Professional Engineering Practice and Industrial Management

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Final Project

Smart Aquarium using IOT

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Declaration

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Project Details

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Project ID	PEP_30

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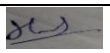
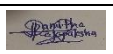
IT22911858	S.A.H.D.M.Perera	
IT22339188	R.M.D.E.Rajapaksha	
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Abstract

Using Internet of Things technology, the Smart Aquarium system changes aquarium management and management by solving issues a standard maintenance method. The system guarantees dependable and regular care for aquatic life by automating vital functions like feeding schedules, temperature management, lighting control, and water level monitoring. This innovation lowers the dangers of human error and improves the overall well-being and health of fish and other aquatic life. It also reduces the risks connected with manual oversight. The system's automated temperature display, which keeps water temperatures within ideal ranges for the health and comfort of aquarium occupants, is essential to its operation. Fish have less stress thanks to the night light control feature, which replicates natural light cycles and encourages natural behaviors. Regular and precisely measured volumes of food are ensured by automated feeding systems, mitigating the negative effects of overfeeding or underfeeding on fish health. In addition, the water level warning system notifies users in real time, providing prompt action in the event of water changes that may affect aquatic life. The Smart Aquarium system's integration of these automatic elements improves user experience by reducing the need for frequent human adjustment while also streamlining maintenance activities. This invention marks a substantial advancement in aquarium technology and provides aquarists with a reliable, approachable way to easily and confidently manage a healthy aquatic environment.

Keywords - Smart Aquarium, IoT technology, ultrasonic sensor, 18B20 Waterproof temperature sensor, LDR sensor unit, Servo Motors, Automated temperature display, Night light control, Automated fish feeding, Water level warnings, Real-time monitoring, Arduino IDE, Arduino Uno board.

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List of Acronyms and Abbreviations

- IoT - Internet of Things
- RTC - Real-Time Clock
- LDR - Light Dependent Resistor
- LCD - Liquid Crystal Display
- IEEE - Institute of Electrical and Electronics Engineers

1. Introduction

1.1 Problem Statement

The current state of aquarium management relies heavily on manual monitoring and intervention, lacking real-time automation capabilities. This manual approach poses significant challenges, including the inability to consistently regulate crucial parameters such as water temperature, lighting schedules, water levels, and feeding routines. These tasks are essential for maintaining a healthy aquatic environment but are prone to human error, leading to potential risks such as environmental instability, equipment failure, and unreliable care for aquatic life. As a result, there is a pressing need for an automated system that can efficiently and reliably manage these aspects of aquarium maintenance to ensure optimal conditions and the well-being of aquatic organisms.

1.2 Product Scope

The Smart Aquarium system uses IoT technology to monitor and control vital aquatic life metrics in aquariums. It improves user experience and ensures continuous care by automating temperature monitoring, light control, and feeding fish. Some benefits include automation, remote monitoring, and improved user experience.

Main Objective

- The creation and use of a modern Internet of Things (IoT) Smart Aquarium system would transform aquarium management by providing the best conditions for aquatic life using smart monitoring and control systems.

Sub-Objectives

- Use IoT devices for real-time control and monitoring functions.
- User-friendly controls may increase the user experience.

- Automate service tasks and simplify feeding schedules.
- Promote the health and safety of marine life by keeping ideal conditions.
- Build the system the best solution in the industry.

1.3 Project Report Structure

Chapter 1: The first chapter describes the problem that was identified as well as the requirements that should be made to provide an effective solution. The problem statement and product scope sections are used for this purpose.

Chapter 2: The second chapter of the document contains the methodology that has been used for developing the system, which includes the requirement analysis, design, and implementation as well as the testing that was carried out. The use of block diagrams as well as the flow charts are included under requirement analysis are included under the design section. Implementation includes information about the technologies used for implementation, and finally, the testing section describes the test cases that were used to verify the functionality of the system.

Chapter 3: This section discusses the strengths and weaknesses of the proposed methodologies, as well as the potential solutions, as well as the project's evaluation and accomplishment.

References: Includes the references that were used for the implementation of the product, mentioned using IEEE style

2. Methodology

2.1 Requirements and Analysis

The functional and non-functional requirements for the Smart Aquarium system were determined through an analysis of existing IoT-enabled systems and best practices in aquarium management. Drawing insights from similar technologies and observing their functionalities, we identified a comprehensive set of functional and non-functional requirements.

2.1.1 Functional requirements

Automated Temperature Display:

- The system shall continuously display the water temperature of the aquarium. It shall update the temperature reading in real time on a digital display.

Night Light Control:

- The system shall include a programmable night light feature that mimics natural lighting cycles. The night light turns on and off automatically, promoting healthy circadian rhythms for aquatic life.

Automated Feeding Mechanism:

- The system shall automate the feeding process by dispensing a controlled amount of fish food once a day. Users can set the feeding schedule and portion size through the system's interface, ensuring consistent nutrition for the fish.

Water Level Warning System:

- The system shall monitor the water level within the aquarium and provide timely alerts when levels deviate from predefined thresholds. Alerts shall be displayed on the system's display to prompt immediate action.

2.1.2 Non-functional requirements

Reliability:

- The system must operate continuously without interruption to ensure stable conditions for aquatic life.

Security:

- Data communication between IoT devices and the central system must be encrypted to prevent unauthorized access.

Scalability:

- The system should be scalable to support multiple aquariums and a growing number of users without performance degradation.

Performance:

- The system should provide real-time updates with minimal latency, ensuring timely adjustments to temperature, lighting, feeding, and water levels.

Maintainability:

- The system should be designed with modular components to facilitate easy maintenance, updates, and bug fixes.

Availability:

- The system should have a high availability rate, with minimal downtime for maintenance or updates.
- The system must ensure the accuracy and consistency of stored data, preventing data corruption or loss.

Compliance:

- The system should adhere to relevant industry standards and regulations, ensuring safety, security, and quality.

2.1.3 Block diagram

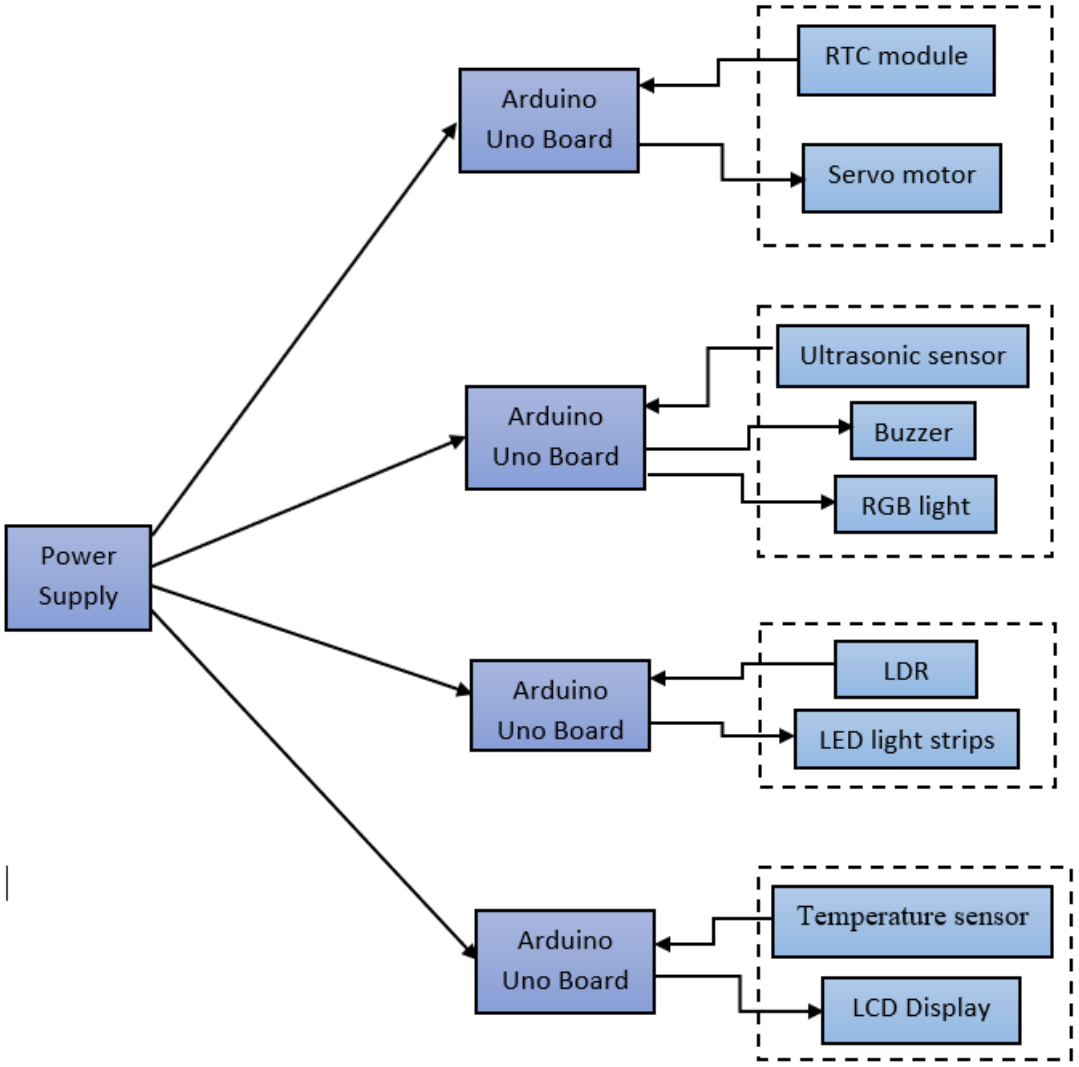

Figure 2. 1 : Block Diagram

2.2 Design

2.2.1 High-Level Architecture Diagram

The high-level architecture diagram presents a bird's-eye view of the Smart Aquarium System's components and their interactions. It showcases the user interface, microcontroller, sensors, and actuators, highlighting their roles in processing, and control. This diagram offers a simplified overview of the system's structure and functionality, aiding stakeholders in understanding its operation briefly.

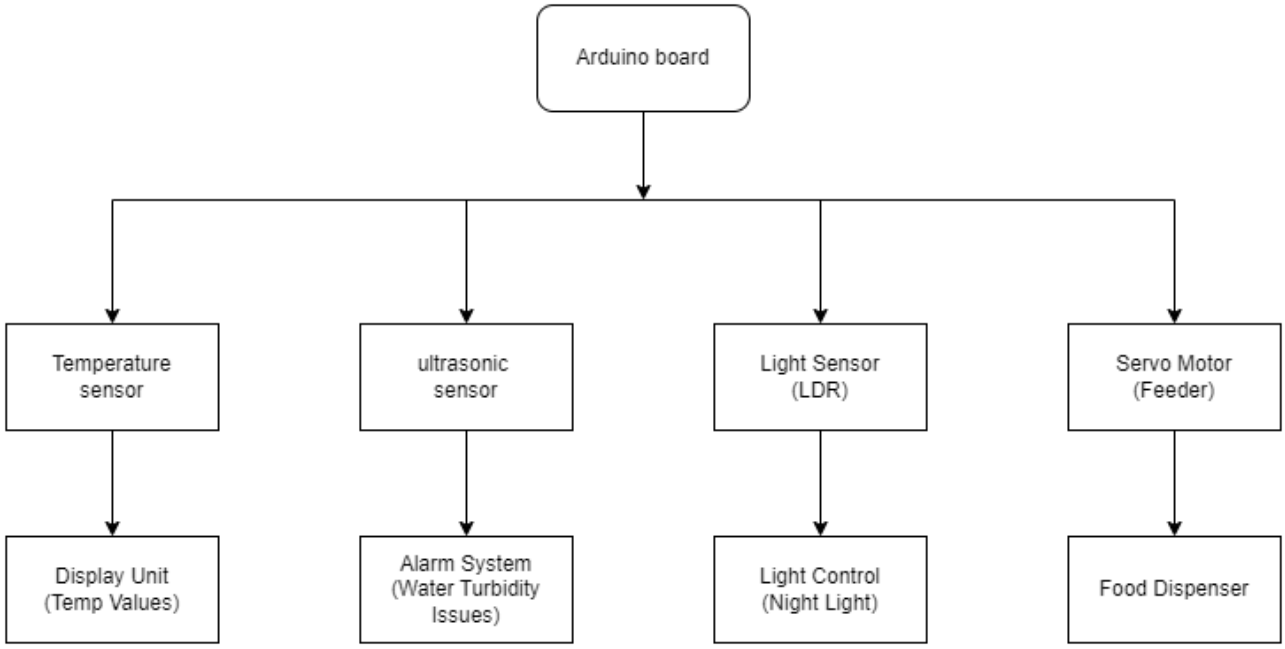

Figure 2. 2 : High-level architecture diagram

2.2.2 Activity Diagram

The activity diagram depicts the step-by-step actions and decisions within the Smart Aquarium System. It illustrates the initiation of the system, monitoring of environmental parameters, and subsequent responses. The diagram provides a visual representation of the logical flow of activities involved in managing the aquarium environment efficiently.

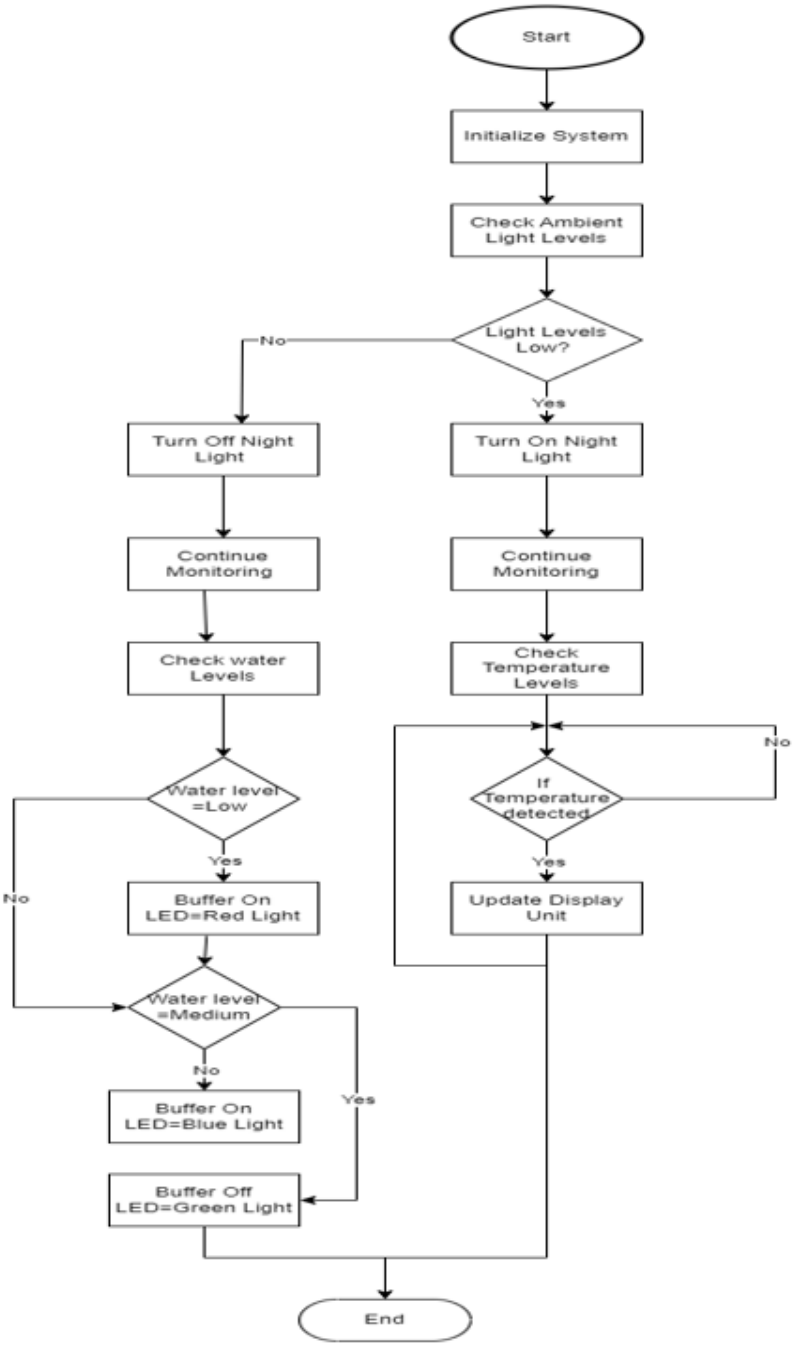

Figure 2. 3 : Activity diagram

2.3 Implementation

The implementation of the Smart Aquarium System using IoT involves several major modules, each responsible for specific functionalities within the system. Below are detailed module structures, reusable code snippets, and development tools used.

Major Module Structures

1. Temperature Monitoring Module

Function: Continuously monitor and display water temperature.

Components:

- 18B20 Waterproof Temperature Sensor: Collects temperature data.
- Arduino Board: Processes data and controls the display.
- LCD Display: Shows the current temperature.

Process Flow:

- Initialize the sensor and display.
- Request temperature readings and update the display in a loop.

2. Light Management Module

Function: Adjust night light intensity based on ambient light levels.

Components:

- LDR Sensor: Detects ambient light levels.
- Arduino Board: Processes sensor data and controls the light.
- LED Lights: Provide illumination.

Process Flow:

- Initialize sensor and light pin configurations.
- Read light levels and adjust light intensity in a loop.

3. Fish Feeding Module

Function: Dispense the required amount of food to the fish at scheduled times.

Components:

- RTC Module: Keeps track of time for scheduling.
- Servo Motor: Controls the dispensing mechanism.
- Arduino Board: Coordinates the scheduling and motor control.

Process Flow:

- Initialize the RTC and servo motor.
- Check the current time and activate the motor to dispense food at scheduled intervals.

4. Water Level Monitoring Module

Function: Monitor water level and display warnings if water level low or high.

Components:

- Ultrasonic sensor: Measures water level.
- Arduino Board: Processes sensor data and triggers alarms.

Process Flow:

- Initialize the sensor.
- Continuously read sensor data, compare it with predefined thresholds, and trigger alarms if necessary.

Reusable Code and Development Tools

- Arduino IDE: The primary development environment used for coding and uploading programs to the Arduino board.
- Libraries:
    - DallasTemperature.h and OneWire.h: For interfacing with the temperature sensor.
    - Servo.h: For controlling the servo motor.
    - Wire.h: For I2C communication with the RTC module.
    - LiquidCrystal_I2C.h: For controlling the LCD display.

Special Algorithms

1. Temperature Monitoring Algorithm:

- Initialize and configure the temperature sensor and LCD display.
- Request temperature readings and update the display.

2. Light Management Algorithm:

- Initialize and configure the LDR sensor and LED light.
- Read ambient light levels and adjust the LED light intensity.

3. Fish Feeding Algorithm:

- Initialize and configure the RTC module and servo motor.
- Schedule feeding times and control the servo motor to dispense food.

4.Water Level Monitoring Algorithm:

- Initialize and configure the ultrasonic sensor.
- Continuously monitor the water level.
- Compare the water level readings with predefined thresholds.
- If the water level falls below a certain threshold, on buffer and lighting LED.

2.4 Testing

Test Case ID	Description	Input	Expected Output	Result	Comments
TC1.1	Temperature Display Accuracy	Set a known water temperature	The LCD displays the correct value	Pass	Accurate readings observed
TC1.2	Temperature Update Frequency	Observe the display for 60 seconds	The temperature value updates 60 times	Pass	Updates observed correctly
TC2.1	Light Adjustment in Low Light	Simulate low ambient light	The LED light intensity increases	Pass	Intensity increased
TC2.2	Light Adjustment in High Light	Simulate high ambient light	The LED light intensity decreases	Pass	Intensity decreased
TC3.1	Scheduled Feeding Activation	Set feeding time to current time +1 min	Servo motor activates at the scheduled time	Pass	Dispensed at correct time
TC3.2	Feeding Quantity Control	Set a specific feeding duration	Servo motor runs for set duration	Pass	Correct quantity dispensed
TC4.1	Water Level Monitoring Initialization	Water Level Monitoring Initialization	Ultrasonic sensor is configured correctly	Pass	Sensor initialized successfully
TC4.2	Buffering and LED Lighting	Turn on buffer and LED if water level falls below threshold	Buffer and LED activated	Pass	Buffer and LED activated when required

Table 2.4. 1 : Testing table

3. Conclusion

One such outstanding project is the Smart Aquarium System, which uses Internet of Things technology to transform aquarium management. As the project nears the end, the project's achievements should be evaluated, areas of improvement should be identified, and the benefits that it brought to the client firm should be acknowledged.

3.1.1 Realization of Objectives

During the project lifecycle, we aimed to realize the following objectives:

IoT System Design and Development: A fully functional IoT system with multiple sensors, actuators, and central controller have been developed for real-time monitoring and control for Temperature, Light, and Water Level of the critical parameters for an aquarium.

This system was built with a user friendly: and easy to navigate user interface that granted aquarium owners the ability to control and automate their maintenance routines and overall manage their system, all resulting in a better overall user experience as well.

IoT Contribution to Aquatic Life Care: we have extended our support for aquatic inhabitants through this IoT-based contribution to their habitat which helps in creating a conducive environment closest to their natural habitat promoting health of aquatic life.

3.1.2 Future Work

In what’s next, there are many paths for making the Smart Fish Tank System even better:

- Connecting More Hardware and Sensors: Adding extra sensors and tools to make the system work with different fish tanks and meet the needs of more users.
- Improving How Users Interact: Making the way people use the system better and easier, maybe by adding phone apps or web pages for watching and controlling it from far away.

- Making It Work Even When Trouble Happens: Putting in backup plans to handle problems with sensors or other parts, so the system keeps working and giving good information.
- Single Arduino Integration: Consolidate system functions onto a single Arduino board for improved efficiency, reduced complexity, and enhanced reliability.
- Mobile App Enhancement: Improve the mobile application for better user interaction and real-time monitoring capabilities, enhancing the overall user experience and accessibility of the smart aquarium system.

3.1.3 Lessons Learned

While we worked, we learned things that will help with our next projects:

- Picking the Right Tech: Choosing the right technology is big for making sure stuff fits together, can grow, and is easy to look after.
- Team Talk and Teamwork: Talking and working well with the team is important for making projects work, solving problems, and deciding things.
- Making Things Step by Step: Doing things bit by bit lets us change and make things better all the time.

3.1.4 Assessment of Project Results

We checked how well the project did by looking at some things we thought were important. Here are some of the good stuffs we did:

- Made the most important parts work, like watching in real time, doing tasks on their own, and making a nice way for people to use it.
- Got good comments from the people who use it, showing they like how it works and find it easy to use.

- that the system is good at keeping fish healthy, making users happy, and keeping them Saw as users.

3.1.5 Client Organization Benefits

These advantages for the client organization come with the development of the Smart Aquarium System:

Market Differentiation: The client organization could differentiate itself from its competitive set by providing an innovative and technologically upgraded solution in the aquarium industry, enabling more of the customers with the choice of the futuristic tech-oriented way of aquarium management.

Customer Engagement: The user-friendly interface and automation capabilities of the system help to increase customer loyalty by simplifying the maintenance of the aquarium and ensuring that the aquatic life inside it is properly cared for.

Operational Efficiency: Automation, like feeding schedules or water quality automatic monitoring, reduces the necessity of manual intervention by streamlining operations, which drive in higher efficiency, and cost savings for the client organization.

Conclusion

Smart Aquarium System powered by Internet of Things is indeed a technological breakthrough in aquarium management. Although it has already fulfilled its primary needs, it is always an ongoing project for innovation and improvements. Capitalizing on this opportunity and leveraging the benefits of the system will enable ‘The client organization' to continue its dominance among aquarium hobbyists by providing state-of-art solutions in the industry.

4. References

[1] MoreSteam. "System Diagrams." [Online]. Available: https://www.moresteam.com/toolbox/system-diagrams.cfm. [Accessed 18 June 2024].

[2] GitHub. (n.d.). Arduino-LiquidCrystal-I2C-library. Retrieved June 18, 2024, from https://github.com/marcoschwartz/LiquidCrystal_I2C.

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5. Appendix C: Selected Code Listings

Temperature Monitoring Algorithm

```
#include <OneWire.h>
#include <DallasTemperature.h>

// Initialization
OneWire oneWire(2);
DallasTemperature sensors(&oneWire);

void setup() {
  sensors.begin();
  Serial.begin(9600);
}

void loop() {
  sensors.requestTemperatures();
  float tempC = sensors.getTempCByIndex(0);
  // Display temperature on LCD or serial monitor
  delay(1000);
}
```

Light Management Algorithm

```
int lightPin = A0;

void setup() {
  Serial.begin(9600);
}

void loop() {
  int lightValue = analogRead(lightPin);
  // Adjust LED light intensity based on lightValue
  delay(1000);
}
```

Fish Feeding Algorithm

```
#include <Servo.h>

Servo feederServo;

void setup() {
  feederServo.attach(9);
}

void loop() {
  // Control servo motor for feeding
}
```

Water Level Monitoring Algorithm

```
int trigPin = 10;
int echoPin = 11;

void setup() {
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);
  Serial.begin(9600);
}

void loop() {
  // Read ultrasonic sensor and compare distance with threshold
  delay(1000);
}
```