AquaGuard: IoT-Based Smart Aquaponics Monitoring System

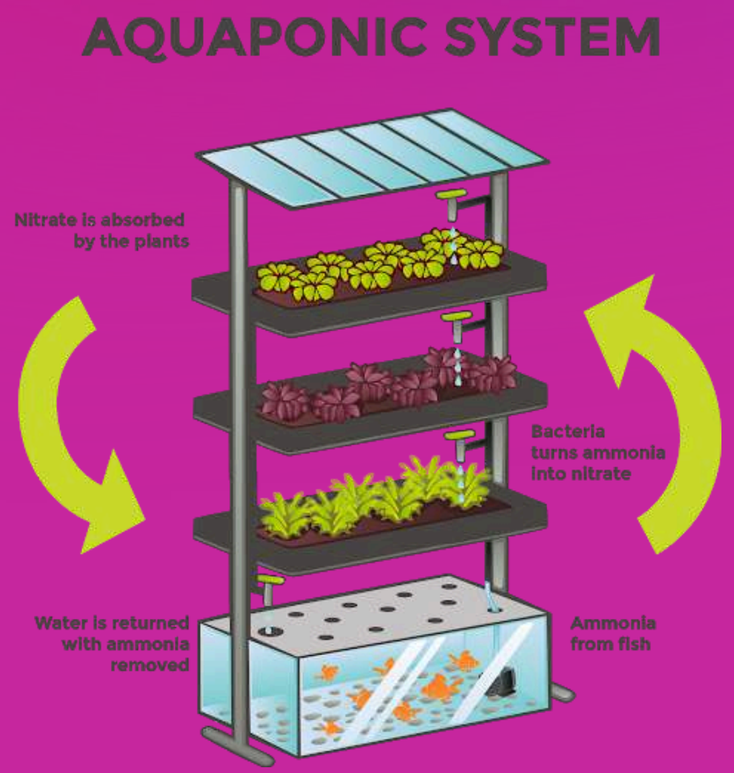
Presented by

Karthikha Sre M - 230701143
K.S.L.Yuktha - 230701154

Next Slide

PROBLEM STATEMENT

Traditional aquaponics systems require continuous manual monitoring of key environmental parameters such as water level, water quality, and temperature to maintain an optimal environment for both fish and plants. Manual methods are time-consuming, error-prone, and inefficient, especially in large-scale setups. There is a need for an automated, real-time monitoring solution that alerts the user immediately when conditions deviate from the desired range to ensure the health and productivity of the aquaponic ecosystem.



ABSTRACT

The Smart Aquaponics Monitoring System is an IoT-based solution designed to automate the monitoring of essential parameters in an aquaponic setup. The system continuously monitors the water level using a water level sensor, detects water quality through a soil moisture sensor (repurposed for conductivity or moisture level), and checks the temperature using a digital temperature sensor. When any parameter crosses a predefined threshold, the system immediately sends an alert to the user via Bluetooth. This real-time monitoring helps maintain optimal environmental conditions for both aquatic and plant life, reduces human intervention, and increases the efficiency and sustainability of the aquaponics process.

OBJECTIVES

1. To monitor water level in the aquaponic tank in real-time and alert the user when it falls below a critical threshold.

2. To estimate water quality using a soil moisture sensor by observing changes in electrical conductivity of the water.

3. To measure and track water temperature continuously to ensure a healthy environment for aquatic life and plants.

4. To send real-time alerts via Bluetooth to a mobile device when any parameter (water level, quality, or temperature) crosses defined safe limits.

5. To reduce manual effort in aquaponics monitoring through automation and sensor integration.

6. To provide a cost-effective, low-power, and scalable solution suitable for small-scale or educational aquaponics systems.

EXISTING SYSTEMS

IoT-Based Cloud Solution for Intelligent Integrated Rice-Fish Farming

Description: This system utilizes portable wireless sensor networks (WSNs) to monitor environmental parameters such as water quality and meteorological conditions. The collected data is transmitted to a cloud platform for analysis and decision-making. SciSpace

Disadvantages:

- Connectivity Dependence: Relies heavily on stable internet connectivity for real-time data transmission, which may be challenging in remote farming areas.
- Data Security Concerns: Transmitting sensitive farm data to the cloud poses potential security risks if not properly encrypted and managed.
- Security and Compliance: Ensure secure data transmission and role-based access control.

IoT Monitoring Systems in Fish Farming

Description: Designed to assist fish farmers in remotely observing their farming systems, this implementation uses various sensors to monitor water parameters. The system provides real-time data to help farmers intervene timely, thereby increasing production.AJPO Journals

Disadvantages:

- Complexity in Implementation: Integrating multiple sensors and ensuring their accurate calibration can be technically challenging for farmers without technical expertise.
- Maintenance Requirements: Regular maintenance of sensors and IoT devices is necessary to ensure consistent performance, adding to the operational workload.

Digital Twin-Based Intelligent Fish Farming with Artificial Intelligence

Description: This system employs digital twin technology and artificial intelligence to create virtual models of fish farming environments. It integrates IoT sensors to collect real-time data, enabling simulation and optimization of farming operations. ScienceDirect

Disadvantages:

- High Implementation Costs: Developing and deploying digital twins and AI models require significant investment, which may be prohibitive for small-scale farmers.
- Data Processing Demands: Handling and analyzing large volumes of data necessitate robust computational resources, potentially limiting accessibility for some users.

PROPOSED SYSTEM

1. **Real-time Water Level Monitoring**: Alerts when water level falls below the safe threshold.
2. **Water Quality Estimation:** Uses soil moisture sensor to indicate potential changes in water conductivity or quality.
3. **Temperature Monitoring:** Continuously tracks water temperature to ensure it stays within the optimal range.
4. **Bluetooth Alerts:** Sends immediate alerts to a connected mobile device or system via Bluetooth for quick action.
5. **Low Power Consumption**: Efficient sensor usage and microcontroller operations to conserve power.
6. **Modular & Scalable Design:** Easy to expand or upgrade with additional sensors or wireless communication methods.

IOT LEVEL

Smart Aquaponics Monitoring System falls under Level 1 of IoT architecture.

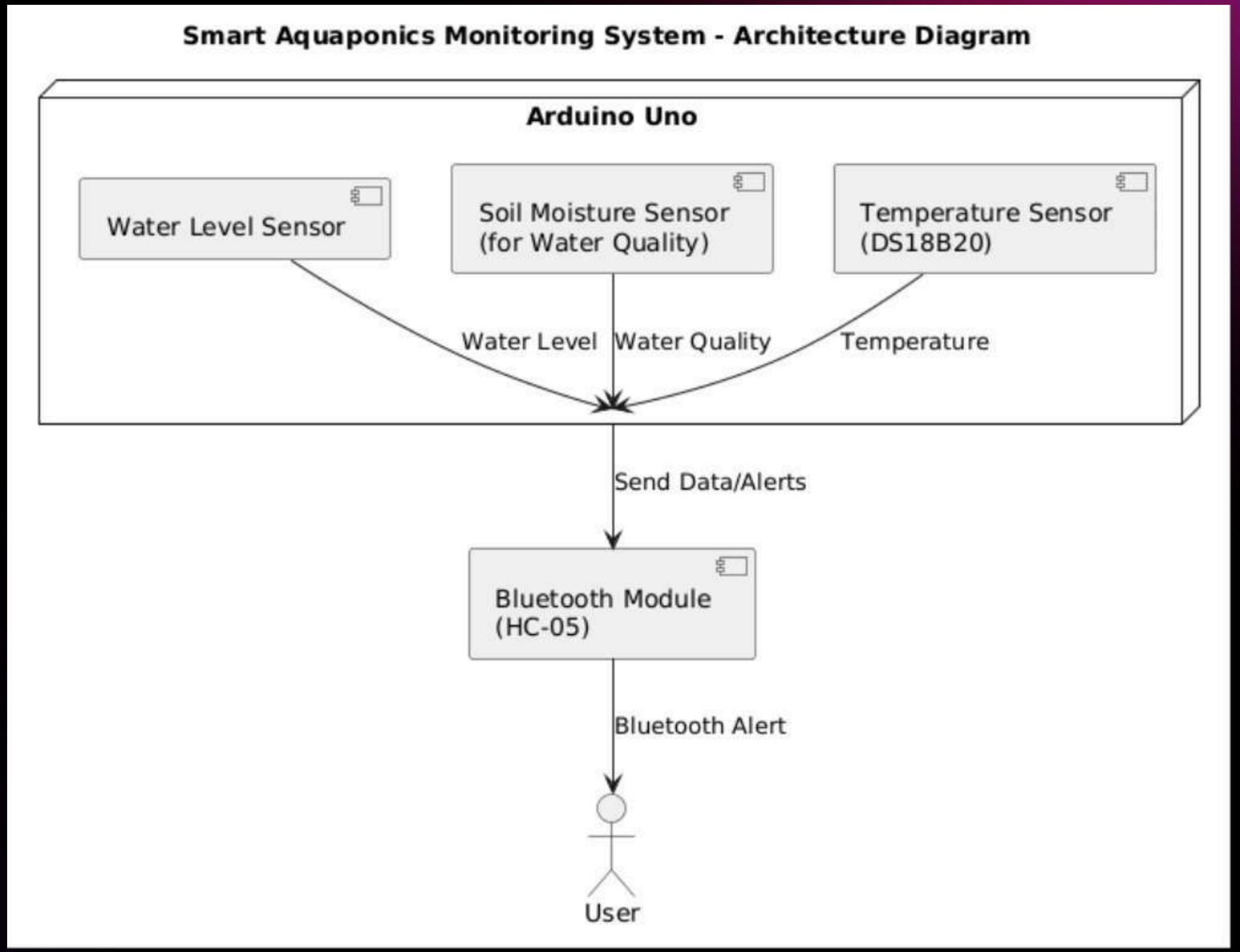
<u>IoT Level 1 – Basic Sensing & Alerting System</u>

- **Sensing Layer:** Water level, soil moisture (used for water quality), and temperature sensors.
- **Nework Layer:** Bluetooth communication.
- **Application Layer:** Simple mobile app or Bluetooth terminal receives alerts.
- No cloud integration, data analytics, or actuation/control features.

COMPONENTS

1. **Arduino Uno R3 (1 unit)**
2. **Soil Moisture Sensor (1 unit)**
3. **Bluetooth Module HC-05 (1 unit)**
4. **DS18B20 Temperature Sensor (1 unit)**
5. **USB Cable for Arduino (1 unit)**
6. **Jumper Wires (approx. 30 pieces)**
7. **Water Level Sensor (1 unit – type: analog sensor)**

FLOW CHART


Smart Aquaponics Monitoring System - Architecture Diagram
Arduino Uno
Water Level Sensor
Soil Moisture Sensor
(for Water Quality)
Temperature Sensor
(DS18B20)
Water Level
Water Quality
Temperature
Send Data/Alerts
Bluetooth Module
(HC-05)
Bluetooth Alert
User

FUNCTIONAL VIEW

APPLICATION

Standalone Applications: Mobile app for monitoring water levels, fish health, and crop status.

Business Applications: Data analytics for farm management, predictive maintenance, and automated control.

MANAGEMENT

Configuration: Setup water level thresholds, temperature settings, and fish safety measures.

Fault Handling: Detect sensor failures, connectivity issues, or component malfunctions.

Report Generation: Generate reports on water quality, fish health, and farming efficiency.

User Management: Admin access for farmers, technicians, and supervisors.

System State: Monitor real-time device status and sensor data

SERVICE ORGANIZATION

Service Composition: Combine sensor data for comprehensive monitoring.

Service Orchestration: Manage data flow from sensors to the cloud and mobile app.

Service Choreography: Enable devices to interact seamlessly for automated operations.

IOT PROCESS MANAGEMENT

Process Modeling: Define workflows for water level management, fish movement detection, and irrigation control.

Process Execution: Execute real-time commands for pumps, valves, and aerators.

VIRTUAL ENTITY

Farm Registry: Store farm-specific data, including field size, fish species, and crop type.

Health Monitoring Services: Track fish and crop health using real-time sensor data.

IOT SERVICE

Real-Time Monitoring: Track water levels, temperature, and fish movement.

Remote Access: Monitor and control farm operations through a mobile app.

Automated Control: Enable automatic water drainage and refilling using MOSFETs.

Emergency Alerts: Notify users in case of critical conditions.

SECURITY

User Authentication: Provide secure access for authorized users.

Data Encryption: Encrypt sensor data during transmission and storage.

Key Management: Ensure secure encryption key management.

Compliance: Follow data protection regulations.

COMMUNICATION

End-to-End Data Transfer: Secure transmission of sensor data to the cloud.

Network Protocols: Use MQTT, HTTP, or CoAP for communication.

Device-to-Device Communication: Enable sensors and actuators to interact.

DEVICES

pH Sensors: Monitor water acidity levels.

Temperature Sensors: Track water temperature.

Storage System: Cloud storage for data logs and analysis.

Water Level Sensors: Measure water levels in the rice field.

Fish Movement Sensors: Detect fish presence using IR or PIR sensors.

Actuators: Control pumps, solenoid valves, and aerators using MOSFETs.

Data Processing Unit: ESP32 for local processing.

Battery Management System: Ensure continuous power supply using a 12V battery.

CONCLUSION

AquaGuard successfully demonstrates how IoT technologies can be harnessed to improve the monitoring and maintenance of aquaponics systems. By automating the detection of critical environmental parameters and delivering real-time alerts, it reduces manual workload and increases system reliability. Its simplicity, affordability, and scalability make it a valuable tool for educational and small-scale use cases.

FUTURE ENHACEMENTS

Future enhancements can include:

- Integration with cloud platforms for remote access and historical data analysis.
- Use of advanced sensors like pH, turbidity, and dissolved oxygen for more precise water quality monitoring.
- Replacement of Bluetooth with Wi-Fi or LoRa for extended communication range.
- Development of a mobile app for real-time visualization and data logging.

REFERENCES

[1] IoT-Based Cloud Solution for Intelligent Integrated Rice-Fish Farming, SciSpace.

[2] Digital Twin-Based Intelligent Fish Farming, ScienceDirect.

[3] AJPO Journals – IoT Monitoring Systems in Fish Farming.

[4] Arduino Documentation – https://www.arduino.cc

[5] HC-05 Bluetooth Module Datasheet

[6] DS18B20 Temperature Sensor Datasheet

THANK YOU