CAPSTONE PROJECT REPORT

PROJECT TITLE

DESIGNING A SYSTEM TO MEASURE WATER LEVEL

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COURSE CODE / NAME

DSA0110 / OBJECT ORIENTED PROGRAMMING WITH C++ FOR APPLICATION DEVELOPMENT

SLOT A

DATE OF SUBMISSION

12.11.2024

BONAFIDE CERTIFICATE

Certified that this report **DESIGNING A SYSTEM TO MEASURE WATER LEVEL** is the Bonafide work of **(192224159) P.ARTHI & (192224165) G.KEERTHI REDDY** who carried out the project work under my supervision.

SUPERVISOR

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ABSTRACT

The system utilizes sensors to capture water levels and transmit data to a central processing unit, enabling timely analysis and response. Designed for flexibility, the system supports customization for specific environmental conditions and user requirements, making it suitable for applications in flood control, water

resource management, and industrial processes. The system emphasizes reliability and durability, incorporating error detection and data integrity checks to ensure consistent performance. With a straightforward interface and robust data handling capabilities, this water level measurement system offers a cost-effective solution to modern water management challenges, enhancing decision-making and supporting sustainable resource management efforts.

The proposed system leverages advanced sensor technology and a user-friendly interface to monitor and report real-time water levels. Designed for adaptability, it can handle varying environmental conditions and customization thresholds, enabling deployment across multiple use cases, from flood management to industrial water management. The system's efficient data processing and error-handling capabilities ensure reliability and quick fault detection, providing actionable insights for users. By facilitating seamless data acquisition and offering detailed feedback, this system promotes iterative development and supports agility in project-specific modifications. Enhanced data security measures protect system integrity, making this tool essential in applications requiring precise and reliable water level monitoring. The design represents a significant advancement in water resource management technology, contributing to safer, more resilient infrastructure systems.

Water level monitoring is essential for various applications, including flood prevention, water resource management, and agricultural planning. As climate change leads to more unpredictable water patterns, the need for reliable and efficient water level monitoring systems has become even more critical. This project proposes the design of a water level indicator system, a streamlined tool to provide real-time insights into water levels across different environments, such as tanks, reservoirs, rivers, and groundwater storage facilities.The main objective of this project is to create a system that accurately indicates water levels and provides timely alerts, enhancing the ability to respond proactively to changing water conditions. The water level indicator will leverage sensor technology, which is capable of capturing water level fluctuations and transmitting this data in real time.

The system will feature visual and/or auditory alerts that inform users of critical levels, allowing for immediate action to be taken when necessary.This project's significance lies in its potential to improve water management processes by offering a practical, user-friendly solution that minimizes the risks associated with overflow, water scarcity, or contamination. By focusing on an efficient, reliable, and scalable design, this water level indicator system aims to support sustainable water management practices, ultimately contributing to safety and resource conservation. Through careful planning, design, and testing, this proposal aims to create a tool that can effectively serve households, industries, and agricultural communities alike.

INTRODUCTION

Water level monitoring is essential for various applications, including flood prevention, water resource management, and agricultural planning. As climate change leads to more unpredictable water patterns, the need for reliable and efficient water level monitoring systems has become even more critical. This project proposes the design of a water level indicator system, a streamlined tool to provide real-time insights into water levels across different environments, such as tanks, reservoirs, rivers, and groundwater storage

facilities.Water, a lifeblood resource, is essential for sustaining ecosystems, agriculture, and human civilization. Effective water management hinges on precise monitoring of water levels in diverse applications, ranging from vast reservoirs to small-scale irrigation systems.

Traditional methods, often manual and labor-intensive, are increasingly inadequate in today's world that demands real-time data and remote accessibility.To address these challenges, automated water level measurement systems have emerged as a crucial tool. These systems, equipped with advanced sensors and data transmission technologies, enable continuous monitoring of water levels, providing valuable insights for informed decision-making. By accurately tracking water fluctuations, these systems empower stakeholders to optimize water usage, mitigate risks associated with floods and droughts, and ensure sustainable water resource management.

This project aims to design and implement a robust, reliable, and cost-effective water level measurement system. By leveraging cutting-edge sensor technologies and micro-controller-based platforms, we will develop a solution capable of accurately measuring water levels in various environments, from open water bodies to confined tanks. The system will be designed to transmit data wireless to a remote monitoring station, enabling real-time analysis and timely intervention. Additionally, the system will incorporate advanced features such as threshold-based alerts and data logging, facilitating proactive response to critical water level conditions.

Through the successful implementation of this project, we aim to contribute to the advancement of water resource management, environmental conservation, and sustainable development. By providing reliable and timely water level data, we empower decision-makers to make informed choices that optimize water usage, minimize waste, and protect our precious water resources.This project aims to design and implement a robust and cost-effective water level measurement system. By leveraging modern sensor technologies and micro-controller-based systems, we will develop a solution that can accurately measure water levels in various environments.

Water, an indispensable resource, is crucial for sustaining life and various human activities. Effective water management requires precise monitoring of water levels in diverse applications, including:

- **Reservoirs and Dams:** Ensuring optimal water storage and release for irrigation, hydropower generation, and flood control.
- **River and Lakes:** Tracking water flow, identifying potential flooding risks, and assessing environmental health.
- **Groundwater Wells:** Monitoring groundwater levels to assess aquifer health and predict potential water shortages.
- **Industrial Processes:** Controlling fluid levels in tanks, boilers, and other industrial equipment.

LITERATUREREVIEW

The field of water level measurement has witnessed significant advancements over the years, driven by the increasing demand for accurate and reliable monitoring solutions. A wide range of techniques and technologies have been employed to address the diverse needs of various applications, including hydro logical studies, irrigation management, and flood control.Traditional methods, such as manual gauge readings and float-based sensors, have been used for centuries. However, these methods are often laborintensive, time-consuming, and prone to human error. To overcome these limitations, modern water level measurement systems have emerged, incorporating advanced sensor technologies and data acquisition techniques.

A substantial body of research has focused on the development and application of various sensor technologies for water level measurement. Ultrasonic sensors, pressure sensors, and radar sensors are among the most commonly used techniques. Ultrasonic sensors measure the time taken for a sound wave to travel from the sensor to the water surface and back, enabling accurate distance measurements. Pressure sensors, on the other hand, directly measure the hydro-static pressure exerted by the water column, which can be converted into water level readings. Radar sensors utilize electromagnetic waves to detect the water surface, providing precise measurements even in challenging conditions.

In recent years, the integration of wireless communication technologies and Io T (Internet of Things) concepts has revolutionized water level monitoring. Wireless sensor networks (WSNs) enable the deployment of autonomous sensor nodes in remote locations, facilitating real-time data collection and transmission. Io T-based solutions further enhance the capabilities of water level monitoring systems, enabling remote access, data analytic, and automated decision-making.

While significant progress has been made, there is still a need for further research and development in several areas. These include:

- **Improving sensor accuracy and reliability:** Developing advanced sensor technologies that can withstand harsh environmental conditions and provide accurate measurements over extended periods.
- **Enhancing data processing and analysis:** Implementing sophisticated algorithms for data filtering, noise reduction, and anomaly detection.
- **Advancing wireless communication technologies:** Exploring energy-efficient and reliable wireless communication protocols for remote sensor networks.
- **Developing user-friendly interfaces and data visualization tools:** Creating intuitive interfaces that enable easy access and interpretation of water level data.
- **Addressing security and privacy concerns:** Implementing robust security measures to protect sensitive data and prevent unauthorized access.

By addressing these challenges and leveraging the latest technological advancements, we can continue to improve the accuracy, reliability, and efficiency of water level measurement systems, ultimately contributing to sustainable water resource management.

RESEARCHPLAN

This project "Designing a system to measure water level" will be conducted through a well-defined research strategy comprising several key components, ensuring a thorough exploration and validation of a water level indicator system applicable across diverse geographic regions. The research plan encompasses foundational research, experimental testing, data collection, and development to create a dependable water level monitoring solution for multiple countries.The initial phase will involve a comprehensive literature review to investigate existing water level measurement techniques, including sensor-based monitoring, data analysis, and system architecture. This review will aim to identify established methods, recent advancements, and limitations in current water level monitoring systems. By analyzing past studies and technologies, this phase will provide a solid theoretical foundation, highlight trends, and inform the selection of suitable sensors, algorithms, and deployment models.

After establishing a theoretical foundation, practical testing with different water level sensors will be undertaken to understand their performance under various environmental conditions. Sensors such as ultrasonic, radar, and pressure-based sensors will be tested for accuracy, durability, and adaptability across different climates and regions. These experiments will evaluate sensor capabilities under changing weather conditions, different water types (rivers, lakes, reservoirs), and various altitudes. Collaborations with environmental scientists and local authorities in different countries will help refine sensor selection and calibration methods based on country-specific environmental factors.Collecting diverse datasets is essential for effective monitoring across multiple regions. Datasets representing water level fluctuations from different environments (e.g., arid, tropical, temperate) will be compiled.

Real-time data on water levels, temperatures, and rainfall in each country will be collected to simulate realistic conditions. This data will be instrumental in training algorithms for predicting water level patterns and ensuring that the system can accommodate a wide range of natural water level variations.The water level indicator system will be developed using C++ or Python, leveraging frameworks suitable for IoT and real-time applications. The system's core components will include sensor data processing, water level state classification, and alert management. Python libraries such as Pandas and NumPy will be used for data handling and analysis, while the Flask framework may be integrated for visualizing water levels and alerts in a web-based interface. The system will be designed for compatibility with major operating systems and devices to ensure ease of access in various countries.

The project timeline will outline key phases, including literature review, field testing, system development, data collection, and deployment across different countries. Specific milestones will track progress on sensor calibration, software development, field testing, and final deployment stages. Regular progress assessments will identify potential risks or delays, enabling timely adjustments and ensuring the project adheres to its schedule.By following this structured research plan, the project aims to create a water level indicator system that is accurate, reliable, and adaptable for use in diverse countries. The final solution will provide critical water level data for proactive water management, risk mitigation, and environmental protection across multiple regions, contributing to sustainable water management efforts globally.

SL. No	Description	07/10/2024-11/10/2024	12/10/2024-16/10/2024	17/10/2024-20/10/2024	21/10/2024-29/10/2024	30/10/2024-05/11/2024	07/10/2024-10/11/2024
1.	Problem Identification						
2.	Analysis						
3.	Design						
4.	Implementation						
5.	Testing						
6.	Conclusion						

Fig.1-Timeline Chart

Day 1: Project Initiation and Planning

- Establish the project’s primary objective of developing a secure and efficient water level indicator system capable of monitoring water levels across different countries.
- Conduct research on water level sensing technologies, data transmission methods, and integration frameworks compatible with multi-country setups.
- Evaluate sensor types (e.g., ultrasonic, radar), data transmission protocols, and IoT platforms for efficient, secure data flow.
- Identify and engage key stakeholders (e.g., hydrology experts, environmental agencies, developers, government bodies) to support project planning and decision-making.

Day 2: Requirement Analysis and System Design

- Analyze user needs and technical requirements for the water level monitoring system, including real-time data acquisition, data accuracy, and security requirements for sensitive information.
- Determine key system specifications, such as water level thresholds for alerting, compatible sensor types, and data transmission protocols for secure reporting across different countries.
- Develop a comprehensive architecture, including data flow diagrams, sensor-to-database connections, and cloud-based or local storage frameworks. Design the encryption/decryption workflow for secure data transmission and storage.
- Specify compatible hardware (e.g., sensors, communication devices) and software frameworks, ensuring cross-compatibility with devices and infrastructure in different countries.

Day 3: Core Development and Sensor Integration

- Begin developing core modules to read water levels from sensors, record data, and transmit it securely to the main system.
- Implement threshold-based monitoring and real-time alert functionality to trigger actions based on water levels.
- Integrate algorithms for accurate data collection, including filtering mechanisms to account for environmental factors that may affect sensor readings.
- Develop protocols to transmit sensor data securely to central databases or cloud storage, preventing unauthorized access during transmission. Implement encryption for data integrity.

Day 4: GUI Design and Prototyping

- Design a user-friendly interface that displays real-time water levels, threshold alerts, and historical data for each country. Ensure compatibility across various devices, including mobile and desktop platforms.
- Integrate data visualization components to present water levels, alert thresholds, and trends in an intuitive format for quick user understanding.
- Add features such as secure input validation, country-specific configurations, and user control over threshold settings. Provide options for stakeholders to review and analyze historical data.
- Conduct initial usability tests to gather feedback on interface functionality and user experience, refining the GUI based on suggestions.

Day 5: System Testing, Security Checks, and Performance Optimization

- Create test cases to simulate various security threats, such as unauthorized access attempts and data tampering, ensuring the system's resilience against vulnerabilities.
- Perform end-to-end testing, simulating real-world usage across different countries to ensure the system's reliability in measuring, reporting, and storing water level data.
- Refine data processing and transmission protocols for efficiency, minimizing latency in data updates while maintaining accuracy.
- Ensure that the system meets industry standards for data security, water level accuracy, and usability, building trust with stakeholders.

Day 6: Documentation, Deployment, and Feedback Collection

- Document the development process, covering system architecture, sensor integration, data processing methodologies, and security measures.
- Prepare the system for deployment, ensuring compatibility with various devices and communication networks used across different countries.
- Deploy the system for beta testing with key stakeholders and end-users. Collect insights on system usability, data accuracy, and alert functionalities to identify areas for improvement.
- Organize feedback sessions to discuss user experiences and gather recommendations. Use these insights to refine and optimize the system for enhanced usability, security, and performance.

METHODOLOGY

Designing a secure water level indicator system involves a structured methodology, integrating sensorbased data acquisition, threshold-based monitoring, and secure data handling. The following methodology outlines the process across several key phases, from requirements analysis to system optimization, with a focus on developing a reliable, efficient, and secure system to monitor and report water levels in real time.

1. **Requirements Analysis**

In this phase, system requirements are defined to understand the scope of the water level indicator. Key objectives include data accuracy, reliability, real-time monitoring, and secure data handling. Use cases, such as water level monitoring for reservoirs, flood prediction, and irrigation control, are evaluated to determine data granularity and sensitivity. This phase concludes with a detailed requirements specification, providing a foundation for designing a robust system.

2. Literature Review and Technology Assessment

A review of existing water level measurement systems and sensor technologies is conducted to understand their limitations and identify optimal solutions. Various sensor types—such as ultrasonic, radar, and pressure sensors are assessed for their precision, compatibility with environmental conditions, and reliability. This phase also includes exploring data encryption techniques for secure data transmission and storage to protect against unauthorized access.

3. System Design

The system design phase focuses on creating a secure and modular architecture for water level monitoring. Key components include:

- **Data Acquisition Module**: Sensors capture water level data and transmit it to a central processing unit. Calibration algorithms ensure accurate measurements under different conditions.
- **Data Processing Module**: This module filters and processes the raw sensor data. Thresholds are set to categorize water levels (e.g., LOW, NORMAL, HIGH), which trigger specific actions for water management.
- **Alert and Control Module**: Based on water levels, this module activates actuators such as irrigation systems and sends alerts if levels exceed certain thresholds.
- **Data Encryption Module**: Implements encryption (e.g., AES) for secure transmission of water level data, ensuring that only authorized users can access sensitive information.

System architecture diagrams and flowcharts are created to guide the development process and provide a visual reference for secure data flow and control logic.

4. Prototype Development

This phase involves developing a functional prototype using programming languages like Python and C++ to implement the sensor data processing and control modules. Relevant libraries are used for sensor interfacing and secure data handling, such as Serial for sensor communication and Cryptocurrency for encryption. The prototype is designed to integrate seamlessly with common hardware, including microcontrollers and IoT devices.

5. Security Implementation

Security mechanisms are integrated to ensure data confidentiality and integrity:

- **Data Encryption (AES)**: Protects water level data during transmission, preventing unauthorized interception.
- **Authentication and Access Control**: Role-based access ensures that only authorized users can configure thresholds and access sensitive data.
- **Tamper Detection**: Implementing tamper detection mechanisms on sensors to ensure data authenticity and system integrity.

6. Testing and Validation

Rigorous testing is conducted to validate system functionality, accuracy, and security:

- **Functional Testing**: Verifies sensor accuracy, water level categorization, and actuator response.
- **Performance Testing**: Evaluates system responsiveness under high data loads and varying environmental conditions.
- **Security Testing**: Includes penetration testing and vulnerability assessments to identify potential security gaps and ensure secure data transmission.

7. Optimization and Evaluation

Based on testing results, optimization techniques are applied to enhance system performance, particularly focusing on minimizing latency in data processing and improving encryption efficiency. The system is evaluated for scalability to handle high-frequency monitoring needs in large-scale applications, such as flood control and agricultural management. Feedback from stakeholders helps refine usability and adjust features to better meet real-world requirements.

8. Documentation and Reporting

Comprehensive documentation is prepared, detailing system design, security protocols, testing procedures, and findings. User manuals, technical specifications, and research reports are created to assist in system deployment, maintenance, and future enhancements.

9. Tools and Technologies

Key tools and technologies used in the development process include:

- **Programming Languages**: Python for data processing and C++ for hardware interfacing.
- **Sensor Libraries**: PySerial and Adafruit libraries for sensor integration.
- **Encryption Libraries**: PyCryptodome for implementing secure data handling.
- **Development Environments**: Visual Studio Code and Arduino IDE for programming and testing.
- **Testing Tools**: Wireshark for monitoring data packets and ensuring secure transmission.

RESULT

Figure1 This C++ code demonstrates a system for monitoring water levels across multiple countries and controls an irrigation system based on predefined thresholds. It includes simulation, water state classification, and data logging functionalities, with the setup and execution managed within the Embarcadero Dev-C++ IDE.

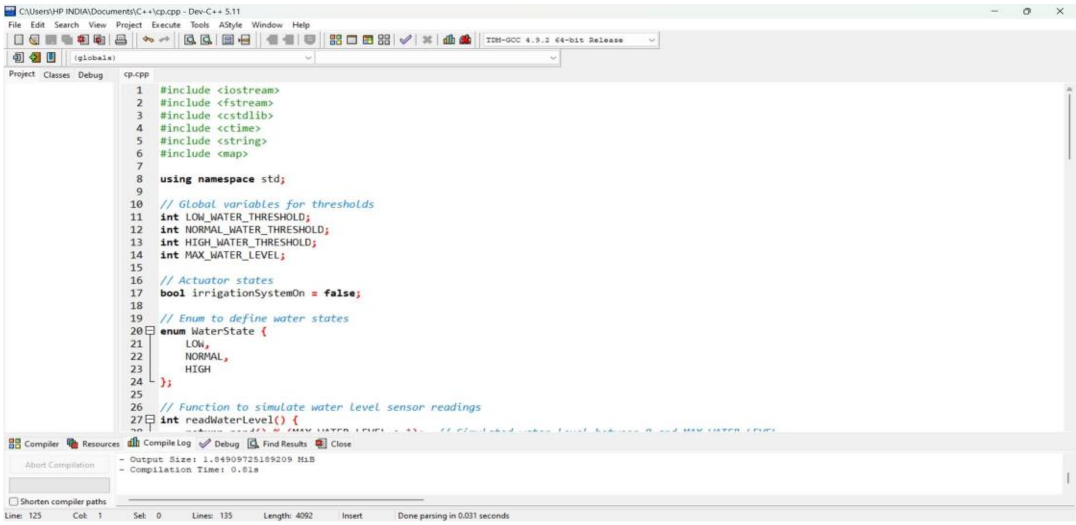

Fig.1:Measuring Water level Code Implementation in C++

Figure2 The program is successfully compiled and running, awaiting input to set the water level thresholds and define the number of countries for water level monitoring.Prompting for User Input: The program first prompts the user to enter threshold values, including low, normal, and high water levels, along with the maximum allowable water level.

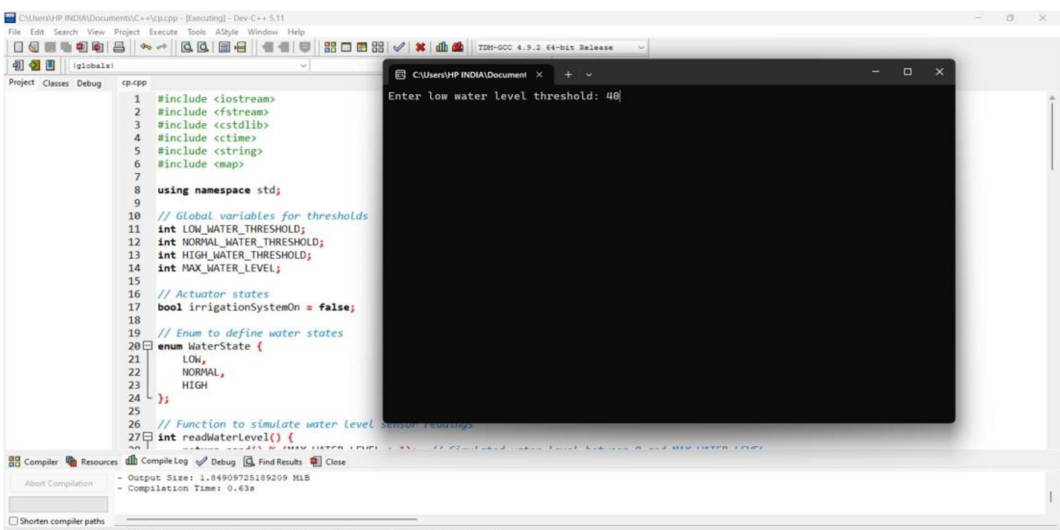

Fig.2: Measuring Water level Program Prompt

Figure 3 The program begins by declaring global variables for different water level thresholds (LOW, NORMAL, HIGH) and a maximum water level limit. Users are prompted to input these thresholds and the number of countries to monitor. These thresholds serve as criteria for categorizing water levels and controlling the irrigation system, ensuring responses are tailored to specific conditions.

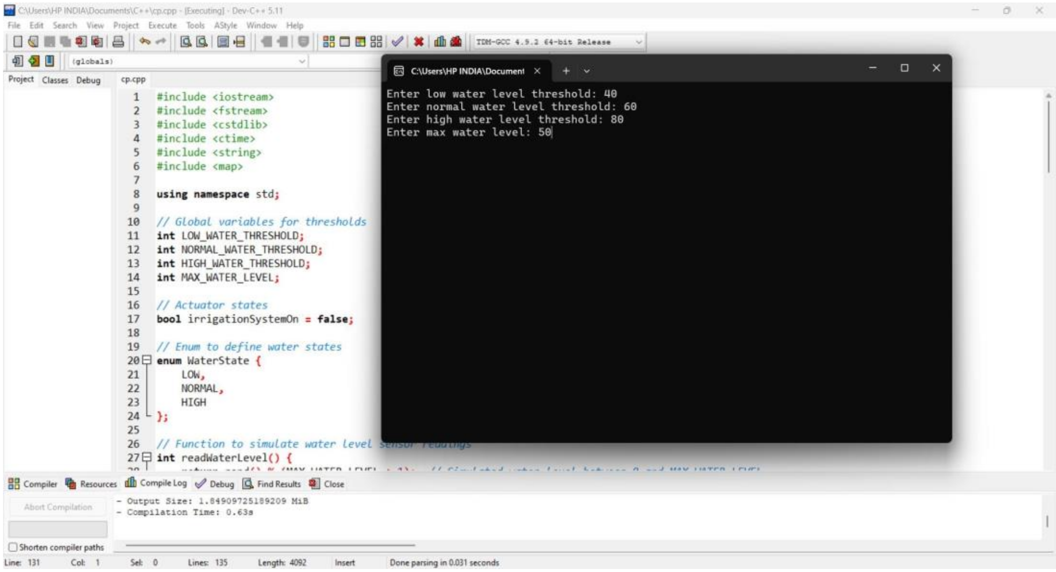

Fig.3: Measuring Water level Program with Input Text(Low,Normal,High,Max water level)

Figure 4 Data for each country, including the country name, water level, and water state, is logged into a text file. The log-data function writes information to "water_level_log.txt," creating a record of water levels and irrigation actions. This provides traceability and supports data analysis for future decisionmaking.

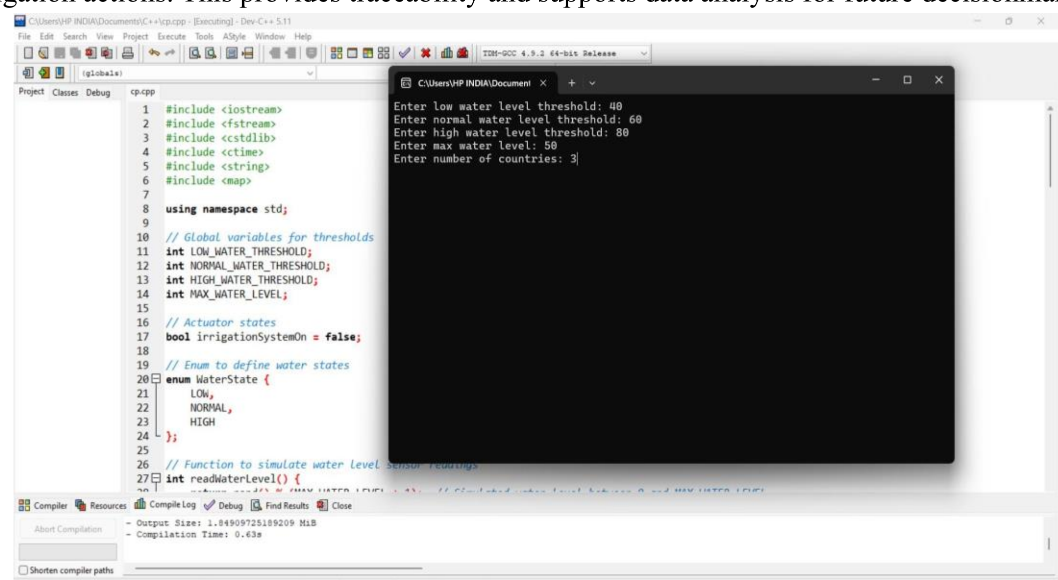

Fig.4:Measuring Water level Program with Input Text for number of Countries

Figure 5The program successfully outputs each country's current water level and irrigation system status. However, depending on the number of countries and iterations, the program may experience a delay in execution time due to the logging process and condition checks. This delay can be minimized by optimizing the code structure, particularly within loops.The simulation successfully provides insights into water level management across multiple countries, with potential applications in agriculture and water resource management.

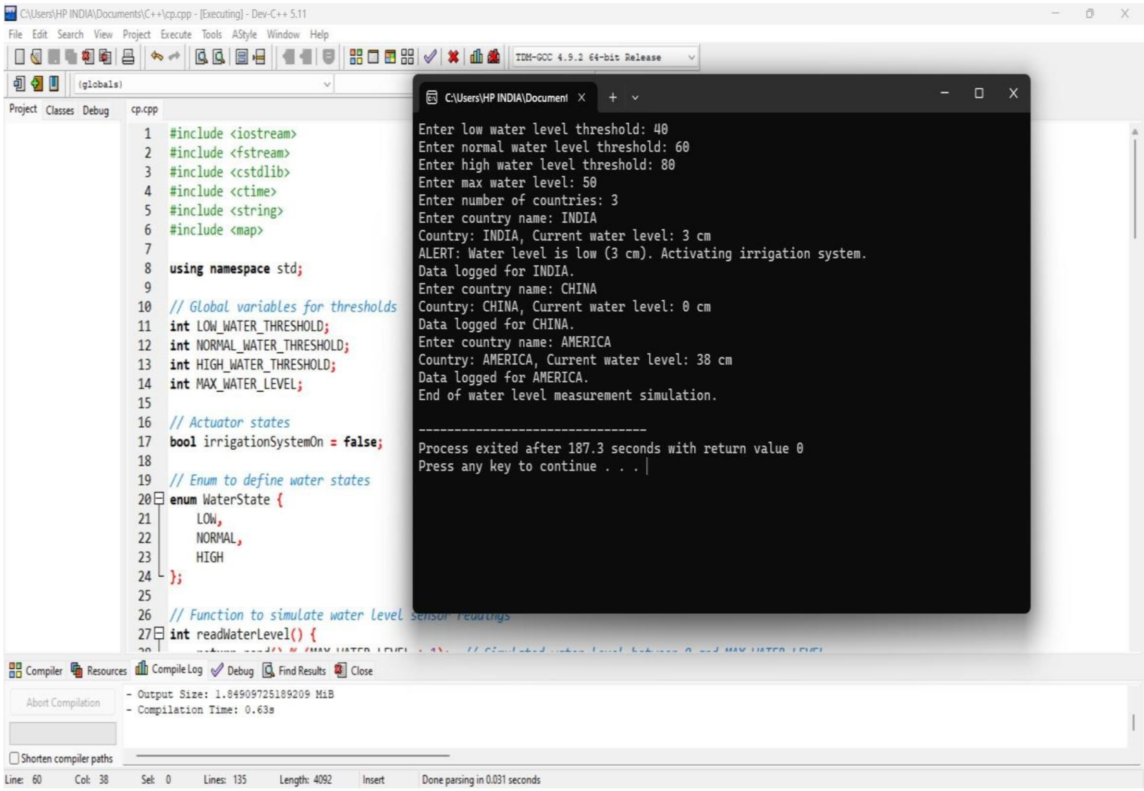

Fig.5:Measuring Water level Program Output with Current Water Level of each Country

CONCLUSION

In Conclusion,Designing a system to measure water levels across different countries offers a critical solution for monitoring and managing water resources effectively. Traditional water measurement methods, while useful, often lack the advanced features needed for real-time, automated response to changing water levels. By implementing a system with adjustable thresholds for low, normal, and high water levels, water resources can be better monitored, and appropriate actions can be triggered automatically based on real-time data.

The water level indicator system developed in this project represents an efficient and effective solution for monitoring water levels, contributing to improved water management and resource conservation. By setting thresholds for low, normal, and high water levels, the system provides real-time status updates that can automatically trigger necessary actions, such as activating an irrigation system during low water conditions. The system's use of real-time monitoring and logging ensures accurate data collection and aids in historical analysis, which can be instrumental in anticipating trends and preparing for environmental changes.

With adaptability to various environments and ease of customization for specific threshold settings, this water level indicator is a valuable tool for regions facing challenges related to water scarcity, flood management, or agriculture. It enables a proactive approach to water management, reducing human error and enhancing reliability in response to fluctuating water levels. This project lays the foundation for scalable, smart water management solutions that can support sustainability efforts and improve resilience against water-related challenges in diverse ecosystems.

The integration of automated monitoring and response mechanisms ensures that water level information remains accurate and current, allowing for timely responses that can prevent issues like drought impact, water scarcity, or flooding. By logging water data continuously, this system provides a foundation for data-driven analysis, offering insights that can support better resource planning and management. Additionally, applying this water level measurement system across various countries makes it adaptable for different environmental needs and geographical conditions, promoting scalable water management solutions globally.

This system is particularly valuable in sectors where water management is crucial, such as agriculture, disaster prevention, and urban infrastructure. Furthermore, it aligns with global efforts to improve environmental sustainability and resource conservation, as it enhances water management efficiency and reduces the likelihood of resource wastage. As the need for effective water management intensifies worldwide, this water level indicator system can help organizations and governments build more resilient water monitoring frameworks, ensuring the preservation and responsible use of water resources in a changing global landscape.

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IMPLEMENTATION CODE

```
#include <iostream>
#include <fstream>
#include <cstdlib>
#include <ctime>
#include <string>
#include <map>
using namespace std;
// Global variables for thresholds
int LOW_WATER_THRESHOLD; int
NORMAL_WATER_THRESHOLD; int
HIGH_WATER_THRESHOLD; int
MAX_WATER_LEVEL;

// Actuator states
bool irrigationSystemOn = false;

// Enum to define water states
enum WaterState {
    LOW,
    NORMAL,
    HIGH
};

// Function to simulate water level sensor readings int
readWaterLevel() {
    return rand() % (MAX_WATER_LEVEL + 1);   // Simulated water level between 0 and
MAX_WATER_LEVEL
}
```

```
// Function to determine the water state based on the water level
WaterState getWaterState(int waterLevel) {
    if (waterLevel < LOW_WATER_THRESHOLD) {
        return LOW;
    } else if (waterLevel < NORMAL_WATER_THRESHOLD) { return
        NORMAL;
    }  else  {  return
        HIGH;
    }
}

// Function to control the irrigation system based on the water state
void controlIrrigationSystem(int waterLevel) {
    WaterState state = getWaterState(waterLevel);
    switch    (state)    {
        case LOW:
            if (!irrigationSystemOn) {
                irrigationSystemOn = true;
                    cout << "ALERT: Water level is low (" << waterLevel << " cm).           Activating irrigation
system.\n";
            }
            break;     case
        NORMAL:
            if (irrigationSystemOn) {
                irrigationSystemOn = false;
                cout << "Water level is normal (" << waterLevel << " cm). Irrigation system OFF.\n";
            } break;
        case
        HIGH:
            if (irrigationSystemOn) {
                irrigationSystemOn = false;
                cout << "Water level is high (" << waterLevel << " cm). Irrigation system OFF.\n";
            }
            break;
    }
}

// Function to log data
void logData(const string& country, int waterLevel, WaterState state) {
    ofstream logFile("water_level_log.txt", ios_base::app); if
    (logFile.is_open()) { string stateStr;
        switch (state) {
```

```
            case LOW: stateStr = "LOW"; break; case
            NORMAL: stateStr = "NORMAL"; break;
            case HIGH: stateStr = "HIGH"; break;
        }
        logFile << "Country: " << country << ", Water Level: " << waterLevel << " cm, State: " << stateStr
<< "\n";
        logFile.close();
    } else { cerr << "Error opening log
        file.\n";
    }
}

int main() {
    // Seed for random number generation
    srand(static_cast<unsigned int>(time(0)));

    // User input for thresholds cout << "Enter
    low water level threshold: "; cin >>
    LOW_WATER_THRESHOLD;
    cout << "Enter normal water level threshold: ";
    cin >> NORMAL_WATER_THRESHOLD;
    cout << "Enter high water level threshold:
    "; cin >> HIGH_WATER_THRESHOLD;
    cout << "Enter max water level: "; cin >>
    MAX_WATER_LEVEL;

    // Map to store countries and their water levels
    map<string, int> countries; //
    Number of countries to input
    int numCountries;
    cout << "Enter number of countries: "; cin
    >> numCountries;

    // Input countries and simulate water level readings for each
    for (int i = 0; i < numCountries; ++i) {
        string country; cout << "Enter
        country name: "; cin >>
        country;

        // Simulate reading the water level for this country int
        waterLevel = readWaterLevel();
        cout << "Country: " << country << ", Current water level: " << waterLevel << " cm\n";

        // Control the irrigation system based on the water level controlIrrigationSystem(waterLevel);
```

```
        // Determine the water state
        WaterState state = getWaterState(waterLevel);

        // Log the water level data logData(country,
        waterLevel, state);

        // Simulate time passing (optional message to indicate progress)
        cout << "Data logged for " << country << ".\n";
    } cout << "End of water level measurement
    simulation.\n"; return 0;
}
```