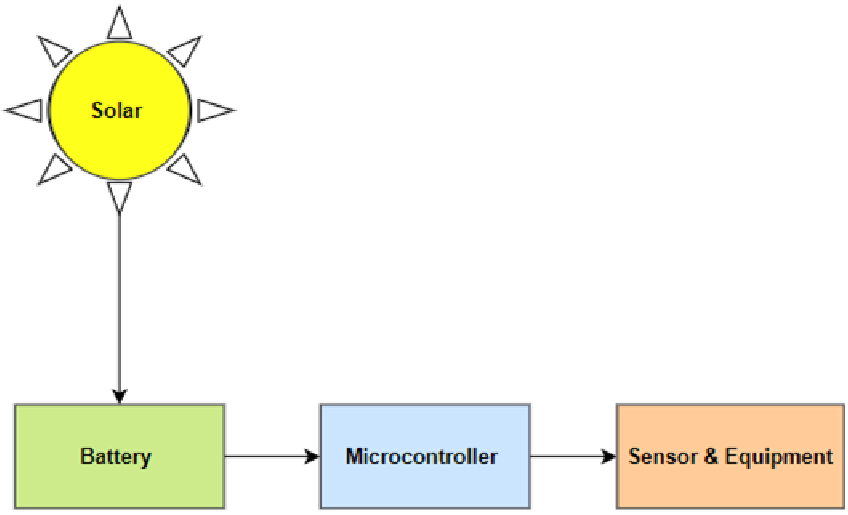

Figure 3.31: Power Management

Figure 3.18 shows how solar power charges a battery, which powers a microcontroller. The microcontroller regulates the power and transfers it to a sensor. The sensor can detect various physical or environmental parameters, such as temperature, pH, or total dissolved solids.

2. Scalability:

Design the system with a modular approach, allowing for easy scalability to accommodate larger farms or additional security components.
This IoT-based smart security system enhances the safety and security of fish farming

operations by integrating sensors, cameras, advanced data processing, and remote monitoring capabilities. The design prioritizes real-time alerts, seamless remote access, and scalability, making it a robust solution for ensuring the security of fish farms.

3.9: Experimental Setup

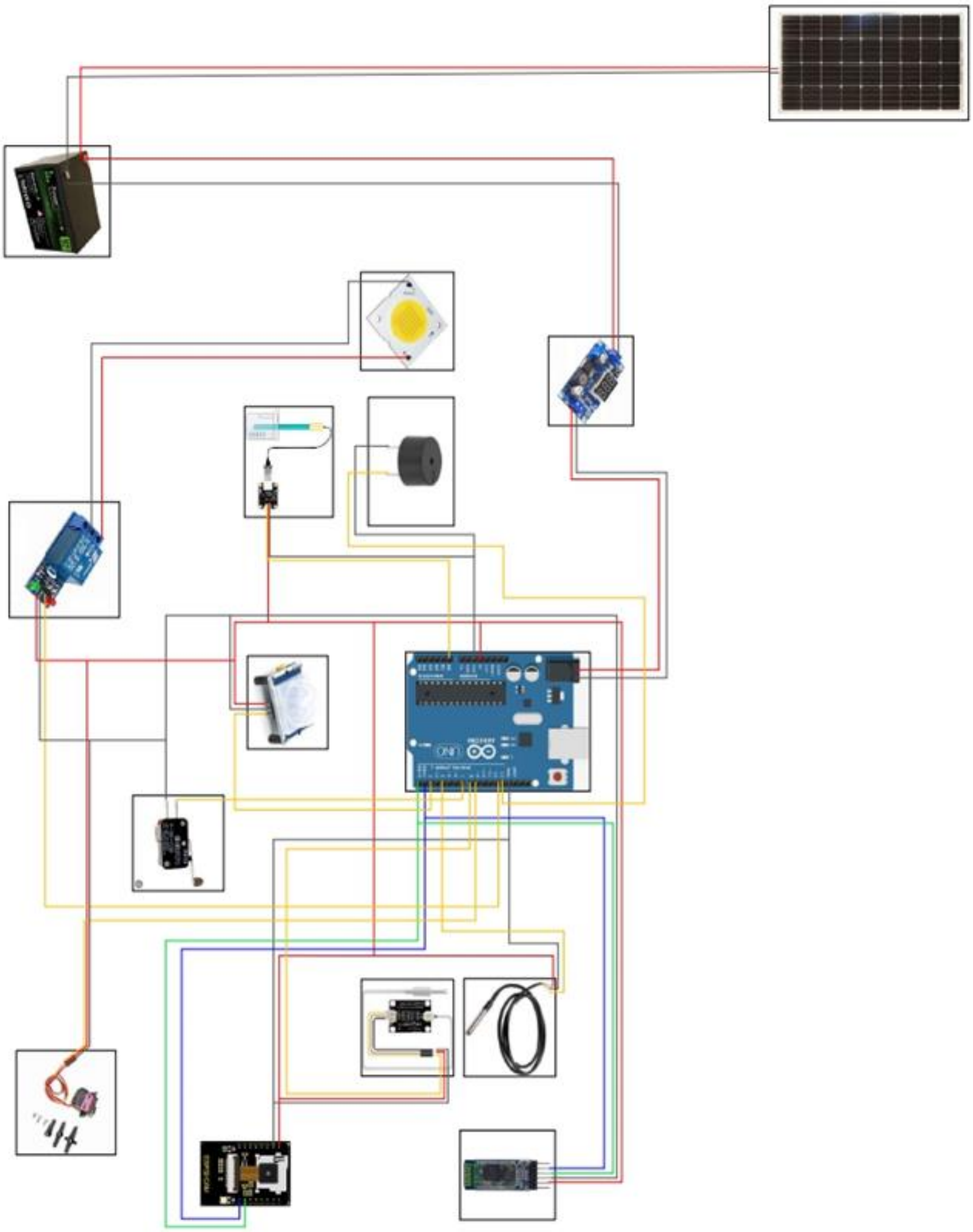

Figure 3.32: Experimental Setup

CHAPTER 4
RESULTS AND DISCUSSION

4.1: Result

4.1.1: Expriment-01

Experiment type: Closed Reservoir (Pond)

Location: Daffodil International University.

Time: 11:00 am -12.00 pm

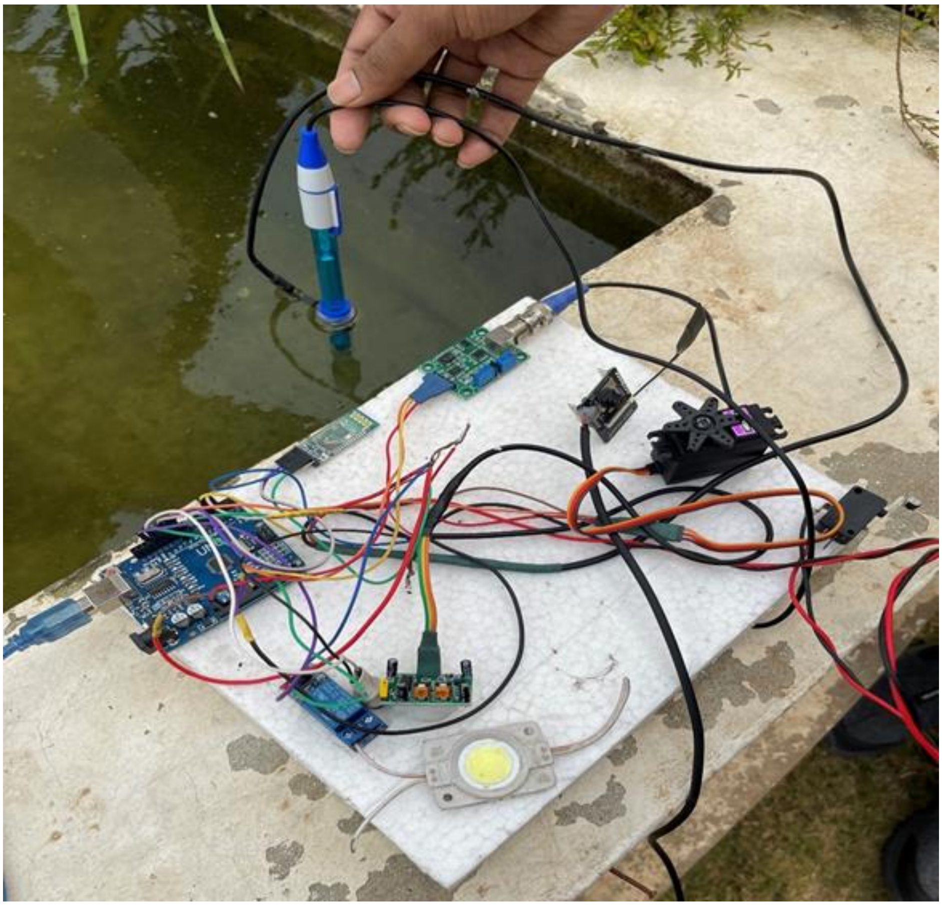

Figure 4.1: Expriment-01

Table 4.1: Experimental data-1

SL	pH	TDS mg/L	Temperature	Remark
01	6.70	21	17 ˚C	Condition is Bad
02	6.71	22.02	17 ˚C	
03	6.70	21.05	17 ˚C	

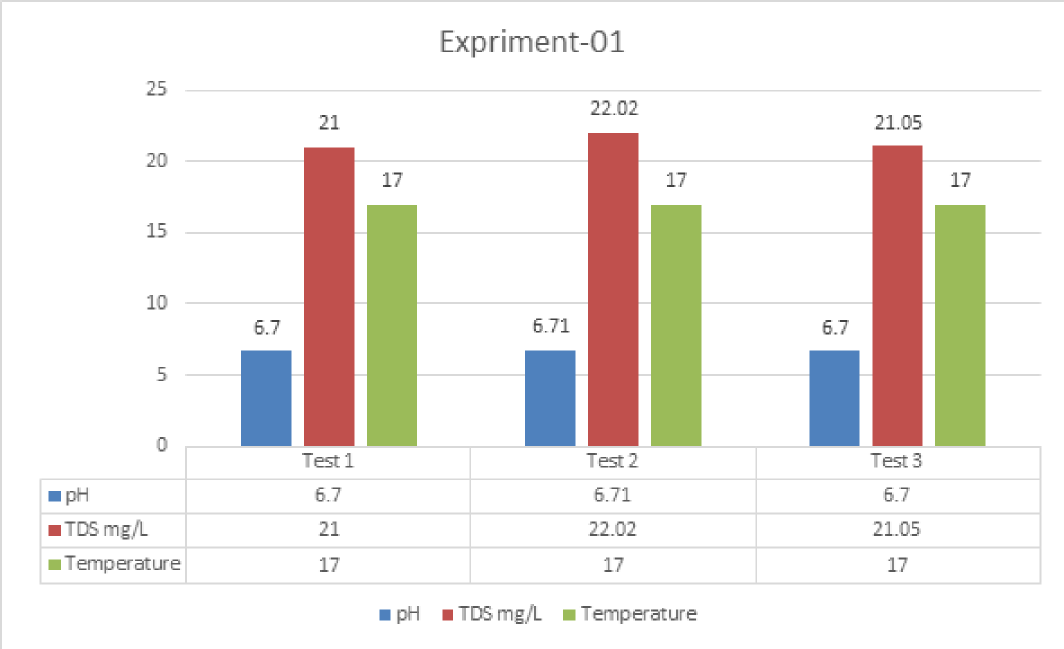

Figure 4.2: Experimental Data 1

The data sheet displays the results of three tests on the TDS (Total Dissolved Solids) in mg/L, pH and the temperature in °C for a pit pond in an IoT-based fish farm. The tests showed similar results. The TDS values were 21, 22.02, and 21.05 mg/L, which indicate the amount of dissolved solids in the water. The TDS value was low, which was not suitable for the fish. The temperature was consistent at 17°C, which was stable. The pH level was 6.70-6.71, which was ideal for fish farming. The optimal pH range for fish farming is (6.0-9.0).

4.1.2: Expriment-02

Experiment Type: Open Reservoir (Pond)

Location: Daffodil International University.

Time: 2.00PM -3.30PM

Table 4.2: Experimental data-2

SL	pH	TDS mg/L	Temperature	Remark
01	7.10	35	17 ˚C	Condition is good
02	7.11	35	17 ˚C	
03	7.11	35	17 ˚C	

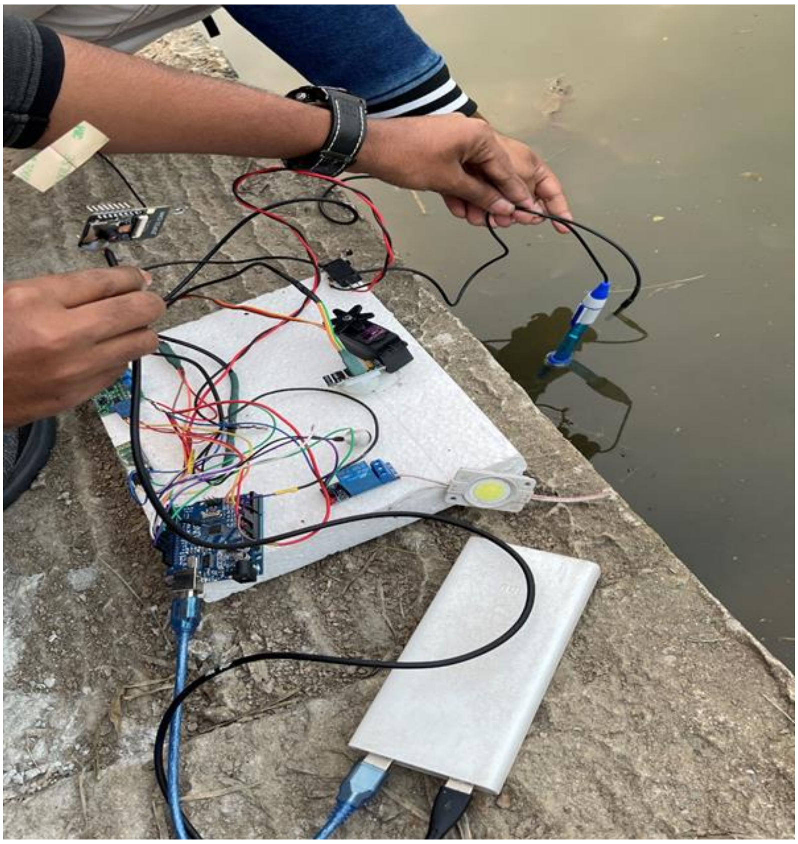

Figure 4.3: Expriment-02

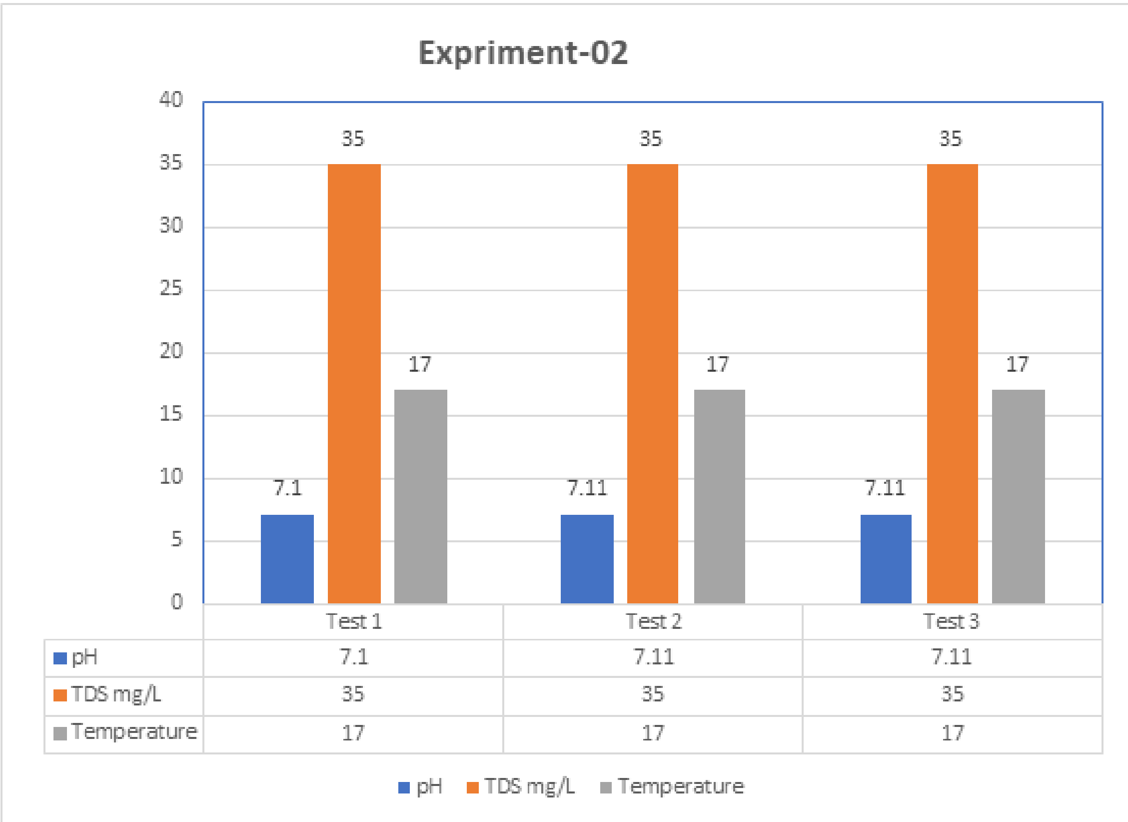

Figure 4.4: Experimental Data 2

We conducted Experiment 2 in a canal and measured TDS, pH and temperature. The TDS values were 35,35, and 35 mg/L, indicating a stable condition for a fish farm. The canal temperature was 17°C, which was also stable, and the pH ranged from 7.10 to 7.11. Therefore, this canal water is ideal for fish health.

4.1.3: Expriment-03 (Aquarium)

Experiment type: (Aquarium)

Location: Daffodil International University.

Time: 10:00 am -11.00 am

Figure 4.5: Expriment-03

Table 4.3: Experimental data Table-3

SL	pH	TDS mg/L	Temperature	Remark
01	8.0	10	24 ˚C	Good
02	8.0	10	24 ˚C	
03	8.01	10	24 ˚C	

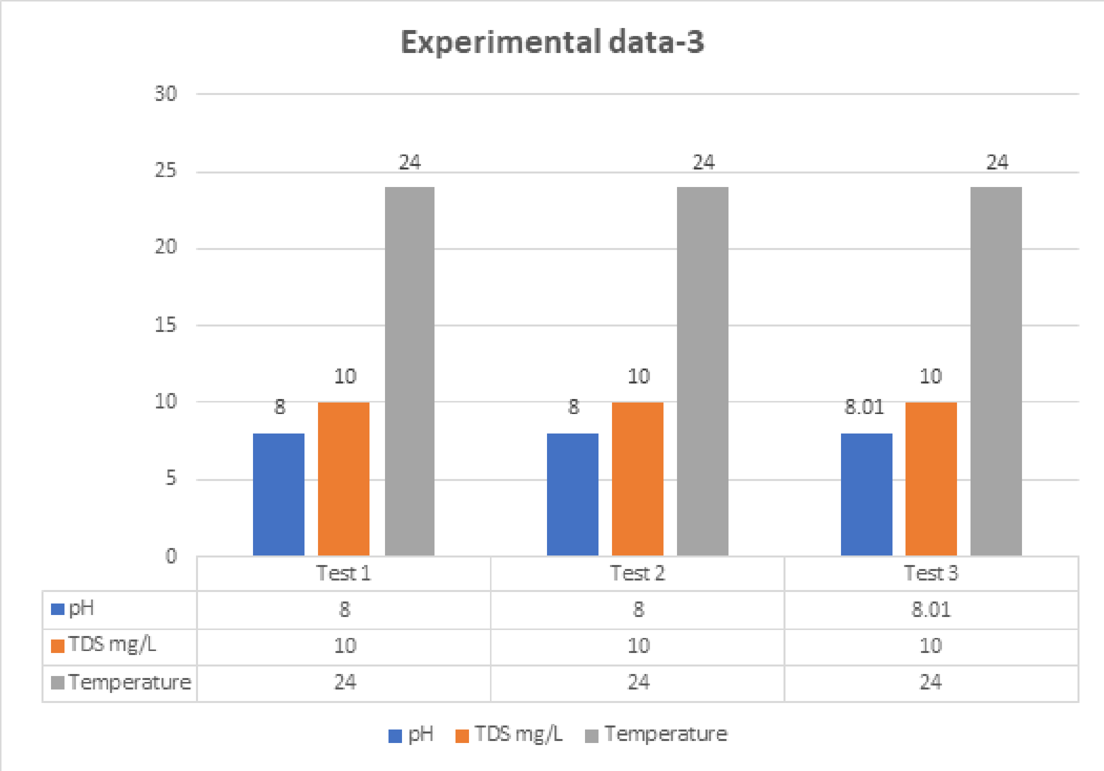

Figure 4.6: Experimental Data 3

We performed Experiment 3 in an aquarium filled with potable water. We recorded the values of TDS, pH, and temperature. The TDS values were consistently 10 mg/L, which is not optimal for all types of fish. The temperature was stable at 24°C, and the pH was slightly alkaline, ranging from 8.0 to 8.01.

4.2: Hardware Implementation

Figures 4.1 and 4.3 depict the proposed system's final prototype. Figure 4.1 shows how all of the equipment is linked and affixed to a board. A switch is utilized to control the power supply in this case. It is linked to a 12 V battery (Power Bank). The LM2596 buck converter is used to lower the input voltage to 5 V because a 12 V input voltage is not required. The ESP-12E module receives this 5 V and begins collecting data from the pH, temperature, and TDS sensors. Figure 4.1 depicts the real-life experiment from which all of the values were gathered. The apparatus was placed in a pond in a floatable housing.

When sensors collect data from the water, the mobile application displays it. We attached this system to our Android app and traveled to a pond to test the pH, TDS, and water temperature.

4.3: Result of pH Sensor

Experimental result depicts the measured pH level of the water as well as the mobile application UI that displays the measured value. To determine the pH of water, a pH sensor must be immersed in it. This sensor will gather the value from the water and send it to the application via Bluetooth. This value will be displayed in the application's pH section. The pH scale normally varies from 6.5 to 8.5 and is ideal for fish production. The pH of the water in that pond was 6.71, 7.11, and 8.01, which is appropriate for fish development. Fish will be safe and healthy in this water because the pH is ideal. Fishermen can develop fish in that pond since it has the standard pH level.

4.4: Results of Temperature Sensor

Experimental result shows how to insert the temperature sensor into the water to obtain the temperature value. It will collect the value from the water and send it to the application via a Bluetooth module. This figure will be displayed in the application's temperature section. The temperature of the water in this experiment was 17.0-24.0 °C, which is suitable for fish production. Fish will be safe and healthy in this water because the pH is ideal. Different fish require different temperatures. The temperature of the water is depicted in

4.5: Result of TDS Sensor

Experimental result depicts a TDS meter, which is a device that measures the total dissolved solids (TDS) in a water sample. The amount of organic and inorganic substances dissolved in water, such as minerals, metals, salts, and other compounds, is referred to as TDS. TDS meters measure the electrical conductivity (EC) of water, which is proportional to the concentration of dissolved solids. The more the EC, the greater the TDS. The readings of TDS meters are displayed in parts per million (ppm) or milligrams per liter (mg/L).

TDS meters are used to assess the quality and cleanliness of drinking water as well as water from aquariums, pools, laboratories, and hydroponics.

TDS meters can detect the presence of toxins or pollutants in water, but they can't tell you what they are. As a result, TDS meters should be used in conjunction with other testing methods to assure the safety and usability of water for various uses.

CHAPTER 5
PROJECT MANAGEMENT

5.1: Cost Management

Components	Quantity	Unit Price	Total Price
Motion sensor	2	65	130
Temperature sensor DS18B20	1	120	120
PH sensor kit	1	2200	2200
Limit switch	6	25	150
Arduino uno	1	750	750
Bluetooth module	2	250	500
TT Gp T (esp32) Cam	1	2000	2000
Servo motor metal	2	330	660
Rang - 3m	1	150	150
Rojon	1	5	5
Female Connector	10	4	40
Relay module 2 channel	1	75	75
Wire clip on	5	25	125
Male connector	8	2	16
TDS module	1	3000	3000
Glue stick	3	10	30
12v power supply charger HikVision-2	1	350	350
5v converter	4	65	260
12 v battery	1	1200	1200
Solar	1	170	170
Alarm 12v	4	12	60
Total			**=11991**

CHAPTER 6

IMPACT ASSESSMENT OF THE PROJECT

6.1: Economical, Societal and Global Impact

in the economical, societal and global impacts of IoT based smart monitoring system for fish farming. This is a very relevant and timely topic, as fish farming is one of the fastest growing sectors of food production and has a significant potential to contribute to food security, poverty alleviation, and environmental sustainability. However, fish farming also faces many challenges, such as water quality degradation, disease outbreaks, high production costs, and market fluctuations. Therefore, it is important to explore how IoT based smart monitoring system can help fish farmers overcome these challenges and improve their productivity, profitability, and social welfare.

1. IoT based smart monitoring system can enable real-time and remote measurement and control of water quality parameters, such as pH, temperature, total dissolved solid, which are crucial for the health and growth of fish. This can help fish farmers optimize the water conditions, prevent fish mortality, and reduce water consumption and pollution[1234].
2. IoT based smart monitoring system can also provide data analysis and decision support for fish farmers, such as disease diagnosis, harvest prediction, and market information. This can help fish farmers improve their efficiency, reduce their operational costs, and increase their income and competitiveness.
3. IoT based smart monitoring system can also have positive impacts on the society and the environment, such as enhancing food security, creating employment opportunities, reducing greenhouse gas emissions, and conserving natural resources and biodiversity.

However, IoT based smart monitoring system also faces some challenges and limitations, such as:

a) The high initial investment and maintenance costs of the IoT devices and infrastructure, which may not be affordable or accessible for small-scale or resource-poor fish farmers.
b) The lack of technical skills and knowledge among fish farmers and extension

workers, which may hinder the adoption and utilization of the IoT based smart monitoring system.

c) The issues of data security, privacy, and ownership, which may raise ethical and legal concerns for the fish farmers and other stakeholders.
d) The possible negative impacts of the IoT based smart monitoring system on the social and cultural aspects of fish farming, such as the loss of traditional knowledge and practices, the increased dependence on external inputs and markets, and the potential conflicts and inequalities among fish farmers and communities.
e) Therefore, it is important to consider the economic, social, and environmental aspects of IoT based smart monitoring system for fish farming, and to develop appropriate policies, regulations, and incentives to ensure its sustainable and inclusive development and implementation.

6.2: Environmental and Ethical Issues:

The environmental and ethical issues for IoT based smart monitoring system for fish farming are related to the potential impacts of such a system on the natural ecosystem, the welfare of the fish, and the social and economic aspects of the fish farming industry. Some of the main issues are:

a) The IoT based smart monitoring system for fish farming may reduce the human intervention and labor required for fish farming, which may have positive effects on the efficiency and productivity of the industry, but also negative effects on the employment and livelihood of the fish farmers and workers.
b) The IoT based smart monitoring system for fish farming may improve the water quality and fish health by controlling the parameters such as pH, temperature, TDS etc., which may enhance the growth and survival of the fish, but also raise the ethical concerns about the manipulation and modification of the natural environment and the fish behavior.
c) The IoT based smart monitoring system for fish farming may increase the transparency and traceability of the fish production and supply chain, which may benefit the consumers and the regulators, but also pose the challenges of data security, privacy, and ownership, as well as the risks of cyberattacks and hacking.

d) The IoT based smart monitoring system for fish farming may require the use of various sensors, actuators, communication modules, and cloud services, which may consume a lot of energy and resources, and generate a lot of electronic waste, which may have negative impacts on the environment and the sustainability of the system.

CHAPTER 7
CONCLUSIONS AND RECOMMENDATIONS

7.1: Conclusions

The IoT based Smart Monitoring System for Fish Farming is a system that uses wireless sensors, microcontrollers, and internet connectivity to monitor and control the water quality and environmental conditions of fish ponds in real time. The system aims to improve the productivity and profitability of fish farming by reducing manual labor, human errors, and operational costs. The system also enables remote access and management of the fish ponds through a web or mobile application.

The main benefits of the IoT based Smart Monitoring System for Fish Farming are:

a) It ensures the optimal growth and health of the fish by maintaining the water quality parameters such as temperature, pH, TDS within the suitable range for each fish species.
b) It prevents the loss of fish due to diseases, predators, or natural disasters by detecting and alerting the fish farmers of any abnormal conditions or events in the fish ponds.
c) It saves time, energy, and resources by automating the fish feeding and water treatment processes based on the data collected from the sensors and the fuzzy controllers.
d) It provides data analysis and visualization of the fish farming performance and trends, which can help the fish farmers to make informed decisions and optimize their business strategies.
e) The IoT based Smart Monitoring System for Fish Farming is a promising solution for the challenges and opportunities of the aquaculture industry in the 21st century. It can enhance the efficiency, sustainability, and competitiveness of fish farming and contribute to the global food security and environmental protection.

7.2: Future Recommendations

Some possible future recommendations for IoT based smart monitoring system for fish farming are:

a) To extend the system to cover more water quality parameters, such as salinity, nitrate, nitrite, and ammonia, which are also important for fish health and growth.

b) To integrate the system with cloud computing and big data analytics, which can provide more storage, processing, and visualization capabilities for the large amount of data generated by the sensors.

c) To implement machine learning and artificial intelligence techniques, which can enable the system to learn from the data and optimize the control and management of the fish ponds.

d) To incorporate the system with blockchain and smart contracts, which can enhance the security, transparency, and traceability of the fish farming supply chain.

e) To develop a user-friendly and interactive web or mobile application, which can provide the fish farmers with real-time information, alerts, and recommendations for their fish ponds.

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