IOT Based Automatic Water Pumping System

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Abstract- *This report outlines the design and implementation of an IoT-based automatic water pumping system. With the growing need for efficient water management, leveraging IoT technology offers a promising solution for remote monitoring and automation. The system incorporates sensors to detect water levels, a microcontroller for decision-making, actuators to control the pump, and communication modules for data transmission. Thorough testing ensures the system's functionality, reliability, and security. By addressing these aspects, developers can deliver a robust IoT-based solution for automatic water pumping, contributing to sustainable water management practices.*

I. INTRODUCTION

INDUSTRIAL VERTICAL AND DOMAIN TECHNOLOGY

INDUSTRIAL VERTICAL:

SMART CITY :

Smart city initiatives often intersect with manufacturing in various ways, such as implementing advanced technologies like Internet of Things (IoT) sensors and data analytics to optimize manufacturing processes, reduce waste, and enhance productivity. Additionally, smart cities may prioritize sustainable manufacturing practices to minimize environmental impact. This integration fosters innovation, efficiency, and sustainability within urban manufacturing hubs, contributing to the overall development and competitiveness of the city.

DOMAIN TECHNOLOGY:

INTERNET OF THINGS:

The Internet of Things (IoT) refers to the network of interconnected devices embedded with sensors, software, and other technologies, enabling them to collect and exchange data over the internet. These devices can range from everyday objects like smartphones and wearable devices to specialized industrial equipment and infrastructure components. In a smart city context, IoT plays a crucial role in gathering real-time data from various sources such as traffic lights, environmental.

INTRODUCTION:

DESIGN THINKING CONCEPTS :

Design thinking is a human-centered problem-solving approach that emphasizes understanding user needs, generating creative solutions, and iteratively prototyping and testing those solutions to arrive at innovative outcomes. It involves empathizing with users, defining the problem, ideating possible solutions, prototyping ideas, testing them with users, and iterating based on feedback. This iterative process fosters collaboration, creativity, and a bias towards action.

THE FIVE STAGES OF DESIGN THINKING

Design thinking follows a five-stage framework

1. EMPATHY

Empathy, in the context of this project, involves understanding and connecting with the end-users of the Amazon clone. It requires the development team to empathize with the needs, preferences, and challenges users may face while navigating and making transactions on the platform.

2. DEFINE

In this second stage, you gather your observations from the first stage to define the problem you're trying to solve. Think about the difficulties your consumers are brushing up against, what they repeatedly struggle with, and what you've gleaned from how they're affected by the issue. Once you synthesize your findings, you are able to define the problem they face.

3. IDEATE

Ideation involves the generation of creative and innovative ideas for features, design elements, and user interactions within the Amazon clone. This phase encourages brainstorming to explore various possibilities that can enhance the user experience and differentiate the clone from the original.

4. PROTOTYPE

Prototyping is the creation of a preliminary version of the Amazon clone, allowing for visual representation and interaction with key features. Prototypes serve as a tangible demonstration, helping the team and stakeholders better understand the user interface, flow, and overall functionality before full-scale development.

5. TEST

Testing involves evaluating the prototype to identify strengths, weaknesses, and areas for improvement. User testing, in particular, allows for real users to interact with the prototype, providing valuable feedback on usability, navigation, and any issues encountered. This iterative process ensures that the Amazon clone aligns with user expectations and resolves potential issues.before the final implementation.

CHAPTER 1

EMPATHY

Empathy is the first step in design thinking because it is a skill that allows us to understand and share the same feelings that others feel. Through empathy, we are able to put ourselves in other people's shoes and connect with how they might be feeling about their problem, circumstance, or situation.

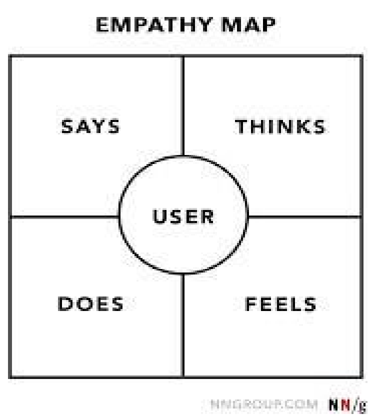

FIGURE 1.1

Lengthy Terms and Conditions

Empathizing with an automatic water pumping system involves acknowledging its role as a vital component of water infrastructure. Understand the challenges it faces, such as fluctuating water demand and external factors like weather conditions affecting its performance. Appreciate the need for reliability, ensuring a consistent water supply for daily activities and emergencies. Consider the system's energy efficiency, recognizing the importance of sustainable and cost-effective operation. Ultimately, empathizing means recognizing the impact the system has on people's lives and well-being, emphasizing the importance of a reliable and efficient water supply. Sometimes many of the people were forgot to turn the motor in their busy situation so, many of the people were requesting to get a machine . when after going to bath many of the people were saying about the water was finished in the tank. Many of the apartment owner saying about that they were keeping worker for turn on and off the motor .

EMPATHY OF OUR PROJECT :

HOUSE OWNER 1: Sometime I forgot to turn off the motor when I am busy with work.

APPARTMENT OWNER : I have a worker to turn ON/OFF the motor ,paying him 8000/- per month.

HOUSE OWNER 2 : Before going to take bath ,it will be nice if I know the level of water in the tank.

CHAPTER 2

DEFINE

The next step is to define the above feelings and identify the main problem to be solved. It's important that, throughout this process, students use language that is identifiable, positive, meaningful, and actionable. Instead of focusing on the negative side of the problem and the lack of options, steer students to using language that is positive, empathetic, and will direct them toward solution-based thinking. Defining the problem is part of the process of shaping a point of view -- our own and others' about the problem. Therefore, the framing should inspire the group, the student, or the entire class to find solutions

FIGURE 1.2

DEFINE FOR OUR PROJECT:

A lot of water and electricity is wasted because of not turning OFF the motor at the right time**.**

CHAPTER 3

IDEATE

Ideation is the third stage of the design thinking process where participants in a design thinking workshop come up with ideas on how to solve a specific user problem. The design thinking process is made up of three phases: empathize, ideate, and prototype.

The ideation phase of design thinking is guided by the user problems that were defined during the empathize phase. Ideation is about the exploration and identification of potential solutions. Not all ideas will be viable solutions, and that's okay. The primary goal of ideation is to spark creativity and innovation.

FIGURE 1:3

IDEATE OF OUR PROJECT

1.Smart Tank Sensors: Install ultrasonic sensors inside water storage tanks to accurately measure water levels in real-time.

2. Pump Control Unit: Develop a control unit equipped with microcontrollers and actuators to automatically start or stop the water pump based on the water level readings from the sensors.

3. Mobile Application: Create a user-friendly mobile app for administrators to remotely monitor the water levels, pump status, and system performance. The app should also allow manual control override if necessary.

4. Data Analytics: Implement data analytics algorithms to analyze historical water usage patterns and predict future demand. This information can be used to optimize pump scheduling and minimize energy consumption.

5. Alert System: Integrate an alert system that sends notifications to administrators via SMS or email in case of abnormal water levels, pump failures, or other critical issues.

6. Energy Efficiency: Incorporate energy-efficient components and algorithms to minimize power consumption, such as using variable speed drives for the pump motor and optimizing pump operation based on demand.

7. Scalability: Design the system to be easily scalable to accommodate different tank sizes and water distribution networks. Additional sensors and pumps can be added as needed without significant modifications to the existing infrastructure.

8. Remote Monitoring: Enable remote monitoring of the system's performance and health parameters, including pump efficiency, power consumption, and sensor accuracy, temperature monitoring to ensure continuous operation and timely maintenance.

9. Integration with Smart Grids: Explore opportunities to integrate the water pumping system with smart grid technologies to optimize energy usage and coordinate with other utilities for better resource management.

10. Water Quality Monitoring: Optionally, include sensors to monitor water quality parameters such as pH, turbidity, and chlorine levels to ensure the delivered water meets quality standards.

By implementing these features, the IoT-based automatic water pumping system can effectively manage water distribution, reduce waste, and ensure a reliable water supply to residents in urban areas.

CHAPTER 4

PROTOTYPE

The prototype phase is a crucial stage in the design thinking process where the ideas and concepts generated during the ideation phase are transformed into tangible representations or models. The primary objective of this phase is to create a working prototype of the proposed solution to test its feasibility, functionality, and effectiveness.

PROTOTYPE FOR OUR PROJECT:

1. Hardware Components:

- Raspberry Pi (or similar microcontroller) as the central processing unit.
- Ultrasonic sensor for measuring water levels in the storage tank.
- Relay module for controlling the water pump.
- Power source (e.g., battery or AC adapter).
- Optional: LED indicators for visual feedback.

2. Software Components:

- Python code to interface with the ultrasonic sensor and control the relay module.
- Web server using Flask framework for hosting a simple web interface.
- HTML/CSS for designing the user interface.
- Optional: Database (e.g., SQLite) for storing historical data and settings.

3. System Architecture:

- The Raspberry Pi reads data from the ultrasonic sensor to determine the water level.
- Based on the water level readings, the Raspberry Pi activates or deactivates the relay module to control the water pump.
- The Flask web server provides a user interface accessible via a web browser or mobile app, allowing users to monitor water levels and manually control the pump if needed.

4. Functionality:

- The system continuously monitors the water level in the tank.
- If the water level falls below a certain threshold, the pump is automatically activated to refill the tank.
- Once the tank is sufficiently filled, the pump is turned off to prevent overflow and conserve energy.
- Users can access the web interface to view real-time water level data, pump status, and manually control the pump if necessary.

5. Testing and Validation:

- Conduct thorough testing to ensure accurate water level measurements and reliable pump control.
- Validate the system's performance under various scenarios, such as fluctuating water demand and sensor inaccuracies.
- Collect user feedback to identify any usability issues and make necessary improvements.

This prototype serves as a proof of concept for the IoT-based automatic water pumping system and can be further refined and expanded upon for real-world deployment. Additional features, such as remote monitoring, data analytics, and integration with other smart city systems, can be implemented in subsequent iterations.

ARDUINO UNO:

The Arduino Uno board is a popular microcontroller development board based on the ATmega328P microcontroller. It features digital and analog input/output pins that can be used to connect various sensors, actuators, and other electronic components. The Uno is commonly used for prototyping and DIY projects due to its ease of use, low cost, and extensive community support. It can be programmed using the Arduino IDE (Integrated Development Environment), which simplifies the process of writing and uploading code to the board.

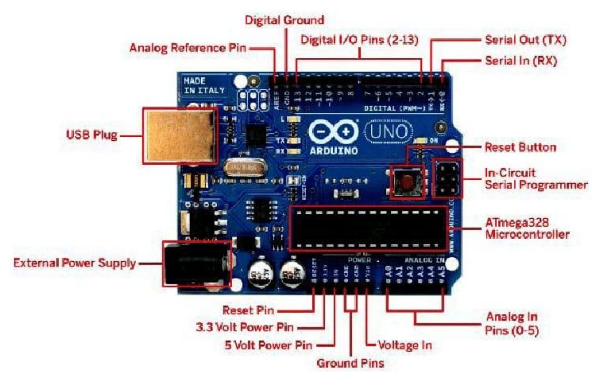

FIGURE 1:4

ULTRAONIC SENSOR:

An ultrasonic sensor is a device that uses sound waves at frequencies higher than the human audible range to measure distances to nearby objects. It typically consists of a transmitter and a receiver, which work together to send and receive ultrasonic pulses.

FIGURE 1:5

Here's how it works:

1. Transmitter: The ultrasonic sensor emits short bursts of ultrasonic waves.
2. Receiver: After emitting the waves, the sensor listens for echoes. When the ultrasonic waves hit an object, they bounce back.
3. Measurement: By measuring the time it takes for the waves to travel to the object and back, the sensor can calculate the distance to the object using the speed of sound in the medium (usually air).

Ultrasonic sensors are commonly used in robotics, automation, and proximity sensing applications. They provide accurate distance measurements and are effective in various lighting conditions and environments. Additionally, they are relatively inexpensive and easy to use, making them popular in DIY projects and commercial applications alike.

RELAY MODULE:

A relay module is an electronic device that allows you to control high-voltage or high-current devices using a low-voltage signal. It typically consists of a relay, which is an electromechanical switch, and a driver circuit that interfaces the relay with a microcontroller or other low-voltage control signal.

Relay modules are commonly used in electronics projects to switch on/off devices such as lights, motors, heaters, or appliances using a microcontroller like an Arduino. They provide isolation between the control circuit (low voltage) and the load circuit (high voltage), which enhances safety and protects the control circuitry.

When the control signal is applied, the relay module energizes the relay coil, causing the switch contacts to close or open, depending on the relay's configuration. This allows the relay module to effectively control the flow of electricity to the connected load.

FIGURE 1:6

Relay modules come in various configurations, including single-channel and multi-channel versions, and they may include additional features such as optoisolation, status LEDs, and protection diodes. They are widely used in automation, robotics, home automation, and industrial applications.

I^2 C MODULE:

It seems like you're referring to the I2C module, also known as the I2C (Inter-Integrated Circuit) communication protocol. It's commonly used in electronics to allow multiple devices to communicate with each other using just two wires (SDA - Serial Data and SCL - Serial Clock).

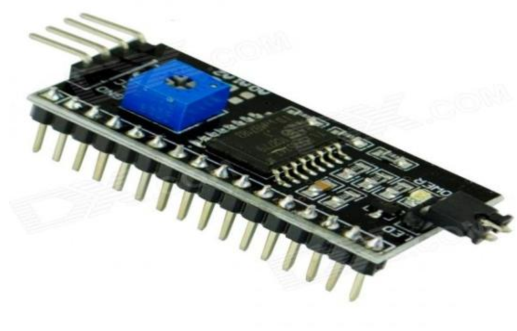

FIGURE 1:7

Here's a brief explanation:

1. Communication: I2C allows multiple devices (like sensors, displays, memory chips, etc.) to communicate with a microcontroller or another device using a simple, two-wire serial interface.

2. Master-Slave: In an I2C setup, there's typically one "master" device (like a microcontroller) that controls the communication and one or more "slave" devices that respond to commands from the master.

3. Addressing: Each slave device in an I2C setup has a unique address assigned to it, allowing the master device to communicate with specific slaves.

4. Synchronous: Communication in I2C is synchronous, meaning that data is transferred based on a clock signal generated by the master device.

5. Speed: The speed of communication in I2C can vary, with standard speeds ranging from 100 kHz to 400 kHz, and high-speed modes going up to several MHz.

I2C modules are commonly used in various electronic projects and devices due to their simplicity and versatility in connecting multiple components together with minimal wiring. They are often used in conjunction with microcontrollers like Arduino, Raspberry Pi, and other embedded systems.

LCD:

LCD stands for Liquid Crystal Display. It's a flat-panel display technology that uses liquid crystals sandwiched between two transparent electrodes and two polarizing filters to create images.

FIGURE 1:8

Here's how it works:

1. Liquid Crystals: Liquid crystals are a state of matter that has properties between those of conventional liquids and those of solid crystals. They can change their orientation in response to an electric current.

2. Polarizing Filters: LCDs have two polarizing filters, one at each end. These filters allow only certain orientations of light to pass through.

3. Electric Field: When an electric current is applied to the liquid crystals, their orientation changes. This change in orientation affects how light passes through them, altering the amount of light that reaches the viewer's eye.

4. Pixels: The display is divided into pixels, each containing a tiny cell filled with liquid crystals. By controlling the electric current applied to each pixel, different colors and shades can be produced.

LCDs are commonly used in electronic devices such as televisions, computer monitors, smartphones, and digital watches due to their thin profile, lightweight, and ability to display sharp images and text. They come in various types, including twisted nematic (TN), in-plane switching (IPS), and organic light-emitting diode (OLED) displays, each with its own characteristics and advantages. Additionally, LCDs are also frequently used in conjunction with microcontrollers and other electronic components in DIY projects, especially in combination with devices like Arduino or Raspberry Pi for displaying data or user interfaces.

MINI PUSH BUTTON:

A mini push button is a type of momentary switch that is typically small in size and designed to be pressed briefly to make or break an electrical connection. Here's a breakdown,

FIGURE 1:9

1. Size: Mini push buttons are compact and usually feature a small button that can be pressed with a finger or a small tool**.**

2.Functionality: They are "momentary" switches, meaning they only maintain contact while the button is pressed. When released, they return to their original state, breaking the connection.

3. Application: Mini push buttons are commonly used in electronic devices and circuits for various purposes, such as triggering actions in microcontroller-based projects (e.g., turning on a light, sending a signal, etc.), reset buttons on electronic devices, or as tactile switches in consumer electronics like remote controls or handheld devices.

4. Varieties: They come in various configurations, including normally open (NO), normally closed (NC), or both (SPDT), depending on the specific application requirements.

Overall, mini push buttons are simple yet essential components in electronic circuits, providing a convenient way to control and interact with devices.

JUMPER WIRE:

A jumper wire is a short wire used to connect two points on a circuit board or electronic component, typically to bypass or complete a connection. They're often used for prototyping, troubleshooting, or making temporary connections in electronic projects.

FIGURE 2:1

ON/OFF SWTICH:

An on-off switch is a simple electronic component used to control the flow of electricity in a circuit. It allows you to either complete or break the circuit, turning a device or system on or off respectively. These switches are commonly found in various electronic devices, appliances, and machinery.

FIGURE 2:2

BREAD BOARD:

A breadboard is a reusable solderless prototyping tool used to build and test electronic circuits. It consists of a plastic board with a grid of holes, into which electronic components and wires can be inserted. Breadboards are commonly used by hobbyists, students, and professionals to quickly prototype circuits without the need for soldering, allowing for easy experimentation and modification.

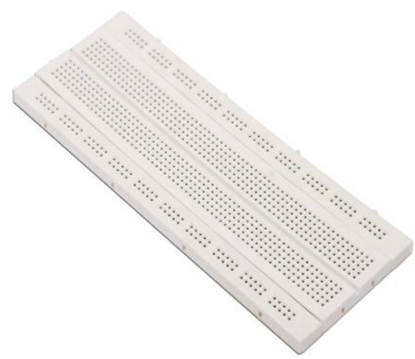

FIGURE 2:3

WATER TANK:

A water tank is a container designed for the storage, distribution, and management of water. It plays a crucial role in various applications, from residential to industrial settings. Here's detailed information about water tanks:

1. Material:

- Polyethylene (Plastic): Common in residential applications due to its durability, lightweight nature, and resistance to corrosion.
- Fiberglass: Used for underground or above-ground installations, known for its strength and corrosion resistance.
- Concrete: Suitable for large-scale storage, especially in industrial or municipal setups. It provides stability and is resistant to external elements.

- Steel: Used in industrial and commercial applications, steel tanks are robust and can handle high-pressure situations.

2. Types:

- Elevated Tanks: Positioned on towers or rooftops, utilizing gravity for water distribution.
- Ground-Level Tanks: Typically installed at or below ground level, suitable for both residential and industrial purposes.
- Underground Tanks: Buried underground, conserving space and protecting against external elements. Common in urban areas.

3. Capacity:

- Water tanks come in various sizes, ranging from small household tanks to large industrial reservoirs, with capacities measured in gallons or liters.

4. Uses:

- Domestic Water Storage: Supplying water for household needs, including drinking, bathing, and irrigation.
- Agricultural Water Storage: Supporting irrigation systems for crops.
- Industrial Water Reservoirs: Providing a stable water supply for manufacturing processes.
- Fire Water Storage: Ensuring a readily available water source for firefighting purposes.

5. Maintenance:

- Regular cleaning and maintenance are essential to prevent contamination and ensure water quality.
- Inspection for leaks, corrosion (in metal tanks), and proper functioning of valves and outlets.

6. Installation:

- Proper installation is crucial to ensure stability, prevent leaks, and comply with local regulations.
- Consideration of factors such as seismic activity, soil conditions, and climate.

7. Accessories:

- Tanks may include features such as overflow pipes, level indicators, inlet/outlet valves, and access hatches for inspection and maintenance.

8. Water Quality:

- Tanks should be designed to prevent algae growth and contamination. Regular cleaning and proper sealing are essential.

Understanding the specific requirements of your application, local regulations, and maintenance needs is crucial for selecting and maintaining an appropriate water tank.

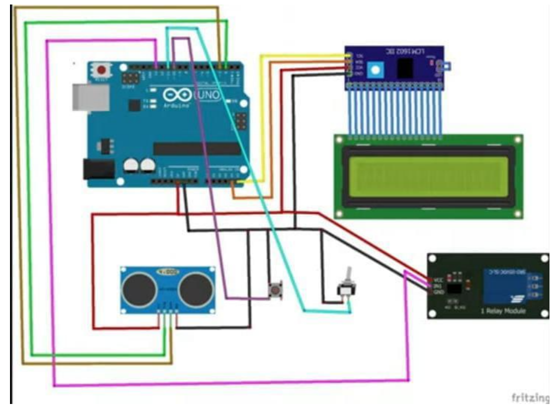

FIGURE 2:4

Circuit Diagram:

- The water level sensor is connected to the microcontroller to provide real-time water level data.
- The microcontroller is connected to the Wi-Fi module to enable communication with the internet.
- The relay module is connected to the microcontroller to control the power supply to the water pump.
- The water pump is connected to the relay module to receive power when

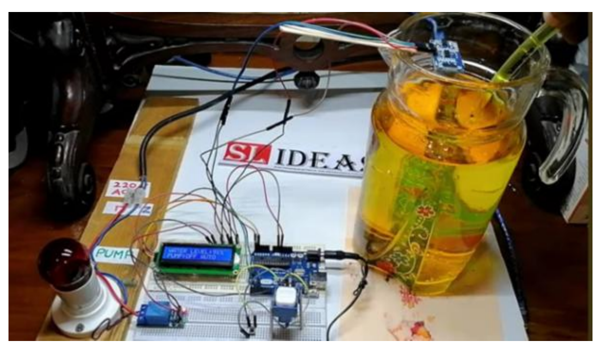

FIGURE 2:5

Here's an overview of a prototype for an IoT-based automatic water pumping system:

1. Objective: The objective of this prototype is to demonstrate an automated system for monitoring and controlling water levels in a tank or reservoir, and automatically activating a water pump when the water level falls below a certain threshold.

2. Operation:

- The water level sensor continuously measures the water level in the tank or reservoir.
- The microcontroller reads the sensor data and determines if the water level is below a predefined threshold.
- If the water level is below the threshold, the microcontroller activates the relay module to turn on the water pump.
- Once the water level reaches the desired level, the microcontroller deactivates the relay module to turn off the water pump.

3. Testing and Iteration:

- Test the prototype to ensure accurate water level measurement and reliable pump activation.
- Identify any issues or areas for improvement, such as sensor calibration or connectivity issues.
- Make adjustments to the prototype as needed and repeat testing until satisfactory results are achieved.

4. Demonstration:

- Present the prototype to demonstrate its functionality, including real-time monitoring of water levels and automatic pump activation.
- Explain the potential applications and benefits of such a system, such as conserving water and reducing manual intervention in water management tasks.

By creating and demonstrating this prototype, you can showcase the feasibility and potential of an IoT-based automatic water pumping system for various applications, such as agriculture, irrigation, or smart home systems.

CHAPTER 5

TESTING

Definition

Testing can be undertaken throughout the progress of a Design Thinking project, although it is most commonly undertaken concurrently with the Prototyping stage. Testing, in Design Thinking, involves generating user feedback as related to the prototypes you have developed, as well as gaining a deeper understanding of your users. When undertaken correctly, the Testing stage of the project can often feed into most stages of the Design Thinking process: it allows you to Empathize and gain a better understanding of your users; it may lead to insights that change the way you Define your problem statement; it may generate new ideas in the Ideation stage; and finally, it might lead to an iteration of your Prototype. Currently Our TLDR bot is live and can be used by anyone Importance of Testing. Testing is the chance to get a product out into the world, test it in real life, and test it in real time. During this phase you have a chance to see if you've framed the problem correctly. Your team can generate user feedback particular to the prototype, and this feedback in turn deepens your understanding of the users. You'll find ideas are generates that feed into all stages of the process during iterations. Lastly, observation during this stage will likely uncover needs that user had never before articulated.

TESTING FOR OUR PROJECT

Testing for an IoT-based automatic water pumping system involves several steps to ensure its functionality, reliability, and security:

1. Unit Testing: Test individual components of the system, such as sensors, actuators, microcontrollers, and communication modules, to ensure they operate correctly in isolation.

2. Integration Testing: Verify that all components work together as expected. This includes testing sensor data transmission to the controller, controller logic for activating the pump, and pump operation based on received commands.w AA

3. Functional Testing: Validate the functionality of the entire system according to its specifications. This involves testing scenarios such as turning the pump on/off based on sensor data, handling communication failures, and responding appropriately to user commands.

4. Performance Testing: Assess the system's performance under normal and peak load conditions. Measure factors such as response time, throughput, and resource utilization to ensure the system can handle its expected workload.

5. Security Testing: Identify and address potential security vulnerabilities, such as unauthorized access to the system or data, insecure communication channels, and vulnerabilities in the IoT devices themselves.

6. Reliability Testing: Test the system's reliability by simulating various failure scenarios, such as sensor malfunctions, communication disruptions, or power outages. Verify that the system can recover gracefully and continue to operate correctly after such events.

7. Usability Testing: Evaluate the system's usability from the perspective of end-users. Ensure that the user interface is intuitive and easy to use, and that users can understand and interact with the system effectively.

8. Compatibility Testing: Test the system's compatibility with different devices, browsers, and operating systems, especially if it includes a user interface accessible via web or mobile applications.

9. Regulatory Compliance Testing: Ensure that the system complies with relevant regulations and standards, such as those related to safety, electromagnetic compatibility, and data privacy.

By conducting thorough testing across these areas, developers can ensure that the IoT-based automatic water pumping system operates reliably, securely, and effectively in real-world conditions.

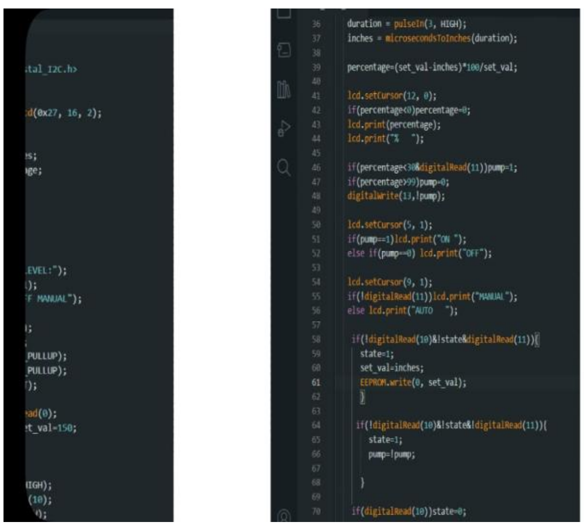

FIGURE 2:6

PROGRAM CODING :

```
const int trigPin = 9;  // Arduino pin connected to the trigger pin of the ultrasonic sensor
const int echoPin = 10; // Arduino pin connected to the echo pin of the ultrasonic sensor
const int pumpPin = 7;  // Arduino pin connected to the relay or pump control

void setup() {
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);
  pinMode(pumpPin, OUTPUT);

  Serial.begin(9600);
}

void loop() {
  long duration, distance;

  // Trigger ultrasonic sensor to send a pulse
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);

  // Measure the time it takes for the pulse to return
  duration = pulseIn(echoPin, HIGH);

  // Calculate distance in centimeters
  distance = duration * 0.034 / 2;

  // Print distance to serial monitor
  Serial.print("Distance: ");
  Serial.println(distance);

  // Check if distance is less than a threshold (adjust as needed)
  if (distance < 10) {
    // Water level is low, turn on the pump
    digitalWrite(pumpPin, HIGH);
  } else {
    // Water level is fine, turn off the pump
    digitalWrite(pumpPin, LOW);
  }

  delay(1000);  // Adjust delay as needed
}
```

VI. CONCLUSION

In conclusion, an IoT-based automatic water pumping system offers numerous benefits such as efficient water management, remote monitoring, and automation. However, its successful implementation relies heavily on thorough testing to ensure functionality, reliability, security, and compliance with regulations. By conducting comprehensive testing across various aspects of the system, developers can mitigate risks and deliver a robust solution that meets user needs and operates effectively in real-world conditions.

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