A Social Application of Artificial Intelligence & IoT for Water Conservation

Sandeep Rathor1* & Shalini Kumari2

1,2Department of Computer Engineering & Applications
GLA University, Mathura
Sandeep.rathor@glau.ac.in
Shalini.kumari_cs18@glau.ac.in

Abstract: Water is an essential resource for all life on earth. As time advances, water is becoming scarcer. Water is a renewable resource and if not managed, in the coming time, it will become a non-renewable resource. Therefore, it is necessary to handle the management of water smartly. So, artificial intelligence technology can be utilized to change conventional water and wastewater into instrumented, interconnected, and intelligent systems. This paper proposes a low cost and affordable smart & intelligent water conservation system. The objective of the paper is to make a smart water conservation system for the society with the help of the artificial intelligence and IoT. Artificial intelligence using IoT provides accurate automatic task and up-to-date information that enables information and systematic decision. Implementation results show that, how have we made water conservation systems smart by using artificial intelligence and various sensors and microcontrollers.

Keywords: Application of artificial intelligence, IoT, Water management system, Social use of artificial intelligence, Water conservation system.

1. Introduction

An artificial intelligence can be utilized with IoT to help people to live and make them work smarter [1][2]. An IoT consists of web-enabled smart devices that use embedded systems, such as microcontrollers, sensors, and communication hardware IoT also used to collect, send, and act on data they acquire from their environments. IoT devices share the sensor data from an IoT gateway or other edge device where data is either sent to the cloud for further analysis or analyzed locally. These devices communicate with other devices and act on the information they get from one another. IoT can help with the ability to monitor operations surrounding infrastructure. IoT technology in Water Management Systems will surely make our lives convenient and conserve our valuable resources like water.

In 2005, none of the 35 Indian cities with a population of more than one million for more than a few hours per day water was being distributed [3]. Because of inadequate pressure, people struggle to collect water even when it is available. According to the World Bank, no one has performance indicators that compare with average international standards. By the study made in 2007, the Asian Development Bank showed that in 20 cities the average duration of supply was only 4.3 hours per day.
According to the United Nations Development Programme, water scarcity is caused mainly because of the poor management of the resource. It is seen that almost half of the world population will face water scarcity by 2025 which indicates that water will be a valuable resource in the upcoming time. Therefore, it is necessary to manage water smartly. The objective of the proposed research is to:

- Give pure water to the users as they can stay healthy.
- Automatic switching on/off of the water pump so that water does not overflow and wastage of water could be reduced.
- Handle the water leakage smartly to reduce the wastage of water.
- Maintain the record of uses of water in the society as it can be helpful for further analysis.

2. Literature Review

Many researchers have proposed their research on water management and safety but water is a very precious resource and requires a holistic solution. The problems associated with water wastage and contamination needs to be addressed carefully. Some researchers have worked in the following context:

The use of artificial intelligence and IoT in agriculture is proposed by Mishra et al., [4]. In this paper, the author proposed a model for agriculture and food by utilizing artificial intelligence and IoT. By the proposed model, all the resources are managed very well but it is specific to agriculture and food only. A new edge architecture of AI-IoT is proposed by deBauge et al., [5]. In this paper, the author managed huge amount of data by using cloud services. The author also provided the mechanism for classical data storage and processing architectures. In this paper, general techniques are discussed and anyone can utilize this concept in their implementation.

Water quality monitoring system has been proposed by Kedia[6]. In this paper, the author has highlighted the need to safe water for everybody despite the economic or geographical conditions. Water purity is indeed a serious concern and we have worked on it in our solution. We have gone further with management of water in addition to purity check. The use of sensor networks is proposed for water quality check [7] but the selection of the particular sensors in not discussed in deep. Selecting a sensor in this context needs to examine many factors such as if it is waterproof or not.

A remote monitoring of wastewater treatment is proposed [8]. Plants are very important to tackle the problem of shortage of water. Water is getting scarce day by day and proper steps need to be taken to save it. Therefore, the author, elaborated one of the most significant problem of water leakage to tackle the wastage of water. In the same context, urban water management is proposed by Eggimann et al., [9]. In this paper, the author used data-driven approaches. Using data, the author build an application for water conservation but there is no data security and privacy mechanism in their research.

Various approaches have been proposed by various authors in this context but there is the need of a system or model that meet a holistic solution. The system should works on
conservation of water with full data privacy and security mechanism. Therefore, in this paper, we proposed a model that full fill this gap.

3. Proposed Model

Initially the proposed model is implemented on a single building. The water from the reservoirs is initially checked before supplying to the society for its quality by using a pH sensor and turbidity sensor and the quality status updates on the real-time cloud server by using nodeMCU (microcontroller). After the sensors approve the quality of water it will be directed towards society. Now we have an ultrasonic sensor that checks the water level in the tanks in real-time. If the level of water falls below the minimum set point (as per algorithm) the ultrasonic sensor will send the signal of low water level to the nodeMCU and then get updated on a real-time cloud. Now the relay will receive the real-time data from the cloud and send the signal accordingly to start the motor [10]. The motor pumps the water in the tank and starts filling it until the ultrasonic sensor sends a signal to nodeMCU for maximum point fill and the relay stops the motor accordingly [11]. By repeating these steps our tanks will be automatically filled and can also be operated through our mobile app.

![Proposed model for water conservation system](image-url)
Figure 2: Work flow of the proposed model for water conservation system

In the proposed model, the water is checked for its quality at its source. The water goes through two quality tests. Initially, the turbidity is measured by the turbidity sensor. If the turbidity is not according to the quality standards, the supply gets stopped, and an alert gets sent to the user. After the turbidity check gets passed, there is a pH check of the water. The pH of the neutral water is 7. Thus, the portable water pH should be in the range 6 to 8. If the water fails the pH test, then the supply will get stop, and an alert will get sent to the user similar to the case of turbidity. After the water passes both of the quality tests, the water get further supplied. Every water tank has sensors for water level measurement. The data from these sensors get monitored in real-time. Whenever we get the minimum threshold value, the motor gets turned on automatically. Similarly, for the maximum threshold, it gets off. When the motor turns on, the water quality check for the water coming from the underground reservoir gets done continuously.

In the back-end, a leakage algorithm is running. The consumption data gets stored on the cloud daily. We use the data for another leakage test. Our model, fix a peak point, i.e., if the
consumption increases by 10% of the usual, then it deduces that there is a leakage somewhere. In case of a leakage, an alert sent to the user about it. The user can take the required actions accordingly.

**Working Algorithm**

**Step 1:** Note the current level of water in the tank (i.e. initial water)

**Step 2:** Initially Time = 0;

**Step 3:** if(time == 60 minutes):
   - Add initial water - current water to consumption
   - Initial water = current water
   - Time = 0;

**Step 4:** Every hour the data of consumption is updated on the cloud.

**Step 5:** Stop

3.1 Interconnectivity

For the interconnection, all the microcontrollers (NodeMCU) are connected through a mesh topology as shown in the figure 3. Mesh topology provides efficient data transfer[12]. Coming to the microcontroller, NodeMCU is very versatile. It provides us various advantages like GPIO pins, WiFi Module(ESP8266), and its special function to act as a server as well as a client.

![Interconnectivity used in the proposed model](image)

**Figure 3:** Interconnectivity used in the proposed model

In the proposed model, one microcontroller (nodeMCU) works as the master and all others work as a slave. The slave microcontrollers send their data to all the microcontrollers within their range and then they further forward to the master microcontroller. So, the data transfer is hop to hop from one node MCU to another, until finally reaching the local server. The local server then stores all the data over the cloud using the router. The data transfer within the devices, i.e. between the sensors and microcontrollers is based on the MQTT protocol (Message Queueing Telemetry Transfer/Transmission) and for the communication between microcontrollers, ESP8266 is utilized which is based on the IEEE standard 802.11.
3.2 Complete Architecture of Proposed Model

All the microcontrollers are connected with the power supply which is provided to the house. A switch is used to connect all the node MCU (connected to the power supply by adapters and USB which will supply +5V) with the pH sensor, turbidity sensor, flow sensor and relay wand a valve in between. The water from the water reservoir is supplied to all the buildings which is connected with a water pump and this water pump is attached by a switch, Relay, and a Node MCU. On the top of these buildings, there are 2 tanks having 2 ultrasonic sensors, one for each tank on each building. These two ultrasonic are connected to a Node MCU and this Node MCU is further connected with the relay. So, the buildings isoperated by a switch on the top of the building itself present near each tank as shown in figure 4. All of the buildings and reservoir’s Node MCU send data directly to the cloud which can be easily monitored or accessed through consumer’s laptops and mobile phones at their homes very easily. Also, this data helps to analyze the daily consumption of water in the societies [13].

![Figure 4: Complete architecture of the proposed model](image)

4. Implementation Results & Discussion

The proposed model is implemented and the data is accessed on the mobile through an application. For a smart intelligent system, we have connected all the sensor’s readings to the secured cloud platform and created a smart mobile application for the users. The readings are uploaded on the secured cloud platform in real-time and also displayed to users in real-time through this application. This application offers many features to the users. To access these features, a specific user id and password is provided to each user to login.

There are different features provided by our smart intelligent system:

- **Water Quality**: This application provides the user to see the pH of water and turbidity.
- **Water Levels**: Application also provides users to read the water levels of their tanks in real-time.
• **Perform Water Leakage Test**: There is a button in the app which reads “perform water leakage test” by which user can perform leakage test as discussed in the water leakage algorithm.

• **Start/Stop Motor**: This app’s main highlight is the feature to manually start and stop the motor to particularly fill the tank whenever the user desires. Although motors are automated, giving these features will be a bonus to users. There are two separate switches in the app for both the tanks placed at each building, and any switch among these can be used for manually starting and stopping the motor for the desirable tank.

• **Cut Water supply**: At any time if a user wants to cut the water supply for any reasons like if he/she is leaving home for some days, so in their absence at home they can cut the water supply using an appropriate button in the app. After clicking the button software will automatically cut the water supply using the smart water meter.

• **Alert/Notification**: Through this app user will also get alerts/notifications about water leakage, etc.

All the data is securely and safely uploaded in real-time on a secure cloud platform. Our proposed model, manages all the aspects including water purification and conservation of water. Our purification checks ensure that safe water is accessible to the people and the leakage algorithm tackles the wastage of water. The leakage is a very serious problem and our model provides minimum wastage by early identification and rectification. The automation using sensors and microcontrollers also ensures zero wastage of water.

Our model can help in conserving water as there is no such model available in market for users. Our model is practical and can be implemented in the cities. The approach is efficient and considers all the various issues that are currently faced in the management of water.

5. Conclusion

In this paper, we proposed a low cost and affordable smart & intelligent water conservation system. Initially the proposed model is implemented on a single building. We have used pH sensors for various future uses too. If the water is becoming acidic, then the software will automatically stop the flowing water by closing the valve at the reservoir using a relay. This acidic water can be stored in another tank and can be used for washing, gardening, etc purposes. Also, users will get an alert from the mobile application about water being acidic and consumers can urgently complain in any nearby waterworks in order to get clean water again.

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