IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

ISO 3297:2007 Certified ⁜ Impact Factor 8.102 ⁜ Vol. 12, Issue 4, April 2023

DOI: 10.17148/IJARCCE.2023.12482

DESIGN OF CLOUD BASED SMART WATER DAMMANAGEMENT SYSTEM USING LORA TECHNOLOGY

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Abstract: Water scarcity is a significant problem that many nations worldwide are dealing with. A mechanism for monitoring waterlevels has been created to prevent water waste. This system wirelessly communicates water level information to registered users while autonomously detecting and signalling water levels in reservoirs, overhead tanks, and other storage containers. People could desire to automate their chores in order to conserve energy and increase productivity. Water levels are frequently checked with ultrasonic sensors,which use high-frequency ultrasonic vibrations to detect the level of liquids or solids. These sensors are installed at the top of a tank and send out waves while simultaneously timing how long it takes the sensor to receive the return signal. For the internal study of water dams, household/society water tanks, and municipal water towers, the suggested solution proposes to use a webserver. It can be difficult and time-consuming to check the water level in these containers. The project also aims to solve the problem of water waste. When the tank is full, individuals frequently fail to turn off the motor, wasting water. The water level monitoring device may be used to keep an eye onwater usage and levels, which will help cut down on water waste. A water level indicator is used to find and show the water level in an overhead tank or any other water container. In this work, we outline the NodeMCU-based design of a water level sensor device. A watersensor detects the water level, an ultrasonic sensor produces ultrasonic waves, LEDs display the water level, and a computer monitors the water levels. The level of any liquid in any application can be monitored with this highly effective circuit.

Keywords: LoRa SX1278, UITRASONIC SENSOR, ESP8266, TP4056, OLED DISPLAY, Li-ion BATTERY, SOLAR PANEL

I. INTRODUCTION

The total amount of water on Earth is roughly 1.4 billion cubic kilometres, and since 95% of it is in the oceans, it is unfit for human consumption. It is imperative to protect fresh water resources since studies show that by 2025, more than 50% of the world's populationmay experience water shortages. This problem has been addressed via monitoring technology, which focuses on air pollution and disastermanagement.

Overhead dam water level monitoring can be a difficult task that necessitates manual inspection or permitting water to overflow from thetop. To address this issue, dipped electrodes or float switches are used in electronic water level gauges. However, the long-term performanceof the system may be compromised by corrosion brought on by the employment of these electrodes. In order to solve this problem, a contactless method of measuring water levels using an Ultrasonic module with Arduino and Flood Detection System has been developed.

Electric water controllers were first created in the early 1990s to monitor water levels in irrigation and agricultural projects as well as chemical businesses. Better performance, lower cost, and easier installation are all benefits of using solid-state electronics in combinationwith integrated electronics. Indicators for water level sensors can control the flow of water in a range of applications, including pools, pumps, and hot tubs.

The entire volume of water on Earth is roughly 1.4 billion cubic kilometers, or the equivalent of a 3 kilometer thick layer. The majority ofthis water, 95% of it, is found in the oceans and is unfit for human consumption. By 2025, experts expect that more than 50% of the world'spopulation would experience water scarcity. For instance, a person in India uses 135 liters of water on average per day, and in the next fewyears, this consumption is predicted to rise by 40%. Therefore, it is crucial to protect freshwater resources. Electronic water level indicatorscan be a practical alternative for water level monitoring, even if some studies have concentrated on monitoring technologies for air pollution and disaster management.

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Contrary to the contactless ultrasonic modules with Nodemcu and Flood Alert System utilized in this project,conventional systems that use dipped electrodes or float switches would not be long-term trustworthy. Electric water controllers were first created in the 1990s for monitoring liquid levels in businesses and irrigation projects.

They have since improved with solid-state and integrated electronics, providing affordable and effective solutions with simple installation. These water level sensors can enhance the functionality of water systems in a variety of settings, including pools, pumps, and hot tubs.

Flooding puts the public's health and water sources at danger by increasing the spread of water- and vector-borne diseases. One of the most prominent risks linked with floods is thecontamination of drinking water facilities and standing water, which can harbor chemical dangers and produce mosquitoes.

II. RELATED WORK

Dania Eridani detailed the various functions of LoRa and its architecture in the paper "Monitoring System In LORA Network ArchitectureUsing Smart Gateway In Simple Lora Protocol" [3]. In contrast to the use of LoRa Wan, the throughput in this system has a reliable outcome but a lower value. It happens because this system offers web server capabilities and a data entry process into a database, both ofwhich are absent from LoRa gateway systems generally.

Flooding detection is highly significant, and it can employ velocity and water level detection on a dam, according to Herman Yuliandokoand Sholeh Hadi Pramono's work, "Design of Flooding Detection System Based on Velocity and Water Level DAM with ESP8266" [4].The ESP8266 has a minimum power consumption and is extremely powerful for managing sensor detection, making it a great choice forrural applications. The ESP8266 is infrequently applied, and the majority of studies make use of wireless sensor networks.

In their article "Smart Water Quality Monitoring And Metering Using LORA For Smart Villages" [5], Anto Merline Manoharan explained that the solution for the smart water distribution and quality monitoring in smart villages is a backup networking option for areas where cellular networks are not available. These Lora-Wan are suitable in areas like forests and mountains where cellular networks are not available. The suggested solution will conserve water and give people access to high-quality water.

The authors of "Automatic Water Level Control System," Asaad Ahmed Mohammedahmed Eltaieb and Zhang Jian Min, exposed readersto the best software and hardware architecture for interfacing in their paper "Automatic Water Level Control System" [6]. For the purposeof detecting the water level, the system makes use of cutting-edge sensing technologies. Relay and Arduino are used to control the motor.At several Junctions of the Beaker, various wires are connected. When water is poured into the beaker. The level of water in the dams isdetermined by the water's contact with the wire. As a result, they have an LCD monitor that shows the water level.

An Internet of Things (IoT) based dam water management system (IoT-DWM) is suggested by Chellaswamy C, Nisha J, Sivakumar K, and Kaviya R in the paper "An IoT Based Dam Water Management System for Agriculture [11]" to reduce water wastage and alleviate water scarcity in agricultural fields. The system is made up of field sensors, an IoT network, and a controller for the dam that calculates the amount of water needed based on numerous factors. The technology has undergone testing in the Indian region of Thanjavur, and theresults of simulations indicate that it saves a sizable amount of water. For large-scale water management, an experimental system has beencreated and put to the test.

The ESP8266 module is a low-cost, WiFi-enabled device that offers potential for battery-powered Internet of Things applications with brief transmission intervals, according to Jo ao Mesquita and Diana Guimar in their paper "Assessing the ESP8266 WiFi module for theInternet of Things [14]". According to this study's authors, the module offers good connectivity within typical building deployments, withpacket delivery ratios of 99% or higher on the same floor, while still being useful across floors. They characterise the module's energy usage, communication range, and sleep modes. Future work will evaluate how well the module performs during handoffs and in use caseswithout infrastructure.

A low-cost ultrasonic sensor that uses the time of flight of an ultrasonic pulse to measure the distance between the ground and particularpoints on a moving vehicle is described by Alessio Carullo and Marco Parvis in their paper "An Ultrasonic Sensor for Distance Measurement in Automotive Applications [15]". With precision of greater than 1 mm, the sensor uses a limited optimisation technique toidentify reflected pulses and automatically adjusts to changing environmental factors. The sensor is appropriate for headlamp levelling andactive suspension systems and operates at speeds up to 30 m/s.

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

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III. BLOCK DIADRAM

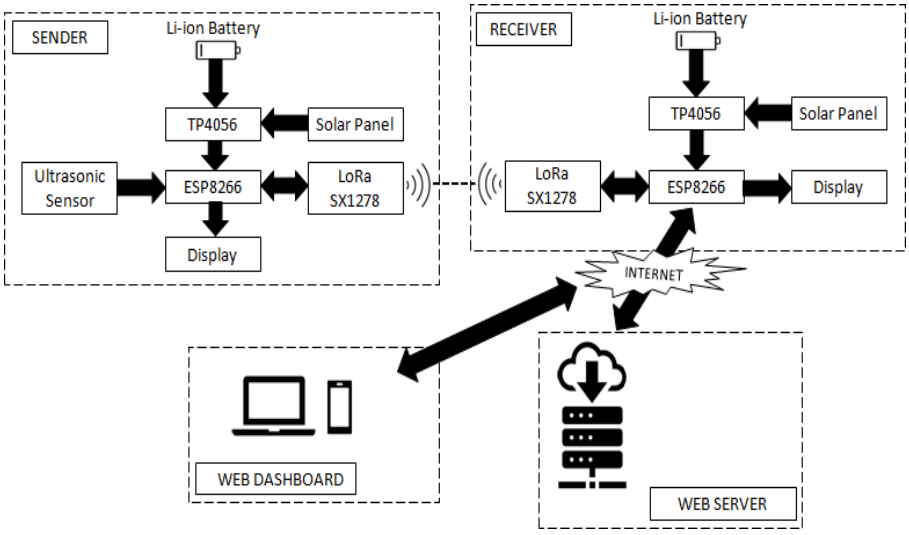

FIG. 1 BLOCK DIAGRAM OF THE PROJECT

IV. CIRCUIT DIAGRAM

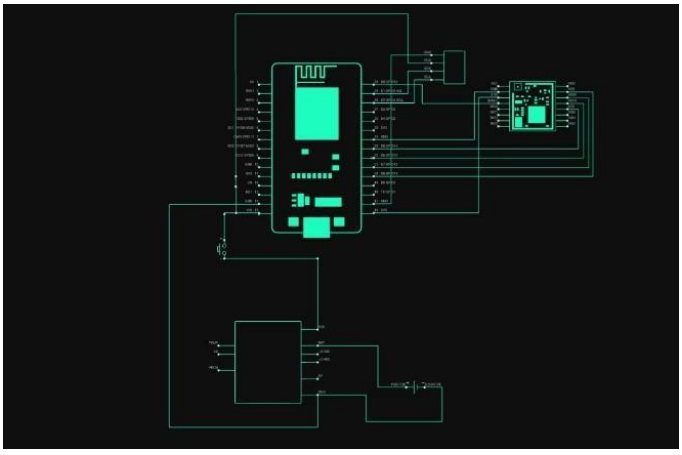

FIG. 2 CIRCUIT DIAGRAM OF THE TRANSMITTER

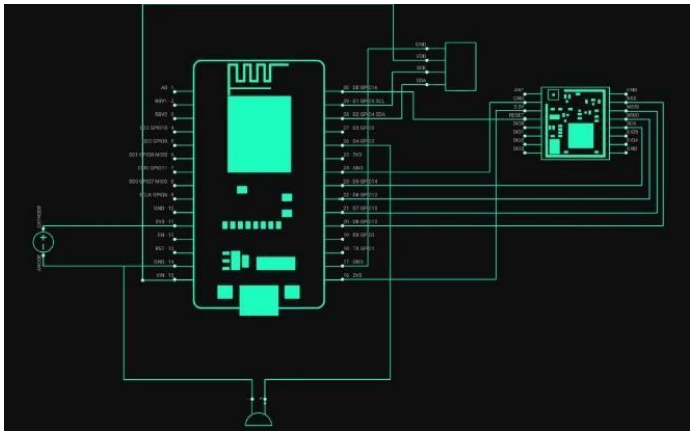

FIG. 3 CIRCUIT DIAGRAM OF THE RECEIVER

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V. HARDWARE DISCTRIPTION

4.1. LoRa

The ultra-long-range low-power data transmission technology used in the LPWAN (low-power wide-area network), also known as LoRa,operates at frequencies below 1 GHz (LoRa for short). A few important features include long range, with a maximum transmission distance of 20 km, low power consumption, with a battery life of 5 to 10 years, and low rate, with a maximum transmission speed of onlya few hundred kbps [1].

Low-power (battery-powered), end-node transmission that can transfer a certain number of data packets in a certain amount of time isthe aim of LoRa research [2].

The wireless module uses the SX1278 device, employing a high spreading factor to send out tiny capacity data over a broad radio band.With a reception sensitivity of up to -148 dbm, it mostly operates in the unlicensed band of frequencies between 137433 and 525433 MHz, including 433 MHz. In open places, the coverage can extend for more than 3 KM between buildings and up to 15 km [1].

fig. 4 image of the LoRa module

4.2. Ultrasonic Sensor

The ultrasonic sensor is equipped with a transmitter and a receiver, both of which use commercial 40 kHz piezoelectric resonant transducers. When activated, the transmitter sends out an ultrasonic pulse that lasts for 200 milliseconds before waiting for the return signal. The receiver then detects the echoes of the ultrasonic waves that bounce back from nearby objects and converts them into electricalsignals, which are used to calculate the distance between the sensor and the objects. Overall, ultrasonic sensors are commonly used in distance sensing applications due to their low cost and reliability [7].[9]

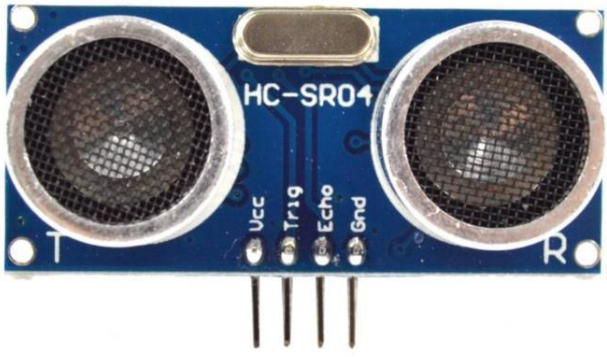

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FIG. 5 IMAGE OF ULTRASONIC SENSOR

These transducers, which are frequently used in anti-thief systems, are easily accessible in water-resistant containers and cost around $1.The generated signal has a period of 25 s, which is equivalent to a wavelength of approximately 9 mm at 20 C. Therefore, a subwavelength detection is required to obtain the required uncertainty [7].

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The goal of ultrasonic rangefinders is to measure the amount of time it takes for a signal to travel from the transmitter to the receiver. The signal's rate of propagation is known. This paper examines the HC-SR04 ultrasonic rangefinder. The sensor is made up of an ultrasonic wave-generating transmitter, an echo-perceiving receiver, and support nodes for the module's regular functioning [8].

When an object is touched by an ultrasonic wave travelling at a speed of around 344 m/s (sound wave velocity), the wave is reflected back to the sensor [9].

4.3. ESP8266

The ESP8266 is a micro controller with minimum power consumption. The ESP8266 also has wireless tools which can be integratedwith internet networks. This ability makes the data sensors can be sent web servers and smart phone applications to inform the floodingalert [9].

Despite the importance of low power consumption, the communication is effective if within range, only, thus imposing a trade-off between communication range and transmission power. Studying this trade-off in detail is beyond the scope of this paper, but we are interested in assessing the practical communication range in low power indoor scenarios, as in a manufacturing plant [10].

The module features an on-board antenna which is particularly suited to be embedded in small devices. These antennas present a rathernon-uniform radiation pattern, with a toroidal geometry revolving around the module and the axis perpendicular to the antenna longitudinal direction [11].

Fig. 6 Image of ESo8266

4.4. TP4056

The TP4056 is a linear charger designed for single cell lithium-ion batteries. It features a low external component count and a small SOP package, making it ideal for portable applications. The internal PMOSFET architecture eliminates the need for a blocking diode, and prevents negative charge current. The charger regulates the charge current to limit the die temperature during high power operation or high ambient temperature. The charge voltage is fixed at 4.2V, and the charge current can be programmed with a single external resistor.The TP4056 terminates the charge cycle when the charge current drops to 1/10th the programmed value after the final float voltage is reached. It also includes features such as current monitoring, under voltage lockout, automatic recharge, and two status pins to indicatecharge termination and input voltage. The TP4056 is able to charge single cell Li-Ion batteries directly from a USB port and has a preset4.2V charge voltage with 1.5% accuracy. It also includes soft-start limits to limit inrush current. The TP4056 is available in an 8-lead SOP package, with an optional radiator that needs to be connected to GND [16].

FIG. 7 IMAGE OF CHARGING MODULE

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4.5. OLED

An OLED (Organic Light Emitting Diode) Display is a thin, lightweight and flexible display technology that provides brighter and morevivid colors compared to traditional LCD displays. The 128x64 OLED Display Module is a popular OLED display that is commonly used in various electronic devices, such as digital cameras, mobile phones, and portable media players.

This OLED display module has a resolution of 128x64 pixels, which provides clear and sharp images. It is designed with a built-in controller IC (SSD1306) that allows easy communication with microcontrollers via I2C or SPI interfaces. The display is also equippedwith an internal voltage regulator that enables it to operate with a supply voltage between 3V and 5V, making it suitable for use with awide range of microcontrollers and development boards.

The OLED display module has a high contrast ratio and fast response time, which makes it ideal for displaying graphics and animations.It also has a wide viewing angle, which ensures that the display remains visible even when viewed from different angles. Additionally,the display has a low power consumption and can be used in battery-powered devices without significantly affecting battery life.

Overall, the 128x64 OLED Display Module is a versatile and cost-effective display solution for a wide range of electronic devices. It iseasy to integrate and provides clear and vibrant images, making it a popular choice among electronics enthusiasts and hobbyists [17].

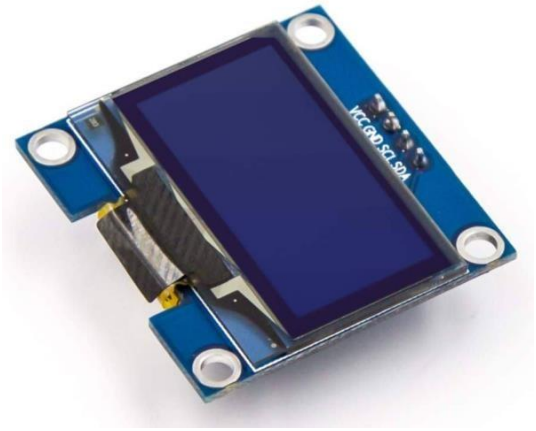

FIG. 5 IMAGE OF OLED

4.6. Li-ion batteries

Li-ion batteries are rechargeable batteries that have gained widespread popularity due to their high energy density, low self-discharge rate, and long cycle life. A 3.7V Li-ion cell rechargeable battery is a type of Li-ion battery that has a nominal voltage of 3.7V and can berecharged multiple times [18].

The 3.7V Li-ion cell rechargeable battery typically consists of a cathode made of lithium cobalt oxide, an anode made of graphite, andan electrolyte made of lithium salts dissolved in organic solvents. These components work together to facilitate the movement of lithiumions between the cathode and anode during charging and discharging cycles [19].

These batteries are commonly used in portable electronics such as smartphones, laptops, and tablets, as well as electric vehicles and renewable energy systems. However, it is important to note that Li-ion batteries have some safety concerns such as overheating and firehazards if not handled properly [18].

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FIG. 5 IMAGE OF LI-ON BATTERY

VI. WORKING

Your project sounds interesting and useful. A smart water dam management system is an innovative idea that can help monitor waterlevels and prevent any potential disasters that may occur due to the rise in water levels. With the help of NodeMCU ESP8266, you canmanage and control all the hardware components attached to it, including the ultrasonic sensor and the Lora module for data transfer.

Using an ultrasonic sensor to measure the distance between the water surface and the sensor itself is an accurate and reliable way todetermine water levels. The ultrasonic level transmitter mounted on the top of the dams transmits an ultrasonic pulse down into the dams,which reflects back to the transmitter from the liquid surface. The time delay between the transmitted and received echo signal is measured, and the microprocessor calculates the distance to the liquid surface, providing real-time data on the water level.

The Lora module is an excellent choice for transmitting data over long distances without an internet connection. It can transmit dataup to 4 km, which is more than sufficient for your project. The data collected from the ultrasonic sensor can be sent to the server via theLora module, where it can be stored and retrieved when needed.

The LCD display can be used to show the real-time distance of water level to anyone who needs it. However, you have taken it to thenext level by incorporating a user-friendly application that allows the user to ask the neo dams about the water level. The real-time datawill be fetched from the online server, and the user will receive the information on their smartphone screen. This provides an efficientand convenient way for users to monitor water levels, preventing any potential hazards.

The alert system you have created is impressive, as it allows users to inquire about the water level status, and the ESP8226 Wi-Fi module will collect the information from the sensor. With the help of Wi-Fi and internet, the data will be stored in the server and converted into a telegram bot message reply with the help of backend code. This provides an easy way for users to get the information they needquickly and efficiently.

VII. CONCLUSION

We have designed an application and completed its partial development. Our application will provide real-time data on the water levelwhich will be based on the status of the dam. In dangerous situations our application will give an alert message to villagers, We have applied engineering knowledge to analyse the problem of interior designing of healthcare systems, and village offices and to take care ofreservoirs, etc. Then we designed the application in two modules. We have investigated the available application to find out the new solutions and updates. We have used a hardware Lora (long-range radio) Modern tool for the implementation of the device and to makeour application. During this project, we applied professional ethics and understood the importance of teamwork and communication whilepresenting projects in various competitions and conferences for project management. This solution can be developed at a generalized level for multiple sectors for life-long learning.

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ACKNOWLEDGEMENT

We would like to acknowledge the Department of Electronics Engineering for the support extended for the completion of this work. Wewould like to express our special thanks to the guide As well as H.O.D of the Electronics Department Prof. **V. N. Mahawadiwar** for theirwholehearted Co-Operation and valuable suggestions, technical guidance throughout the work, and kind official support given and encouragement. We would also thank our friends for their encouragement in completing this work.

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