IoT based Smart Water Monitoring System

Rohit Kumar[1], Shubham[1], Palak Shandil[2], Avinash Kumar[3], Bhgah Y. Adam[4], Hamza Abdullah M. Adam[5], Sushil Dohare[5], Saptadeepa Kalita[1*]

[1] Department of Computer Science and Engineering, Sharda University, Greater Noida, India
[2] GL Bajaj Institute of Technology and Management, Greater Noida, India
[3]SITACS, Rastriya Raksha University, Gujarat, India
[4]Health Education and Promotion Department, College of Public Health and Tropical Medicine,Jazan University, Saudi Arabia
[5]Jazan University, College of Public Health & Tropical Medicine, Epidemiology Departmental, Jazan, Saudi Arabia

Abstract

Traditional water tanks which is not able to monitor the water level in water tank and not able to control the water pump, thus wasting of water due to overflowing of water is very serious problem. This works aims to solve these issues and offer an effective, affordable solution. An IoT (Internet of Things) system that aids users in solving such issues is integrated with sensors and devices to monitoring the water levels. The accessible IoT technology is implemented through Arduino. The water tank's level of water is broken down into maximum, minimal, and nominal levels, each of which is indicated by a various colour. An HC-SR04 ultrasonic sensor is installed on the tank's top to monitor the water level, measure the distance between the point and the sensor, and transfer the information to the Android app via Arduino. The Android applications has two option on/off switch that is used to check water level and operate the same. The Android application offers a user interface with buttons for manual operation, a motor status LED, and a tank.

Keywords: Smart Water Management, IOT, Arduino, HC-SR04

1. Introduction

Water is the most important thing found on earth which is helpful for living beings to survive. Without water, life is impossible on earth. It is the most precious thing for living beings. Water conservation is very essential in order to preserve the groundwater. Due to the population explosion and their growing aspirations for urbanisation, industry, and other forms of development, safe drinking water is becoming more polluted and harmful. The oceans hold 97% of the world's water, which covers 71% of the planet. The ocean water is too salty and cannot be used for domestic purposes like drinking, cooking, washing, and so on. So, only groundwater (3% of a total volume of water) is accessible which is used by humans to fulfil their daily needs. In recent surveys, it is found that freshwater resources are rapidly diminishing, Creating panic among various countries [14]. The primary causes of this crises include uneven water management deployment, consumption of water increased drastically in urban areas, lack of awareness among humans in order to consume water resources. In rural areas, water is largely used from ponds, lakes, and tube wells by the people to fulfil their agricultural uses, personal hygiene, washing, drinking, watering plants, etc. Whereas in the urban areas, water distribution by the government bodies like municipal corporation large overhead or underground water tanks are used to store the water, and various parts of major cities receive water supply from such tanks. There is an abundance of water, particularly in small towns and cities. However, although the population of the planet is expanding, there is a shortage of freshwater resources. The need for water is rising today as a result of population expansion in both urban and rural areas. Naturally, the safe drinking water distribution system must be maintained in order to consistently meet people's needs for safe drinking water as that the consumption of water rises. Fresh water is desperately needed, particularly in crowded cities. Water tanks are one of the key pieces of equipment that almost every local, state, and private institution has today as a storage container for clean water for daily use. It is well known that the availability of clean water is a critical part of

safety, comfort and energy efficiency for customer satisfaction and productivity. Water tanks on the roof/tower require pumps as a means of filling the water, and its distribution uses gravity to direct the water to multiple points of use, so the water tanks on top require no power or other power [15].

For a very long time, water was essential to everyday life. With global ecosystem as it is now, managing and protecting water is vital to human survival. Today, there is a significant need for consumer-based humanitarian projects that can be established using IoT technologies. The suggested method, however, we use an Android mobile application to detect the water level in the real-time scenario and allows the user to monitoring and operating the water tank as per requirement of the user.

2. Literature review

Reddy et al. [1] develop a system in which many IoT devices are used for Smart water pump Switches. In this system IC555, Relay board, Crystal Oscillator, Switch, and wires is used. The working of ic555 and the crystal oscillator is sensing the water level and transmit the signal to the electric circuit board *(Relay Board)* that is connected through the wire to the water pump. After receiving the signal, system act out their specific work like on/off the water pump. Water level monitoring system which is an IoT device. It is designed for control the water wastage which is occurred by the overflowing of the water tank in an urban area. This technique aids urban residents in determining the water level and prevents drinking water waste in cities [2]. Getu et al. [3] focused in a water monitoring system's architecture. A system is created that can automatically monitor the water level and operate the water motor. Their technology first detects the water level before sending the signal to a board that is connected to the relay board. With the use of flip-flop sequential logic, this device automates processes. When the water level reaches the water tank's lowest level, this device automatically turns on, and when it reaches its highest point, it automatically turns off [16][17].

Johari et al. [4] developed a water monitoring system using gsm technology. A system is designed that uses GSM communication technology for monitoring the water level and send the signal through SMS to the person. Their prototype is tested and implemented over many areas. This is a straightforward GSM network-based water level monitoring device. This work sensed the water level by this system's ultrasonic sensor for overhead and underground tanks. Additionally, this will include a pump switching and control system that displays and tracks the tank's water level. Power supply, microcontroller, sensor, display, and Arduino Uno make up this system. They use a 20 kHz ultrasonic sensor to determine the water level, and a crystal LCD display to show it [5].Wadekar et al. [6] delivers a study on Internet of Things (IoT) devices that assist users in monitoring and managing water use. The device is simple to put anywhere in the residential area, and we can see the water level there. due to the fact that the data will be cloud-stored. The water motor is automatically controlled by the motor in real-time in accordance with the water level. When the water is filled to the top of the tank, the motor will automatically turn on and shut off when water level reaches the bottom [18][19]
The ZR16S08 microchip is described in this paper as an Internet of Things (IoT) alternative for a smart water system. Knowing that leakage is one of its defining characteristics, the systems carefully check the water flow in the distributing channel's pipelines to assure the quality of the water supply [7]. An important key characteristic of the IoT water management system is automation. Everyone's life is made simpler and easier as a result [20][21][22].
A platform-independent, service-oriented architecture called OPC UA (Object Linking and Embedding for Process Control Unified Architecture) is used to monitor procedures of manufacturing and distribution. On the basis of this concept, we provide a paradigm for smart water distribution that fuses Internet of Things technology with technologies for coordinating business processes and making decisions. Singh et al. provide detailed descriptions of the architecture for subsystem interactions and the physical scenarios against which the implementation is tested to manage and interoperate with specific vendor equipment in specific contexts of water management processes. [9] Groundwater had already long played a significant role in daily living. Water management and protection are necessary for human economic stability given the situation of the environment globally. Consumer-based humanitarian projects that may be quickly built using Internet of Things (IoT) technology are greatly

needed nowadays. This paper implies a real-time, Internet of Things-based system for water monitoring [10].

A prototype is developed using sensors and devices to monitor the level of water in a personal or commercial tank. This work explores the benefits and challenges of using IoT architecture in water management, as well as current and future applications of this technology. The potential impact of IoT technology on water sustainability and the role of water utilities in driving this innovation forward is also discussed.

3. Proposed system

The proposed system is based on the notion that, particularly in blunder areas, level of water is a crucial element when coping with floods. A water level sensor to monitor a desired parameter, and when the parameter is reached, a signal is immediately forwarded to social media sites like Twitter. Data storage was set up on a cloud server. Readings for the water level are shown on the screen of the transmitter.

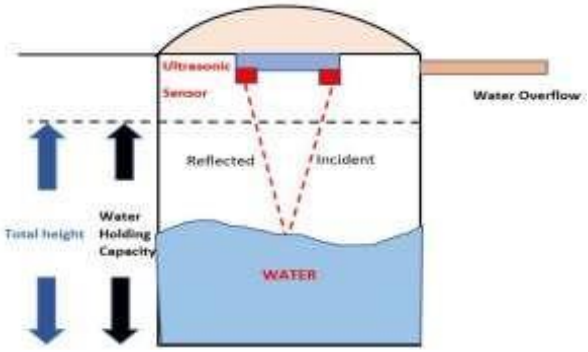

Fig 1: Proposed system

The below mentioned Table 1 shows the list of components that are used for the proposed system.

Sl. No.	Components
1	ESP32
2	Ultrasonic Sensor (HC-04)
3	Pump
4	Resistor (1K 10K)
5	IC7805 (Voltage Regulator)
6	Capacitor (1000uf)
7	Diode (4007)
8	Transistor
9	Wire

The circuit diagram of the proposed system is represented in Fig 2.

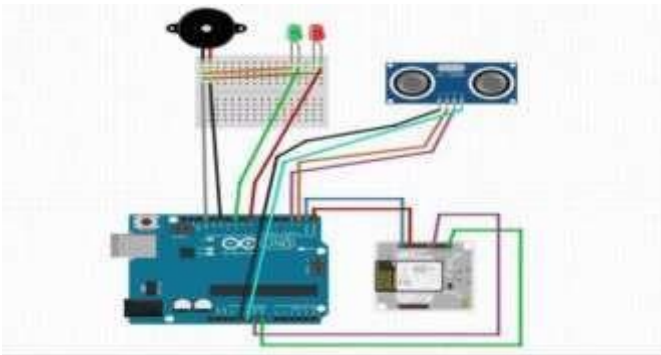

Fig 2. Circuit Diagram of the Proposed System

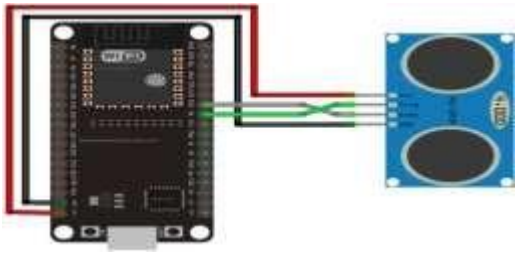

Fig 3. Level Detection Circuit

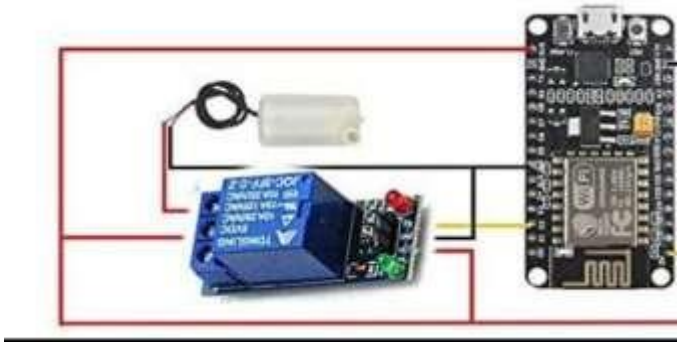

Fig 4. Pump and Relay Board Connection

4.Evaluation of Water Monitoring techniques

There exist various water monitoring techniques that were implemented since ages. Some of them were the ancient traditional monitoring techniques which later on switched to smart monitoring techniques.

4.1 Traditional monitoring

The traditional water monitoring system is a manual process. It involves checking the water tank on a regular basis to ensure that it doesn't overflow. This allows for 24/7 h monitoring of tanks without the need for manual checking. Which is manually may not be feasible in many cases. If any leaks occur on the tank, then they will be reported manually. Which are causes of water wastage.

However, there are various drawbacks to this process. Firstly, it is time-consuming and requires a lot of energy. Secondly, it is not accurate and can lead to the wastage of water as well as electricity. Thirdly, it does not provide alerts when the tank is about to overflow which can result in major problems like flood or leakage in the house. 24/7 Water Monitoring is expensive and difficult for homeowners. There is no water tank that can be monitored 24/7 on its own without needing human interaction to fill it when it reaches a certain level [11].

4.2 Offline automated monitoring

Today, there is an emerging trend of water conservation and reforestation. With the increase in population, the growing need for potable water is inevitable. The current method of refilling tanks is not sustainable and inefficient as it requires constant monitoring to refill tanks when they become empty. The system is designed for remote monitoring of water tanks. The system includes a wireless sensor node, a set of actuators, and a processor. The wireless sensor node gathers the data from the

sensors and sends it to the processor wirelessly. The actuator sets the tank's valve according to the data received by the processor.

No matter how clean and well-maintained oner water tank is, it is important to regularly monitor the level of residual water for the sake of safety. The offline Monitoring system can automatically measure how much water is left in oner tank (in litters and gallons), and alert one when one need more. This can be used in places where there is no electricity or internet connection available but there is still a need for water storage tanks to be monitored periodically [11].

4.3 WSN-based Monitoring

WSN is a new type of wireless sensor network that has been widely used in monitoring water quality in rural areas. Wireless sensor networks are a promising technology for extending the capabilities of off-line monitoring systems. It is also a set of spatially distributed autonomous sensory nodes that cooperatively monitor physical or environmental conditions, such as temperature, sound, pressure, motion or pollutants. In this system, sensor node reads the sensor data and processes them for monitoring. The captured data sends to the main section through wireless channel (e.g., Lora WAN, Xbee, Wi-Fi, Bluetooth, server). The main channel further processes the data and then send back to the main section. The main section has further functions such as analysis and decision-making.The WSN-based system is a new type of monitoring system that can be used in many different fields, such as agriculture, environment, home security, and health care. This system is based on rural drinking water source monitoring system design can provide timely information for users about water quality in real-time [12].

4.4 Smart Monitoring:

It is designed to ensure water conservation by monitoring the quality of water and the amount of water used. This monitoring system consists of sensors, a communication module, a data-logging device, and an application. The sensors monitor the level of dissolved oxygen (DO), pH level, temperature, conductivity (EC), turbidity (NTU), and chlorine residual (ppm) in real-time. The communication module sends data to the cloud for storage and analysis while the data logging device stores all sensor readings in local memory for offline analysis. The application provides users with real-time alerts on potential problems such as leaks or low levels which require attention from maintenance personnel. With the help of a smart water meter, one can monitor oner tanks on oner own schedule- at any time or interval one chooses. One will also not have to worry about detecting leaks in time to stop them because the meters themselves self-regulate the amount of water M. Kumar Jha et al. provide based on consumption patterns detected within the system [13].

5. Benefits of IoT Architecture in water management

Below mentioned are some of the benefits of monitoring water level based on IoT architecture.

Introduction of Technologies: In recent years, the Internet of Things (IoT) and related technologies have revolutionized various industries, including water management. IoT architecture involves the use of interconnected sensors, devices, and data analytics tools to monitor and manage water systems in real-time. By leveraging this architecture, water utilities can improve efficiency, reduce costs, and enhance customer service. IoT technology is particularly useful in water management, where it can help utilities to monitor water quality, detect leaks and breaks, and optimize water usage. Sensors can be used to monitor water levels, flow rates, and pressure, allowing for early detection of issues and more efficient use of water. Real-time data analytics can provide insights into patterns and trends in water usage, which can inform decision-making around resource allocation and system optimization. Moreover, IoT technology enables remote access and control of water systems, reducing the need for on-site visits and improving system maintenance and efficiency. This also allows water utilities to provide real-time information to customers on their water usage and billing, improving customer satisfaction and reducing complaints.

Real-time monitoring: IoT architecture allows for continuous monitoring of water systems, including water levels, flow rates, and water quality. This enables early detection of any abnormalities or issues in the water system, allowing for timely interventions to prevent water wastage and system failures

Data-driven decision-making: With IoT architecture, data on water systems can be collected and analysed in real-time. This allows for data-driven decision-making, including identifying patterns and trends in water usage, predicting future demands, and optimizing water supply.

Remote access and control: IoT architecture enables remote access and control of water systems, allowing for adjustments to be made to water levels, flow rates, and quality parameters from a central location. This reduces the need for on-site visits and improves system maintenance and efficiency.

Cost savings: IoT architecture can help reduce operational costs by improving water efficiency and reducing water wastage. It can also help with predictive maintenance, which can prevent equipment failures and reduce repair costs.

Improved customer service: With IoT architecture, water utilities can provide better customer service by providing real-time information on water usage, billing, and alerts for water quality issues. This can improve customer satisfaction and reduce complaints.

6. Implementation of IoT in water management system

IoT based smart water monitoring system is now implemented in every industrial as well as agricultural sectors. Some of the areas where applications of IoT based water monitoring techniques are used are discussed in the below section.

6.1 Smart Water System

The water system is a complex, large-scale system. The system includes all the water sources, such as rivers, lakes and streams. All these sources are connected to the water treatment plants that provide clean drinking water to the consumers. As we can see, there are many risks in this process. For example, if someone leaks a pipe and it is not detected in time, then the entire water system will be contaminated with dirty and polluted water. This can lead to outbreaks of diseases that could affect people's health. IoT technology provides an opportunity for detecting these problems before they occur. IoT sensors can detect any changes in the quality of drinking water or even pipe leaks before they have an impact on human health or on the environment A smart water system is a system in which the water quality is monitored by using IoT technology.

6.2 Smart Irrigation System

The agricultural industry is already aware of the advantages that IoT technology brings to their sector. Agriculture is one of the sectors that are adopting new technologies to improve productivity and profitability. IoT devices Collects the data that can be used for various purposes such as monitoring and controlling agricultural processes. Weather stations are an example of an IoT device used in agriculture; they collect information from different types of weather sources such as temperature and precipitation. Collected data is then transferred to a database where it's analysed for agricultural forecasting purposes.

Another interesting application of IoT in agriculture is in the field of prediction. Farmers use IoT to collect data from their systems and systems they are connected with via the internet. Data collected can help predict weather conditions before sowing or harvesting crops. Farmers can use this information to schedule their activities regarding crops so they can maximize productivity and profitability while minimizing risk exposure. Some example devices used for agricultural forecasting include solar-powered environmental sensors, digital scales, thermometers, barographs and precipitation collectors. Additionally, farmers can also use mobile terminals to check market conditions, prices and other relevant factors affecting their business decisions. The industry needs new innovative technological solutions for more efficient agriculture operations; this includes implementing smart technology such as the Internet of Things into farms. Many applications like

weather forecasting or managing livestock help produce better crops with minimal input from farmers. Implementing smart technology allows farmers to spend more time focusing on producing high quality crops rather than maintaining equipment themselves.

6.3 Smart Gardening

Gardening is an outdoor activity enjoyed by many people. Many people find gardening therapeutic and enjoy the fresh produce it provides. However, gardening is a time-consuming task; it requires planning, equipment and labour. Using IOT in smart gardening reduces the time spent in tasks and makes them more convenient. Gardening involves a lot of time spent walking around and checking various areas of oner garden. Checking oner garden's progress over time collects data that helps one plan oner garden. An IOT device can be used to collect data about plants, pests and soil conditions. One can then make informed decisions about oner garden's care. Additionally, one can share oner garden's data with others for feedback or to help one with one's problems.

7. Pros and Cons of IoT based Water Monitoring System

Some of the advantages of IoT based Water Monitoring System are:

Power Saver

Water level regulators are the best way to save electricity because we are in an era where we have to be conscious of energy. Adjusting the water level normally consumes electricity and waste water. However, automatic control limits power consumption and requires less water to regulate the supply.

Money Saver

Water level controllers help one save money by limiting wasted water and electricity. These devices precisely regulate the amount of energy used to prevent unnecessary water/electricity consumption. Over time, the money saved is very important.

Automatic

Another notable advantage of these devices is their self-adjusting capability. Minimize the frustration of manually monitoring oner water tank by eliminating manual intervention with a timer. The automatic operation of these devices keeps the water level at proper level.

Water maximization

On average, water pumps are used more frequently during lunchtime. The water levels controller can maximize water usage during lunchtime and automatically reduce water wastage at night. This allows one to make the most of the water at the right time while always maintaining the right water level.

Compared to the pros, the cons of smart water monitoring are too less. Some of the cons are the environment can be rusted, foul and deteriorate which can affect the working of the sensors and devices. There has to be annual maintenance or regular monitoring of the tanks in order to check the proper working of the system.

8. Conclusion and Future Scope

Water is one of the most essential for human life. It is used for drinking, cooking, bathing, and many other things. So, it should be treated with care and not be polluted. In this research, a smart solution is proposed to stop overflowing of water tanks, which in turn can lead huge water wastage. So, the proposed system uses water level controllers helps to save money by limiting wasted water and electricity. These devices precisely regulate the amount of energy used to prevent unnecessary water/electricity consumption. Over time, the money saved is very important.

In future, the systems can be modified to detect the temperature and humidity of water. Water quality sensors such as pH, humidity and turbidity can be implemented to continuously monitor the water purity along with the water level. It can also integrate the implementation of GSM systems along with IoT.

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