Solar Aqua Guard: A Next-Gen IoT Approach to Water Tank Monitoring

Sabeena K.
Dept of Computer science and Engineering
College of Engineering Karunagappally(IHRD)
APJ Abdul Kalam Technological University

Haseena P. Y.
Dept of Electrical and Electronics Engineering
College of Engineering Karunagappally(IHRD)
APJ Abdul Kalam Technological University

Abstract:- Water is an essential element of life, we must take measures to conserve water resources and ensure the water quality that we receive. The primary objective of our project is to develop a modular and user-friendly system that enables real-time monitoring and dissemination of water quality data to consumers. The system incorporates arduino, automatic water flow control, sensors and a wireless communication module to achieve this goal. The system operates by collecting water quality parameters through the deployed sensors. These sensors measure key parameters such as pH, turbidity, temperature and TDS, which are crucial indicators of water quality. The collected data from the sensors is then transmitted to the arduino. To ensure seamless and real-time communication, the system incorporates a WiFi wireless transmission module. This module facilitates the transmission of the processed water quality data from the controller to a remote management platform or server. The data is securely uploaded to the server via WiFi connectivity, allowing for immediate access by authorized users. This user interface provides a convenient means for users to receive, query,and visualize the monitoring data. Users can access the latest water quality information, view historical trends and set up customized alerts or notifications to be promptly informed of any significant changes or potential water quality concerns. Overall our project develops a modular IoT-based system that seamlessly integrates sensors, arduino, and wireless communication to enable real-time monitoring and dissemination of water quality data. By providing users with easy access to this information, we aim to enhance awareness, empower decision-making, and promote proactive measures for water quality management.

Keywords:- *iot; water tank; solar;smart;*

I. INTRODUCTION

In recent years, with the rapid development of society and economy, the pure pursuit of economic interests by human beings is seriously polluting the water environment. The discharge of industrial sewage and urban and rural domestic sewage far exceeds the self purification capacity of ecosystems. Whether for drinking, household, food production or recreational activities, safe and readily available water is needed for public health. Once the water source is polluted, people's life and health will be seriously threatened . Water scarcity refers to the inadequate availability of freshwater resources to meet the demands of a population. It is a pressing global issue that affects both developed and developing countries. Growing population, climate change, and inefficient water management practices contribute to the increasing water scarcity crisis[1]. This scarcity has severe implications for agriculture, sanitation, health, and overall socio-economic development.

Water quality monitoring is crucial to ensure the safety and suitability of water for various purposes, including drinking, irrigation, and industrial use. Poor water quality can lead to significant health risks, such as the spread of waterborne diseases and contamination of food crops. Monitoring water quality parameters, such as pH, TDS, turbidity, and microbial content, helps identify potential contaminants and take necessary measures to prevent their harmful effects[2]. In these testing times, the quality of water is a sensitive matter. Smart cities need to prioritize water quality monitoring.

The works reported related to the aforementioned issues are detailed as follows. Mishra et al.[3] introduces a grid-integrated solar water pump system with unidirectional power flow control, employing a MATLAB platform for simulation and experimentation. The system, utilizing a Switched Reluctance Motor (SRM), showcases reduced payback periods, efficient water pumping, and a unique online dwell angle optimization technique for versatile applications. In another literature[4], the authors present an efficient control scheme for a self-reliant solar-powered water pumping system, featuring a 4-phase SRM drive and a three-level boost converter. The system, designed for off-grid communities, maximizes PV array power, equalizes voltages, and eliminates the need for phase current sensors, showcasing adaptability through simulation in MATLAB/Simulink under various conditions. Wang et al.[5] proposed a low-cost turbidity sensor for continuous online water quality monitoring, utilizing wireless protocols and IoT concepts. The proposed sensor, with its dual detection principles and 0-1000 NTU measurement range, provides a cost-effective solution for large-scale intelligent water turbidity monitoring, surpassing the limitations of existing commercial instruments.

Here we have the best solution to make an IoT based water quality monitoring system which gives the real time quality of the water. The key features are that our proposed solution is solar powered, and has pump control , measures pH value ,water quality and prevents contamination of water to some extent. In this paper, the following section delves into the implementation details of the energy storage system and RFID-based fee collection system in Section 2. This section will also cover the necessary components and circuit diagrams. Moving on to Section 3, you'll find a brief summary of simulation results and the hardware prototype. The concluding remarks wrap up the article in the final section.

II. IMPLEMENTATION

The block diagram of the entire framework is depicted in Fig. 1.

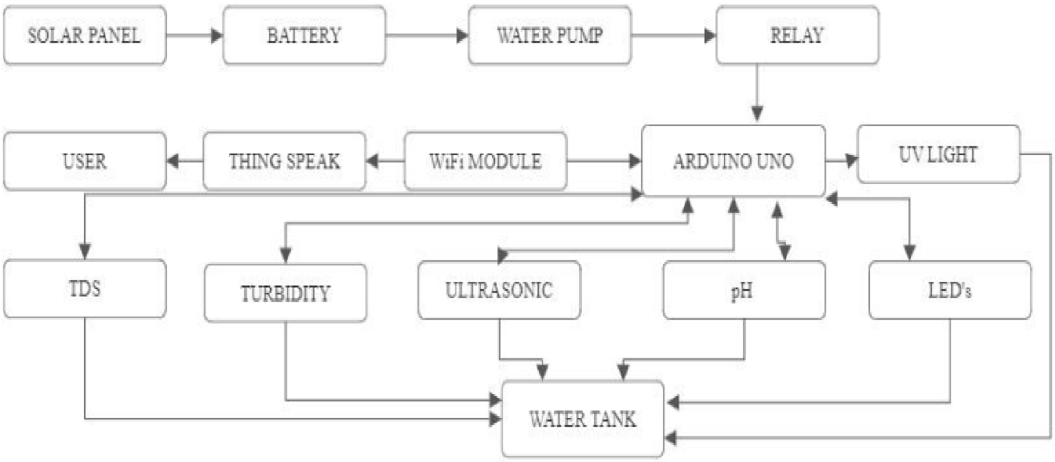

Fig. 1: flow of work

The main component is the microcontroller Arduino. The Arduino is powered by solar and charges the battery [7]. To prevent the water from overflowing, automatic water level control and detection is implemented. For this, the pump is connected to the Arduino using a relay and for level detection an ultrasonic sensor is used. The ultrasonic sensor senses the water level and sends the information to Arduino. When the water level is low, the relay turns on automatically and thus the pump starts. Water flows in the tank, when the required level is attained (high),the switch turns Off the pump automatically. The UV turns on and off along with the pump, for disinfection of water. The UV strip is connected and controlled by Arduino. Then for water quality checking, pH, TDS and Turbidity sensors are used. These are connected directly to the Arduino. LEDs are used or the indication of high and low values of these sensor readings.The data measured from the sensors are sent to things that speak through the Wifi module ,from this user can monitor the data from anywhere.

A. Components

In our solar panel project, several essential components play crucial roles in harnessing renewable energy from the sun. The primary element is the PV module, which comprises photo-voltaic cells that convert sunlight into direct current electricity. These cells function as p-n junction diodes, and when organized together, they form a PV panel. A collection of PV panels creates a PV array, which supplies solar electricity to various electrical equipment. These photovoltaic modules rely on the photovoltaic effect to generate electricity, with commonly used materials being wafer-based crystalline silicon cells or thin-film cells. The structural member of a module can be the top layer, ensuring durability and efficiency. Another crucial component in our project is the water pump. Specifically, we use submersible pumps featuring a hermetically sealed motor connected to the pump body. This design prevents pump cavitation, which can occur in applications with a significant elevation difference between the pump and the fluid surface. Submersible pumps push fluid to the surface rather than relying on atmospheric pressure, making them suitable for various heavy oil applications using heated water as the motive fluid.A relay is another integral part of our project. It serves as an electrically operated switch with input and operating contact terminals. The relay's multiple contact forms, including make contacts and break contacts, allow us to control the water overflow in the system, ensuring efficient and safe operation.

To monitor water quality in our project, we employ TDS and turbidity sensors. Total Dissolved Solids (TDS) sensors indicate the concentration of soluble solids in water, with higher TDS values signifying lower water cleanliness. These sensors find application in domestic water quality testing and hydroponics. Turbidity sensors measure the relative clarity of a liquid by quantifying the haziness caused by particles invisible to the naked eye. When interfaced with Arduino, these sensors enable the creation of a Water Quality Monitoring System. In addition to turbidity, our water quality measurement includes pH sensors, which provide information about the acidity or alkalinity of the water, aiding applications like agricultural and fish farming, wastewater treatment, pharmaceuticals, and chemicals. A pH value of 7 is neutral, while values below 7 indicate acidity and above 7 signify alkalinity. These sensors play a crucial role in maintaining water quality and ensuring the success of our solar panel project. Other crucial components include UV LEDs(depicted in Fig.2) for water disinfection, protecting against harmful pathogens like bacteria, viruses, and parasites. Ultrasonic sensors play a pivotal role in distance measurement, object detection, and liquid level monitoring, even for complex-shaped or transparent objects. These integrated technologies ensure the efficiency and safety of our solar-powered IoT-based smart water tank.

Fig. 2: UV LED

B. Circuit Diagram

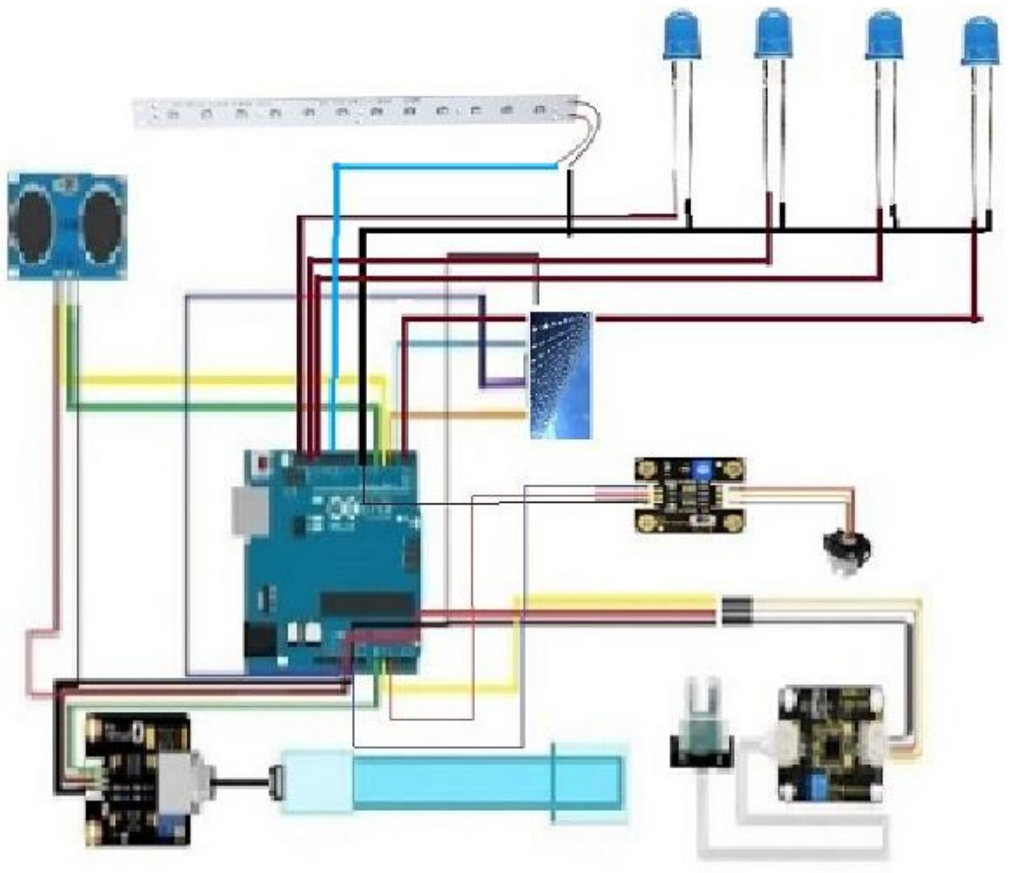

Fig. 3: Circuit diagram

The key component is the microcontroller Arduino. The Arduino is powered by solar and charges the battery. It also powers the 5V Arduino using TP4056 and boost converter. TP4056 gives constant voltage and current while Boost converter converts 3.7 V to 5V [4] . To prevent the water from overflowing, automatic water level control and detection is implemented. For this, the pump is connected to the Arduino using a relay and for level detection an ultrasonic sensor is used. The ultrasonic sensor senses the water level and sends the information to Arduino.When the water level is low, relay switches on automatically and thus the pump starts. Water flows in the tank, when the required level is attained (high), The switch turns Off the pump automatically. The UV turns on and off along with the pump, for disinfection of water. The UV strip is connected and controlled by Arduino. Then for water quality checking, PH, TDS and Turbidity sensors are used. These are connected directly to the Arduino.vidulas.

III. RESULTS AND DISCUSSIONS

A. Simulation diagram

The circuit is simulated with the help of Tinkercad which is depicted in Fig 4.

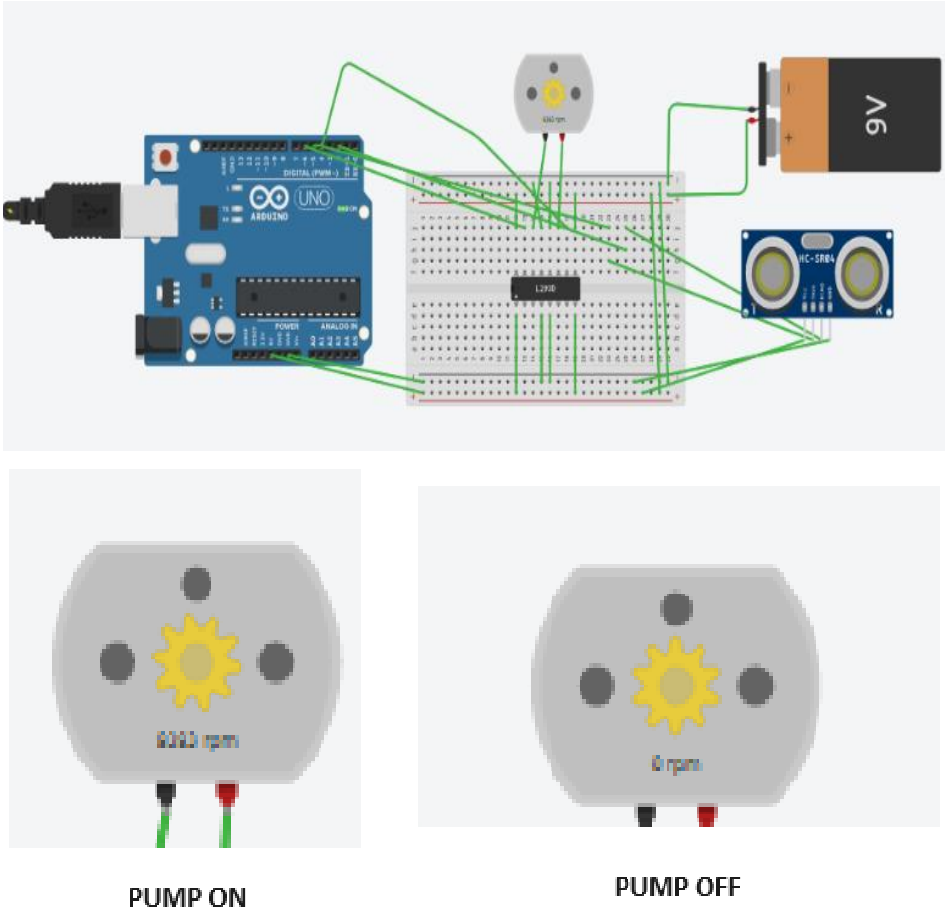

Fig. 4: Simulation screen shots

B. Hardware Implementation

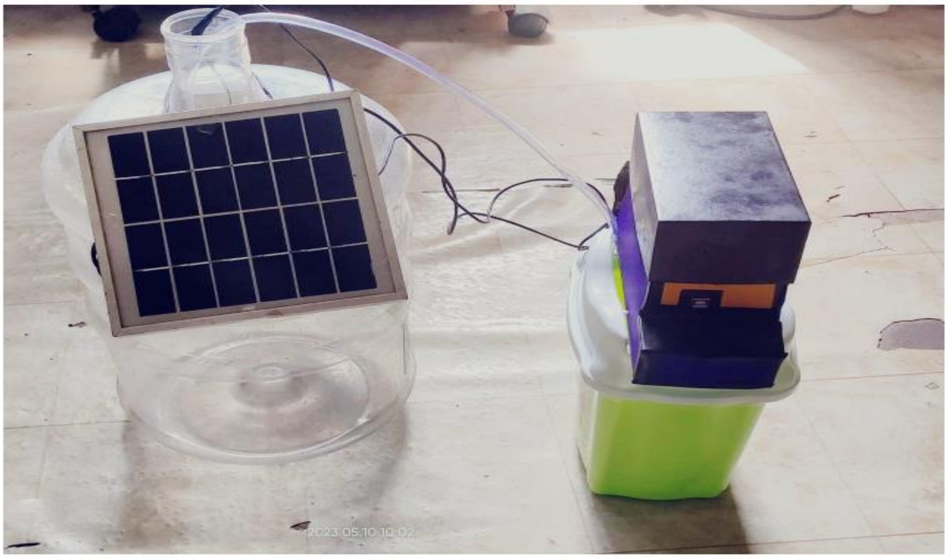

Fig. 5: Hardware simulation

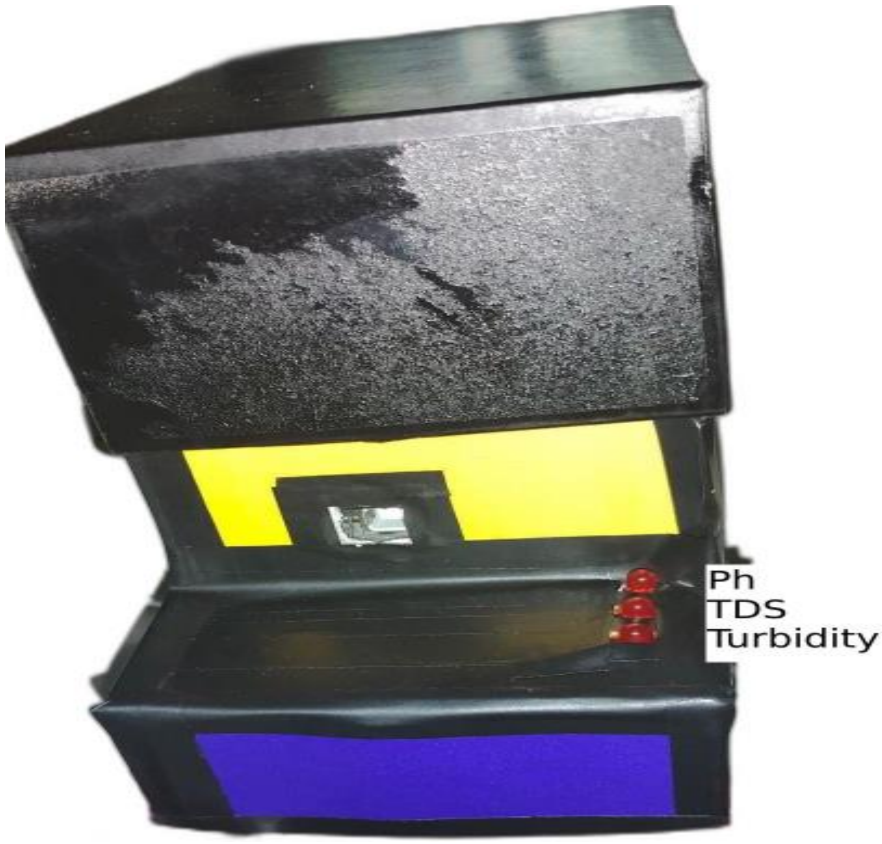

Fig. 6: LED indicators

ThingSpeak is an IoT analytics platform that enables the aggregation, visualization, and analysis of real-time data streams in the cloud.

Fig. 7: Thing speak live analytics

IV. CONCLUSION

In this paper, we utilized pH, TDS, and Turbidity sensors, ultrasonic sensors for water level sensing, UV strips for water treatment, and relays for automatic switching on and off of motors is an innovative and eco-friendly solution for managing water resources.The use of these sensors allows for real-time monitoring of water quality, ensuring that the water in the tank is safe for consumption or other uses. The ultrasonic sensors provide an accurate measurement of the water level, preventing the overflow of water and the consequent wastage of resources.The incorporation of UV strips for water treatment ensures that the water stored in the tank is free from harmful microorganisms, making it safe for use. The automatic switching on and off of motors using relays saves energy and reduces costs. Overall, the project demonstrates the potential for IoT technology to improve water management practices, particularly in areas facing water scarcity or poor water quality. The use of solar power makes the project sustainable and reduces the reliance on fossil fuels. Future improvements could include the integration of machine learning algorithms to enhance the accuracy of water quality monitoring and the development of a user-friendly interface for accessing the data collected by the sensors.

REFERENCES

[1.] Cloete, Niel Andre, Reza Malekian, and Lakshmi Nair. "Design of smart sensors for real-time water quality monitoring." IEEE access 4 (2016): 3975-3990.

[2.] Jewel, Mehedi Hasan, and Abdullah Al Mamun. "Internet of Things (IoT) for Water Quality Monitoring and Consumption Management." In 2022 4th International Conference on Sustainable Technologies for Industry 4.0 (STI), pp. 1-5. IEEE, 2022..

[3.] Mishra, Anjanee Kumar, and Bhim Singh. "Grid-integrated SRM-driven solar water pump with power flow management." IEEE Journal of Emerging and Selected Topics in Power Electronics 9, no. 3 (2020): 2723-2734.

[4.] Mishra, Anjanee Kumar, and Bhim Singh. "An efficient control scheme of self-reliant solar-powered water pumping system using a three-level DC–DC converter." IEEE Journal of Emerging and Selected Topics in Power Electronics 8, no. 4 (2019): 3669-3681.

[5.] Wang, Youchao, SM Shariar Morshed Rajib, Chris Collins, and Bruce Grieve. "Low-cost turbidity sensor for low-power wireless monitoring of fresh-water courses." IEEE Sensors Journal 18, no. 11 (2018): 4689-4696..

[6.] Redwan, Fahim, Shadman Rafid, Ahanaf Hossain Abrar, and Bishwajit Banik Pathik. "An exploratory approach to monitor the quality of supply-water through IoT technology." In 2019 international conference on automation, computational and technology management (ICACTM), pp. 137-142. IEEE, 2019.