SMART WATER TANK MONITORING SYSTEM USING IoT

Dr.K.Selvavinayaki, Dean School of Computer Science , Nehru Arts and Science College, Coimbatore. E-Mail:nascselvavinayaki@nehrucolleges.com
M.Vijay, M.Jishnu, S.Sai kiran, III BCA, Department Of Computer Applications, Nehru Arts and Science College, Coimbatore. ,E-Mail:Msvijayvijay3@gmail.com,

ABSTRACT:
This study introduces a state-of-the-art approach to water resource management by unveiling a novel Smart Water Tank Monitoring System. Amidst the escalating challenges of water scarcity and sustainable resource management, there is a pressing need for innovative solutions that can offer real-time monitoring and control of water assets. Our proposed system represents a significant leap forward in addressing this need by harnessing the synergy of Internet of Things (IoT) technology and voice interaction capabilities on the Android platform. At its core, the system integrates a suite of cutting-edge sensors, including the DS18b20 temperature sensor, turbidity sensor, and ultrasonic sensor, seamlessly interfaced with an ESP8266 WiFi module for robust data transmission. Key features of our Smart Water Tank Monitoring System include continuous monitoring of critical parameters such as temperature, water quality, and water level within the tank. The collected data is securely relayed to the Firebase Realtime Database for storage and comprehensive analysis, guaranteeing both the integrity and accessibility of the data. A distinguishing aspect of our system is the development of an intuitive Android application equipped with an innovative voice interaction interface.

Keywords: Smart Water Tank Monitoring System, IoT, Voice Interaction, Android Platform, Sustainability, Water Resource Management.

INTRODUCTION:

Water, the elixir of existence, courses through Earth's veins, nurturing ecosystems, sustaining societies, and propelling economies. In an epoch defined by burgeoning populations, rapid urbanization, and climatic upheaval, the conservation and prudent management of water resources stand as imperatives for the prosperity of present and forthcoming generations. Amidst this aquatic crucible, the emergence of the Smart Aquatic Monitoring System heralds a watershed moment in water stewardship and sustainability.

The Smart Aquatic Monitoring System represents a convergence of cutting-edge technology, ecological mindfulness, and user empowerment. By seamlessly integrating avant-garde sensors, IoT connectivity, and cloud-based analytics, this system affords real-time oversight and governance of aquatic reservoirs, empowering users to optimize water usage, obviate waste, and adapt nimbly to shifting conditions. Beyond its technological prowess, the Smart Aquatic Monitoring System embodies a seismic shift in our kinship with water, nurturing a profound reverence for its sanctity and instilling a culture of preservation and custodianship.

This treatise plumbs the depths of the multifaceted Smart Aquatic Monitoring System, unraveling its genesis, raison d'être, applications, and potential ramifications on aquatic governance. Through an exhaustive exploration of its constituent elements, operation, and interface design, we endeavor to illuminate the transformative potential of this technology in addressing exigent aquatic tribulations. Furthermore, we scrutinize the economic, societal, and environmental reverberations of deploying smart aquatic monitoring systems across an array of scales, from individual homesteads to expansive water distribution networks.

In addition to its proximate dividends in aquatic conservation and resource optimization, the Smart Aquatic Monitoring System possesses the potency to catalyze broader societal metamorphoses toward sustainability and resilience. By endowing individuals, communities, and enterprises with data-driven insights and actionable intelligence, this technology engenders a culture of accountability and collective stewardship for aquatic resources. Moreover, through its amalgamation with existing infrastructure and communication meshes, the Smart Aquatic Monitoring System serves as a crucible

for innovation and synergy in the aquatic realm, catalyzing collaborations among stakeholders and propelling advancements in aquatic governance paradigms.
As we chart a course through the labyrinthine currents of contemporary aquatic challenges, the Smart Aquatic Monitoring System emerges as a lodestar, offering pragmatic solutions and kindling a new epoch of aquatic stewardship. Through sustained inquiry, innovation, and implementation, we can unlock the full potential of this technology to fashion a more sustainable and aquatically secure future for all denizens of our watery orb. Join us on this odyssey as we harness the power of ingenuity and collaboration to safeguard our planet's most precious elixir: water.

BACKGROUND AND CONTEXT:

Water management is a central story in the field of contemporary aqua-conservation efforts, closely linked to the pursuit of sustainable resource use. The necessity of effective water management intensifies as humankind's impact on the globe grows, calling for a reconsideration of current monitoring and conservation strategies. In this context of environmental urgency, the Smart Water Tank Monitoring System is born—a cutting-edge light among the traditional waters of tank monitoring techniques.
Gone are the days of archaic float gauges and rudimentary assessments; the Smart Water Tank Monitoring System heralds a new epoch of precision and insight, where every droplet of water bears testimony to the evolving dynamics of resource utilization. Drawing inspiration from the intricate dance of hydrodynamics, this system interlaces the threads of IoT (Internet of Things) technology, real-time data analytics, and intuitive interfaces, creating a tapestry of interconnected sensors and intelligent algorithms.
In the lexicon of innovation, the Smart Water Tank Monitoring System stands as a testament to human ingenuity, a symbol of our capacity to leverage technological prowess in the service of environmental sustainability. With each data point transmitted, each algorithmic inference drawn, we inch closer to a future where water resources are managed with astute precision - a future where the flow of progress harmonizes seamlessly with the rhythm of nature.

As we embark on this odyssey of technological exploration, let us not lose sight of the intrinsic value of water nor the urgency of our stewardship responsibilities. Let us embrace the challenge of sustainable resource management with unwavering resolve, cognizant of the fact that the fate of our aquatic ecosystems hinges upon the choices we make today. With the Smart Water Tank Monitoring System as our guiding beacon, let us navigate the currents of uncertainty with fortitude and foresight, knowing that together, we can forge a path towards a more resilient and water-secure future.

SYSTEM METHODOLOGY:

The micro-controller is the heart of the Smart Water Tank Monitoring System, providing the intelligence and processing power necessary to collect sensor data, analyze it, and communicate with external devices and platforms. In this system, we utilized the ESP8266 micro-controller due to its compact size, low power consumption, and built-in Wi-Fi capabilities.

1. Micro-controller (ESP8266):

The ESP8266 micro-controller is programmed using the Arduino IDE (Integrated Development Environment), which allows us to write and upload code to the micro-controller in the C++ programming language. The code written for the ESP8266 defines the behavior of the system, including how it interacts with sensors, collects data, and communicates with the cloud platform and mobile application.

- Water Level Monitoring: The ESP8266 micro-controller continuously monitors the water level inside the tank using ultrasonic sensors. These sensors emit high-frequency sound waves that bounce off the surface of the water and are then received by the sensor. By measuring the time it takes for the sound waves to travel to the water surface and back, the micro-controller can accurately determine the water level in the tank.

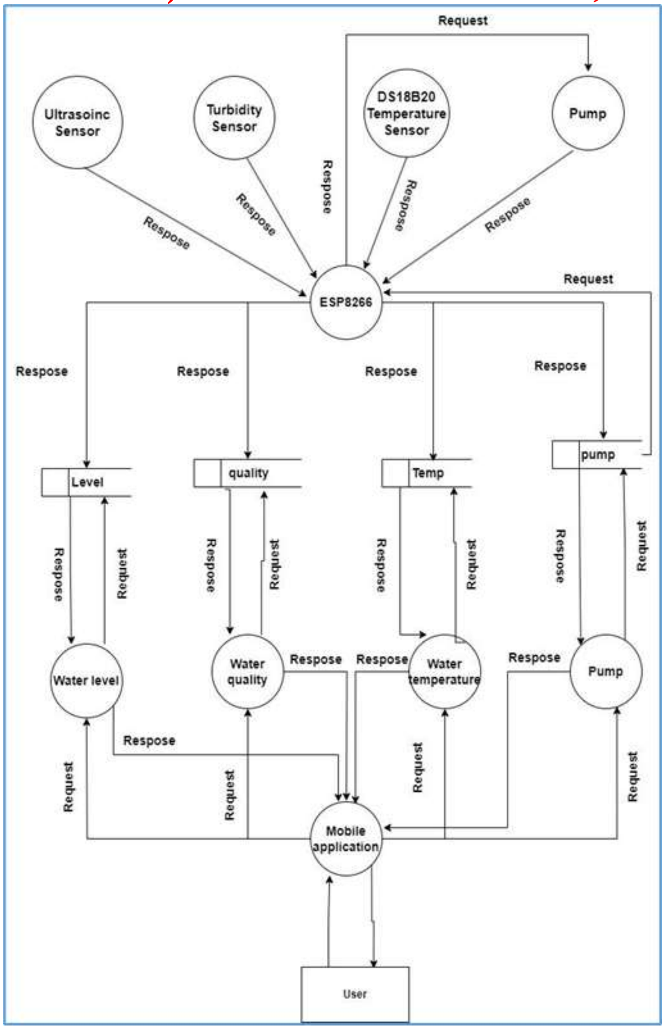

Figure:[1]Data flow diagram

- Threshold Detection: The micro-controller is programmed to set predefined thresholds for minimum and maximum water levels. When the water level falls below the minimum threshold, indicating that the tank needs to be refilled, the micro-controller triggers the water pump to turn on. Conversely, when the water level reaches the maximum threshold, signaling that the tank is full, the micro-controller instructs the pump to turn off.
- Pump Control: Upon detecting a change in water level that surpasses the set thresholds, the micro-controller sends control signals to the water pump to either activate or deactivate its operation. These control signals are transmitted via relay modules or motor drivers connected to the micro-controller, enabling it to interface with the pump and control its on/off status.
- Sensor Interface: The ESP8266 is connected to various sensors such as ultrasonic sensors for water level measurement, DS18B20 temperature sensors, and turbidity sensors. It reads data from these sensors periodically to monitor water parameters.
- Data Processing: The micro-controller processes the sensor data, performing calculations or transformations as needed to convert raw sensor readings into meaningful information. For example, it may convert ultrasonic sensor readings into water level measurements in centimeters or inches.Here fig{1} refer the flow of data in our system.
- Communication: The ESP8266 establishes a Wi-Fi connection to transmit sensor data to the cloud platform, such as Firebase Realtime Database. It utilizes protocols such as MQTT or HTTP to securely send data packets containing sensor readings and metadata.
- Control: The micro-controller can also receive commands or instructions from the cloud platform or mobile application, allowing users to remotely control devices such as water pumps or valves. For example, users can turn on or off the water pump based on the water level readings received from the sensors.

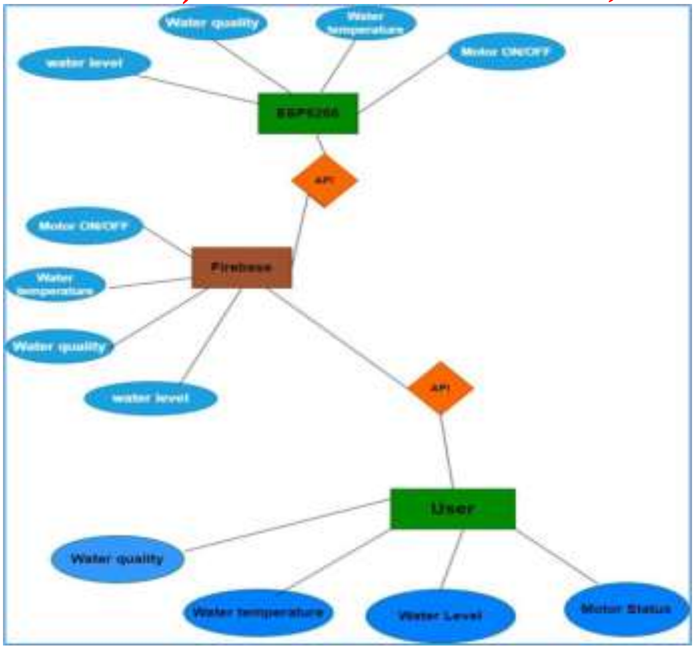

Figure:[2] ER diagram

2.User interface

The user interface, developed in Sketchware, provides intuitive access to system functionalities through voice commands using predefined keywords, available in both English and Tamil languages. Users can interact with the system by speaking command keywords in their preferred language, enabling effortless monitoring and control of the Smart Water Tank Monitoring System. Some of the command keywords include "temperature" to inquire about water temperature, "level" to check the water level in the tank, "quality" to assess water quality based on turbidity readings, "on" and "off" to control system operations such as activating or deactivating the water pump, and "automatic" to enable or disable automatic mode for pump control. By using these command keywords, users can effectively communicate with the system and perform actions such as checking sensor readings, adjusting settings, and controlling system operations, all with the convenience of voice commands. Additionally, users can visually see data presented on the mobile app interface, available in both English and Tamil languages, ensuring accessibility and ease of use for a wider range of users. This intuitive and user-friendly interface enhances the user experience, making it easy for users to manage their water resources efficiently.fig{2} refer the how user data are flow in the way and fig{3} refer the structure of App

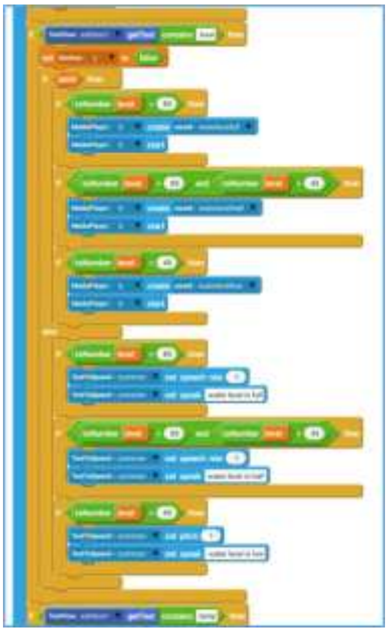

Figure:[3] Structure of an App

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3. Sensors:

a. Ultrasonic Sensor:

i. Measures water levels inside the tank using ultrasonic waves.

ii. Utilizes time-of-flight calculations to accurately determine the distance to the water surface.

b. DS18B20 Temperature Sensor:

i. Monitors water temperature to ensure it remains within optimal ranges.

ii. Provides precise temperature readings for monitoring and analysis.

c. Turbidity Sensor:

i. Determines water clarity by measuring the concentration of suspended particles or

ii. contaminants.

iii. Enables assessment of water quality and detection of impurities.

4. Water Pump:

i. Automatically refills the water tank when the water level falls below a predetermined threshold.

ii. Ensures a continuous supply of water for various applications, such as irrigation or domestic use.

5. Power Supply:

i. Provides electrical power to the system components, ensuring uninterrupted operation.

ii. May include options such as batteries, solar panels, or mains power sources, depending on the application and location.

5. Connectivity Module:

i. Facilitates communication between the micro-controller and external devices or platforms.

ii. Enables data transmission over Wi-Fi or cellular networks, ensuring seamless integration with cloud-based services.

Sample data forms:

Distance: **0 cm**

Raw Analog Reading: **293** Turbidity Value: **41**

Water is slightly turbid Temperature: **-127.00°c**

Distance: **0 cm**

Raw Analog Reading: **300** Turbidity Value: **39**
Water is slightly turbid Temperature: **-127.00°c**

Temperature: **-127.00 °c**

Distance: **0 m**

Raw Analog Reading: **309** Turbidity Value: **38**

Water is slightly turbid Temperature: **-127.00°c**

Distance: **0 m**

Raw Analog Reading: **293** Turbidity Value: **41**
Water is slightly turbid

6. Data Storage and Transmission:

a. Cloud Platform (e.g., Firebase):
i. Stores and manages sensor data collected by the system.
ii. Provides secure storage and retrieval of real-time and historical data logs.

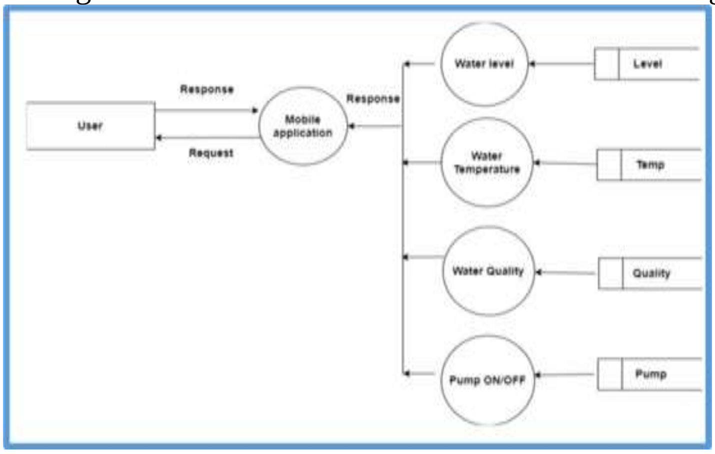

Figure:[5]Server-Side

b. Mobile Application:
i. Serves as the user interface for accessing sensor data, receiving alerts, and controlling system operations.
ii. Enables remote monitoring and control via smartphones or tablets, enhancing user convenience and accessibility.

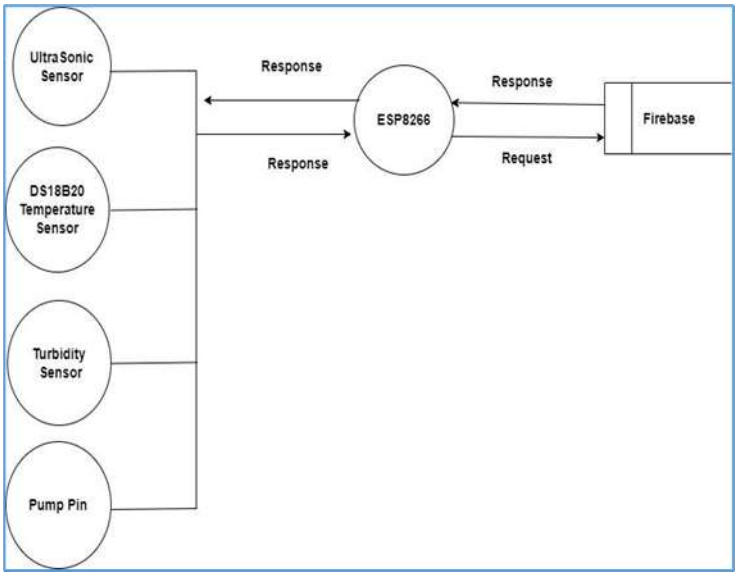

Figure:[6]User-Side

SYSTEM FLOW:
1. Sensor Ensemble:
i. The system begins with the Sensor Ensemble, comprising the Ultrasonic Sensor, DS18B20 Temperature Sensor, and Turbidity Sensor.
ii. The Ultrasonic Sensor measures water levels with precision.
iii. The DS18B20 Temperature Sensor monitors water temperature fluctuations.
iv. The Turbidity Sensor assesses water quality and detects impurities.

2. Microcontroller:
i. At the core of the system stands the Microcontroller (ESP8266), orchestrating the sensor ensemble's data streams.
ii. The Microcontroller processes sensor inputs and makes informed decisions.

3. Algorithmic Arrangements:

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Supporting the Microcontroller are algorithms that harmonize sensor data, interpreting water levels, quality, and usage patterns.

4. Pump Activation:
i. When the data indicates depletion, the Water Pump activates to ensure a continuous flow of water.
ii. The Water Pump responds to the Micro-controller's directives.

5. User Interface:
i. The system's User Interface allows users to engage with the system, view real-time data visualizations, and receive alerts.
ii. Users can control system operations and shape water management practices through the interface.

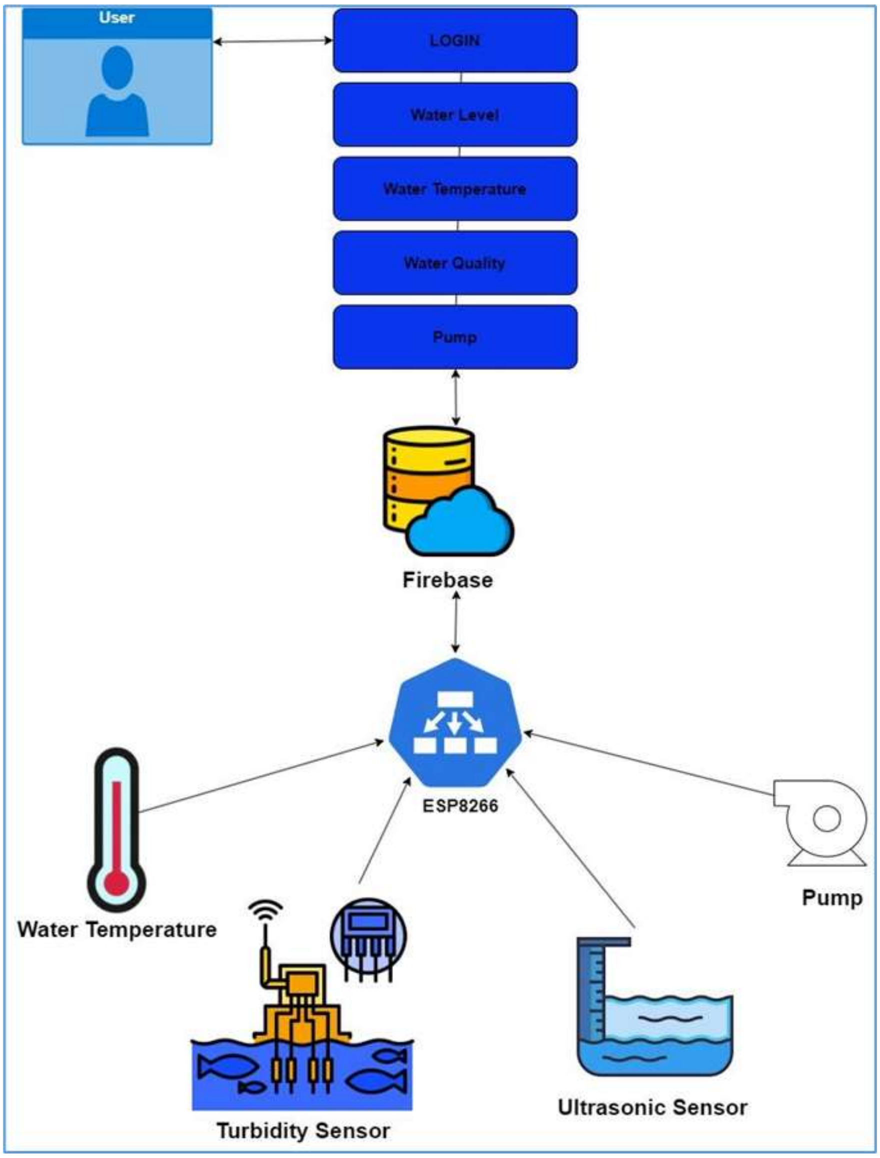

Figure:[7] System flow diagram

SYSTEM RESULT:
The project outcome of the Smart Water Management System encompasses several key facets: Firstly, it improves water management practices by enabling real-time monitoring and intelligent decision-making, thereby enhancing efficiency and sustainability. Secondly, it promotes resource conservation efforts by empowering users with actionable insights to optimize water usage and reduce wastage. Thirdly, it contributes to environmental protection by monitoring water quality and encouraging

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responsible water management practices. Fourthly, it empowers stakeholders with valuable data-driven insights to inform policy-making, research initiatives, and community outreach programs. Lastly, it contributes to a sustainable future by leveraging technology to address water scarcity challenges and foster resilience in water management practices.

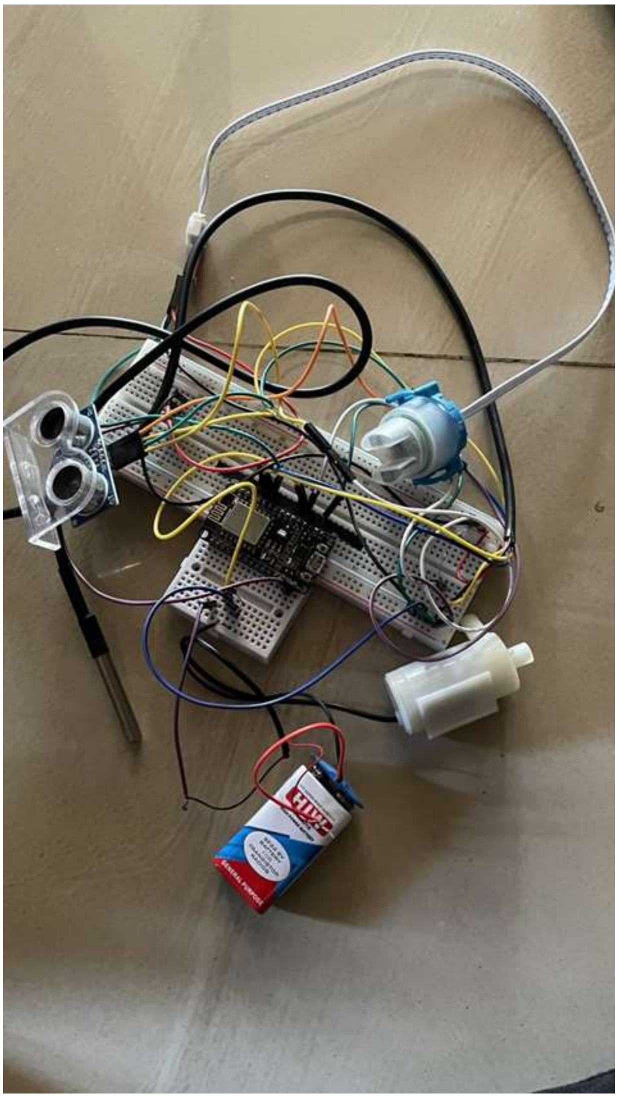

Figure:[8] Hardware system

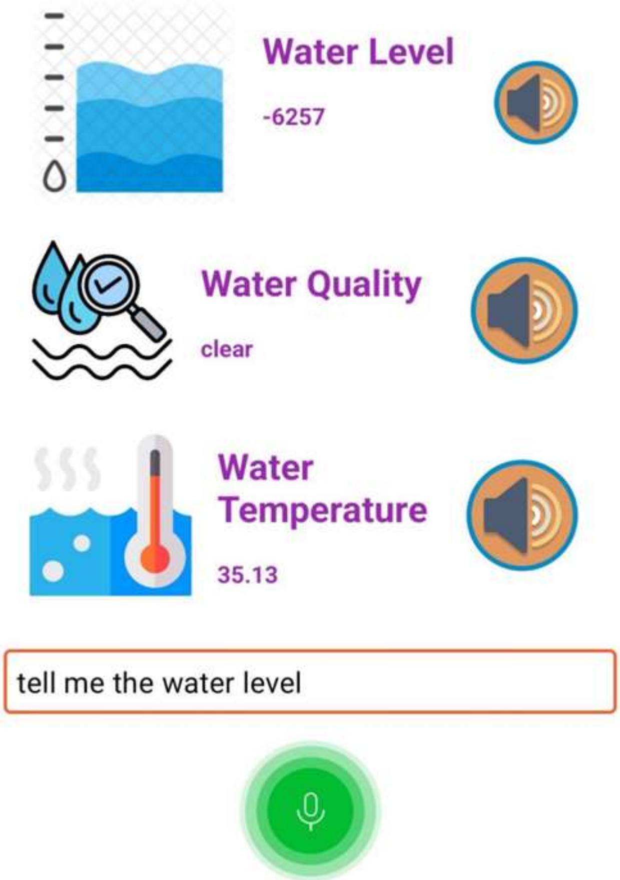

Figure:[9] Software system

CONCLUSION:

In summation, the Smart Water Management System embodies a paradigm shift in resource conservation, seamlessly marrying technological prowess with ecological mindfulness. Through the orchestrated interplay of state-of-the-art sensors, sophisticated algorithms, and intuitive user interfaces, it heralds a new era of water stewardship. By empowering stakeholders with actionable insights and intuitive controls, it not only optimizes water utilization but also cultivates a deeper reverence for our finite water resources. As we chart a course towards sustainability, the Smart Water Management System emerges as a beacon of innovation, epitomizing our unwavering commitment to preserving the planet's most precious asset.

FURTURE ENHANCEMENT:

a) Enhanced Predictive Analytics: Implement advanced predictive analytics algorithms to forecast water demand patterns and optimize resource allocation accordingly.

b) Remote Monitoring and Control: Introduce remote monitoring and control capabilities, enabling users to access and manage the system from anywhere via mobile apps or web interfaces.

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c) IoT Integration: Explore integration with Internet of Things (IoT) technologies for real-time communication between water management systems and utilities, facilitating more efficient water distribution.

d) Water Purification Technologies: Investigate the integration of advanced water purification and recycling technologies to improve water quality and promote sustainable reuse practices.

e) Collaboration for Policy Making: Collaborate with environmental agencies and research institutions to leverage data insights for informed policy-making and water conservation initiatives.

f) Cybersecurity Measures: Strengthen cybersecurity measures to safeguard against potential cyber threats and ensure the integrity and confidentiality of system data

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