Cost Effective Domestic Water Management System

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Abstract- *In general, the majority of houses depend upon overhead tanks as their primary water source. It is obtained from underground water storage, which is perfect for individuals who want to conserve storage. Typically, people turn on the motor when their taps run dry and turn it off when the tank begins to overflow. As a result, water is wasted unnecessarily, and in emergency situations, water may not be available. Monitoring the water level in the tank is necessary to control these phenomena, which is frequently observed in both urban and rural locations. A device is required that can turn on the motor when the tank's water level is low and turn it off as soon as the level reaches its maximum. Checking the water flow and purity may be necessary from time to time. Through the use of electronic sensors and controls, it is possible to monitor and keep track of the water level in order to automatically manage the level. The water flow rate can be detected as the water flows to the overhead tank with the use of a water flow sensor. Water purity can also be evaluated with a PH level monitor.*

Keywords- LORA sx1278, pH Sensor, Float switch, Water flow sensor

I. INTRODUCTION

The first recognized battery-operated electric motor was created by Thomas Davenport in 1834. Nichola Tesla is the first who invented the AC commutator free polyphase Induction Motor, which is now implemented and used for pumping water in houses. In the early times, we have used these motors for pumping the water and we have to switch ON or switch OFF the motor manually and we need to check the water level every time. Then it is developed into semi-automatic, in this type we have to switch ON the motor manually, the water level in the tank is monitored by a sensor. It detects the water level and it will turn OFF automatically. To protect the motor from the dry run, fully automatic is developed. It has a controller to transmit information to the relay. There will be two sensors for detecting the upper and lower level of water and the data will be send to the relay. Then the motor will turn OFF automatically [1],[4],[5]. Then with the help of the transmitter and receiver it is developed into wireless. The automatic water level indicator and controller is developed with the help of RF transmitter and receiver for the wireless transmission of data [2]. There are three float sensors for indicating the water level and if the float sensor is opened, it detects the tank is not full. If both the sensors in the upper and lower level are opened, then the tank needs to get filled with water. The data will be transmitted to the receiver and then the motor turn ON automatically. If the tank gets filled, it will turn OFF automatically. There will be interference in the data transmission because of any other radio waves disruption and it will work for a short range. To overcome the issues, *LoRa (Long Range) module* is used [1],[3],[4],[8]. It is used for long range data transmission, wireless network which is possible to communicate from a powered device to a server. In addition to that, two different sensors like pH sensor for measuring the pH the water and water flow sensor for measuring the water flow rate are used [4],[8]. The cost-effective domestic water management system is proposed based on the wireless transmission of data using IOT. Early, RF transceiver is used for the data transmission, due to some drawbacks it is replaced with *LoRa*. The proposed water management system consists of float switches, pH senor, water flow sensor, ESP 32, LORA [1],[3],[8]. The overhead tank's water level is detected via the float switch and passes the data to the *LoRa* receiver, the data will be communicated through the IOT cloud for further analysis [4],[5]. The ESP 32 is the medium which transfers the data to the LORA [2][9]. The pH sensors are used to detect the pH level of water to check its purity [4]. The LORA is used as a transceiver, because if there is a single house transceiver can be used, but for a street we need LORA (because range of LORA is up to 10km) [4][7]. It is possible to determine the water flow rate by using the flow sensor, by this sensor we can measure the water consumed by each house in the street [1]. This solution will be helpful for the people to avoid water wastage and it is cost efficient, so everyone can use this product. It is a permanent solution to avoid the overflowing of overhead water tank [10].

A. REQUIREMENTS

The app interface should be used in Laptops and also in mobile phones. It should be easy to use and user friendly. Data of the sensor able to viewed by user in monitor or mobile phones. Parameters of each sensor should be practical and it should display the same in the monitor or mobile phone that

user uses. It should able to access the water management data by using laptop or mobile phone. Every data should be accessed with network including IOT cloud access facilities.
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To become environmentally friendly, the sensors should detect the data in every monsoon. The data should transmit and receive properly.

The water management system works under many sensors data and many other technologies like lora, ESP32. Here every data is unique and linked with each other so that it is easy to access. Secondly, it made the storage process in IOT simpler. In IOT data is stored as machine language, so it is easy for us to convert. So the data should be designed and coded to use the IOT in an effortless way. The water management system should have connecting options with the new technologies, so that we can avoid buying new devices. It should be able to connect with different types of motor so that we can keep away from purchasing new customized motors. It should not only be made to use in only urban areas but also it should be made to use in rural areas or countryside too. It should have options to combine with other products.

II. LITERATURE REVIEW

The results of an extensive survey conducted in 'Water Level Monitoring and Leakage Detection System using Long Range Module' by Pranita S. Patil the leakage in the underground pipe was detected using an acoustic wireless sensor based on the hydrophone. The pressurized pipes were measured constantly by the acoustic sensors and if there is any leak, it will detect the leakage using the sensor and stores information in the controller. Real-time wireless transmission of the data to the gateway. In the investigation of reference, leakage detection is carried out utilising a liquid flow meter sensor. For the water level detection acoustic sensors are placed at each level of water. It will detect the water level and pass the data to the LoRa transmitter. Then leakage detection can be done using a liquid flowmeter. The data which is stored in the controller can be retrieved in the mobile or pc because the data will be stored in the web server. The results of an extensive survey conducted in 'Water Level Monitoring and Leakage Detection System using Long Range Module' by Poorwa D. Kapgate. The AT mega 328P controller is used to read the data from the sensors by the water level every time. The data is transmitted wirelessly through the LoRa transceiver. The data which is stored in the controller can be retrieved using cloud server. It can read the data but it can't display or it can't send the data to the user. It is just used to store the data. In this survey there is no solution for water leakage.

The results of an extensive survey conducted in 'Radio Frequency Based Water Level Monitor and Controller For Residential Applications' by D.B.N. Nnadi. The RF based system is employed to keep an eye on and regulate the water level for residential applications. The level sensor is used to sense the water level in the overhead tank. The RF transceiver with 433MHz, power supply 5V and its operating distance range is up to 20 metres which is used for the data transmission without antenna. If an antenna is used then the data transmission range is up to 100 meters it is only for open space and in a crowd the range of transmission is up to 60 meters only. The multiple data transmission is not possible in the RF transceiver. It is possible only by using an encoder and decoder. The data which is read by the controller will be displayed on the LCD. The prototype's control unit will automatically switch on and off the one centrifugal water pump.

The results of an extensive survey conducted in 'Water Level Monitoring and Leakage Detection System using Long Range Module' by Shambhavi B. Rathour. The VL53L1X sensor is used for the distance measurement by using the laser light reflected from the object so we can measure the distance. It works like an ultrasonic sensor which is used for obstacle detection. Once the data signal transmitted is received by the receiver, then we can calculate the distance by using the time. The water level can be monitored by using this sensor. When the laser light passed from the sensor will be reflected and by using the reflected time, we can measure the water level within the tank. If the water level is low, the light will reflect very slowly. If the water level is high, the light will reflect very fast. The operating voltage is also the same as other sensors(5V).

The results of an extensive survey conducted in 'Water Level Monitoring and Leakage Detection System using Long Range Module' Nitin P. Mawale. The Zigbee network is a transceiver which is used for the data to interface in the cloud. It is very costly compared to other networks and interfacing this network is very complicated. After interfacing, the data will be stored in the web server. Then the data will be monitor through mobile or PC.

OBSERVATION

AT mega 328P act only as controller. It has less number of analog and digital pins. It cannot use it as a module. It cannot send or receive signals such as wifi or Bluetooth. RF transmitter and receiver can transmit or receive data within 60 meters if crowded. If it is an open space it can transmit up to 100 meters. VL53L1X sensor cost is high. It is not a water proof sensor. The literature review indicates that different approaches are required to address the aforementioned issues.

III. METHODOLOGY

Figure 1 Block Diagram Transmitter

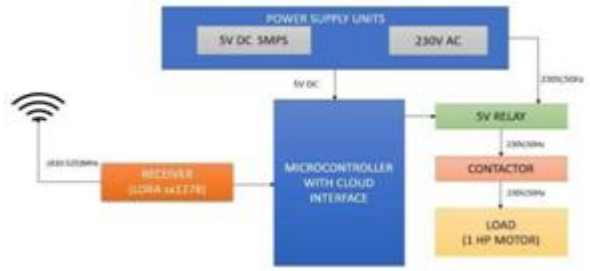

Figure 2 Block Diagram Receiver

Transmitter:

Power Supply

5V DC SMPS is used as the power supply for the transmitter circuit. Power supply is connected to the microcontroller (230V is converted to 5V).

Float Switch

For the float switch 5V supply and 50mA supply is given. Float switch is used for detecting the water levels for both underground and overhead tank**.** The Block diagram of Transmitter is shown in Fig 1 It acts as a switch. If there is no water in the underground and overhead tank, the contact will get closed in the switch and it indicates that there is no water in the underground and overhead tank.

Table 1 Components Specification

Module	Voltage	Current
Controller	5v	0.15 mA
Float switch	5v	50 mA
Water flow sensor	4.5v	15 mA
pH sensor	5v	0.4 mA
LoRa sx1278 TX	3.7v	93 mA
LoRa sx1278 Rx	3.7v	12.15 mA
Relay	5v	70 mA
Actuator	230v	15 A

pH Sensor

For the pH Sensor 5V supply and 0.4mA supply is given. The acidity and alkalinity of water and other liquid substances can be measured scientifically using a pH sensor. Monitoring the water's purity is helpful.

Waterflow Sensor

For the water flow Sensor 5V supply and 15mA supply is given. To compute the water flow rate, a water flow sensor is employed. The liquid's capacity equals the water that flows in a given amount of time.

Transmitter – LORA sx1278

For the TRANSMITTER – LORA Sx1278 3.7V supply and 93mA supply is given. **LoRa (Long Range Network module)** is a wireless technology that offers long-range (If it is an open space, its operating range can be from 10 to 15km Without an antenna it can transmit data up to 500m. With an antenna it can transmit data up to 8 to 10km approximately. Data Transmission distance varies according to the crowd density), low power, and secure data transmission for IoT applications. It is used for transmission of data in transmitter side.

Receiver:

Power Supply

In receiver circuit, 5V DC SMPS is used as the power supply for LORA Rx and microcontroller. 230V AC supply is connected to actuator.

5V Relay

For the Relay 5V supply and 70mA supply is given. The 5V relay acts as a switch for contactors. Once data is received, then the relay will get operated.

Actuator

For the Actuator 230V supply and up to 15A supply is given. The Actuator is used to switch ON the motor. The Actuator is used for single phase motors. The specified data used for practical illustration is tabled in Table 1.

Receiver – LORA sx1278

For the RECEIVER – LORA Sx1278 3.7V supply and 12.15mA supply is given. LoRa (Long Range network module) is a wireless technology that offers long-range (If it is an open space, its operating range can be from 10 to 15km Without an antenna it can transmit data up to 500m. The Block diagram of Transmitter is shown in Fig 2 with an antenna it can transmit data up to 8 to 10km approximately. Data Transmission distance varies according to the crowd density), low power, and secure data transmission for IoT applications. It is used for receiving the data from the transmitter side.

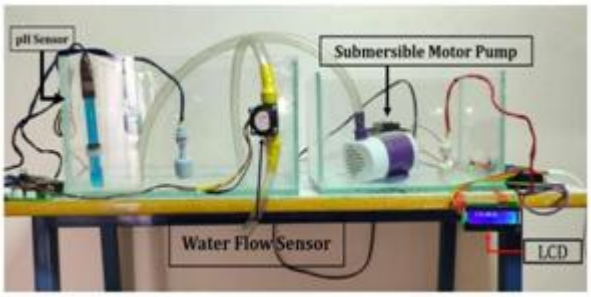

Figure 3 Overall Setup

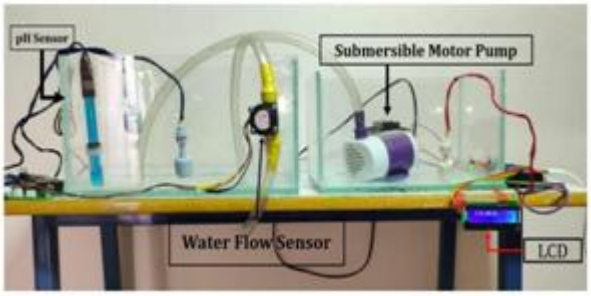

Figure 4 Transmitter

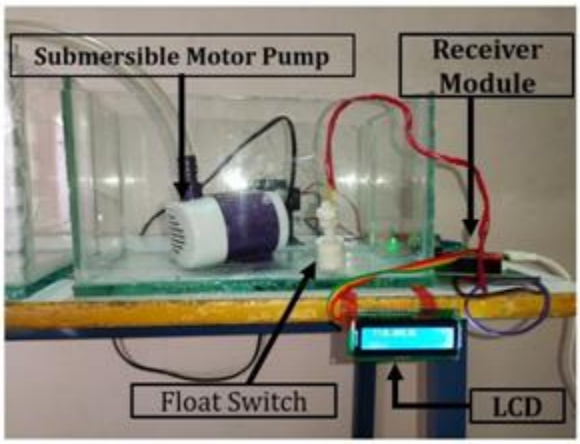

Figure 5 Receiver

The overhead tank level of water is determined through using the float switch. The Overall setup is shown in Fig 3 It is positioned in the overhead water tank's lower and upper levels. The Transmitter is shown in Fig 4 The data from the float switch has been successfully relayed to the receiver, and the upper level of the water has been detected.

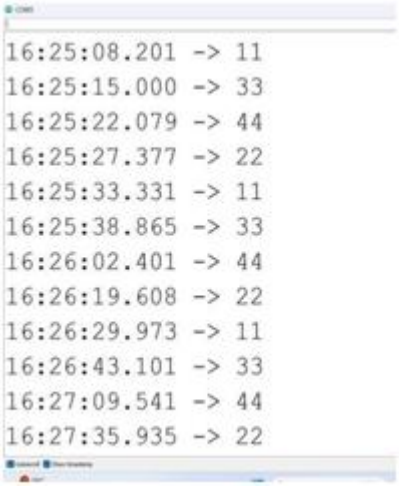

Figure 6 Float switch

The water flow rate of each house can be measured. It is possible to determine the water flow rate by using the flow sensor. The Receiver is shown in Fig 5 It is placed in the outlet of the overhead tank pipes which are separately given to the home. The output determines that the water consumed by each house in the apartment can be measured The Float switch is shown in Fig 6.

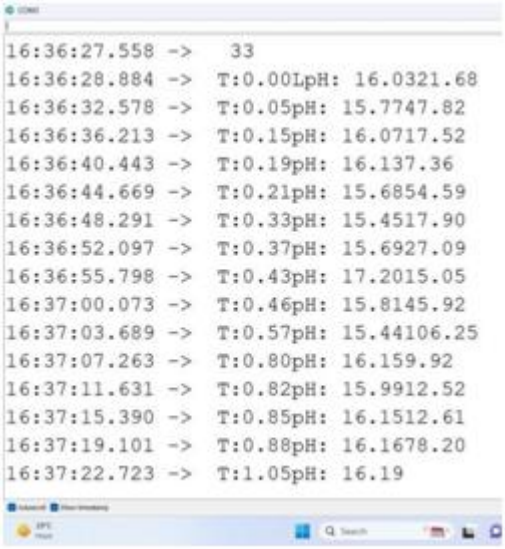

Figure 7 Water Flow & pH Sensor

Analyze The pH above 6.5to 8.5 is base and less than 6.4 is acid, so the pH value of the water should be 6.5 to 8.5. It is measured by the pH sensor. The water flow & pH sensor is shown in Fig 7 It is placed in the inlet of overhead water tank to check the purity of the water. The output has been successfully verified and the water's pH has been determined.

IV. CONCLUSION

In conclusion, the development and implementation of a cost-effective domestic water management system hold significant promise for addressing the growing challenges of water scarcity and efficient resource utilization in households. Through a thorough analysis of various strategies and technologies, this project has demonstrated the feasibility of designing a system that optimizes water usage, minimizes wastage, and reduces overall costs. By incorporating innovative approaches such as rainwater harvesting, greywater recycling, smart meters, and efficient fixtures, it is possible to achieve a sustainable and economical domestic water management solution. This not only benefits individual households by reducing their water bills but also contributes to the broader goal of water conservation and environmental sustainability. Further research, testing, and wider adoption of these cost-effective strategies are essential to realizing a more water-efficient future for households and communities.

V. FUTURE SCOPE

The project opens up several avenues for future research and development:

Enhanced Data Analytics: Implementing advanced data analytics and machine learning algorithms on the collected IoT data can provide deeper insights into water usage patterns, enabling better predictive modeling and optimization strategies.

Integration with Smart Home Systems & Mobile Applications: Integrating the IoT-based water management system with other smart home devices and systems can create a comprehensive smart home ecosystem. This could include automation based on water usage, allowing for a more holistic approach to resource management. Creating intuitive smartphone apps that make it simple for homes to track and manage their water usage, establish objectives, and get insights will boost user involvement and promoting sustainability, efficient resource management and enhanced living standards for both people and communities.

Water Quality Monitoring: Extending the system to monitor and analyze water quality in real-time can be crucial for ensuring safe and healthy water consumption. Integrating sensors for water quality assessment will enhance the utility and safety of the system.

Scalability and Accessibility: Expanding the reach of the system to cater to a larger number of households and ensuring its accessibility to a broader audience, including low-income communities, will contribute to a wider adoption of sustainable water management practices.

REFERENCES

[1] Patil, Pranita S., Poorwa D. Kapgate, Shambhavi B. Rathour, Nitin P. Mawale, and Rajendra Khope. "Water level monitoring and leakage detection system using long range module (LoRa)." *SAMRIDDHI: A Journal of Physical Sciences, Engineering and Technology* 12, no. SUP 2 (2020): 41-45.

[2] Nnadi, D. B. N., Oti, S. E., & Ezika, P. C. (2015). Radio Frequency Based Water Level Monitor and Controller for Residential Applications. Nigerian Journal of Technology, 34(3), 573-581.

[3] Ismail, Shereen, Diana W. Dawoud, Nadhem Ismail, Ronald Marsh, and Ali S. Alshami. "IoT-based water management systems: survey and future research direction." IEEE Access 10 (2022): 35942-35952.

[4] Lakshmikantha, Varsha, Anjitha Hiriyannagowda, Akshay Manjunath, Aruna Patted, Jagadeesh Basavaiah, and Audre Arlene Anthony. "IoT based smart water quality monitoring system." Global Transitions Proceedings 2, no. 2 (2021): 181-186.

[5] Shahanas, K. M., & Sivakumar, P. B. (2016). Framework for a smart water management system in the context of

smart city initiatives in India. Procedia Computer Science, 92, 142-147.

[6] Yasin, H. M., Zeebaree, S. R., Sadeeq, M. A., Ameen, S. Y., Ibrahim, I. M., Zebari, R. R., ... & Sallow, A. B. (2021). IoT and ICT based smart water management, monitoring and controlling system: A review. Asian Journal of Research in Computer Science, 8(2), 42-56.

[7] Tsai, K. L., Chen, L. W., Yang, L. J., Shiu, H. J., & Chen, H. W. (2022). IoT based smart aquaculture system with automatic aerating and water quality monitoring. Journal of Internet Technology, 23(1), 177- 184.

[8] Chen, W., Hao, X., Lu, J., Yan, K., Liu, J., He, C., & Xu, X. (2021). Research and design of distributed IoT water environment monitoring system based on LoRa. Wireless Communications and Mobile Computing, 2021, 1-13.

[9] Ragab, M. A., Badreldeen, M. M. M., Sedhom, A., & Mamdouh, W. M. (2022). IOT based smart irrigation system. International Journal of Industry and Sustainable Development, 3(1), 76-86.

[10] Doni, Ashwini, Chidananda Murthy, and M. Z. Kurian. "Survey on multi sensor based air and water quality monitoring using IoT." Indian J. Sci. Res 17.2 (2018): 147-153.