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IoT in Water Resource Management: Trends and Innovations in Water Level Monitoring Systems

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Abstract

One of the major problems faced by most of the countries in the world is the issue of water scarcity, and wastage during transmission has been identified as a major culprit; this is one of the motivations for this research, to deploy computing technician creating a barrier to wastage in order to not only provide more financial gains and help the environment as well as the water cycle which in turn ensures that we save water for our future. Internet of things (IoT)-based water level monitoring system is an innovative system which will inform the users about the level of liquid and will prevent it from overflowing. To demonstrate this system makes use of containers, where the ultrasonic sensors are placed over the containers to detect the liquid level and compare it with the container's depth. The system makes use of AVR family microcontroller, Raspberry Pi, LCD screen, Wi-Fi modem for sending data and a buzzer. A 12 V transformer is used for power supply in this system. The LCD screen is used to display the status of the level of liquid in the containers. The liquid level is highlighted as colored to show the level of liquid present in the container with the help of a web page to the user. The buzzer starts ringing when the set limit of the liquid is crossed. Thus, this system helps to prevent the wastage of water by informing us about the liquid levels of the containers.

Keywords: NodeMCU (node microcontroller unit), liquid crystal display (LCD), Wi-Fi, sensor, Blynk (software application)

INTRODUCTION

One of the major problems faced by most of the countries in the word is the issue of water scarcity. The scarcity is mainly due to the wastage of water. There is a need to control water wastage to save the environment and water resources. Water level monitoring systems are one of the techniques to address the control of water wastage. They observe the level of water and provides information to the registered users through wireless. In view of this, the Bluetooth module-based water level monitoring system is an innovative idea that will inform the users about the level of liquid and will prevent it from overflowing.

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The water level monitoring system is an automatic process to detect and indicate the level of water in the reservoirs, overhead tanks, or any other storage containers, etc. All the households are storing water in overhead tanks by using motor pumps. When the water is stored in the tank, no one can identify the level of water, and no one can know when the water tank will be filled. So, there is an overflow of water in the tank, which results in wastage of energy and water. To resolve this type of problem by implementation of water level monitors and control systems using wireless technology which will

transmit the information to the smart phone and indicate water level monitoring and alarm circuits can be used in factories, chemical plants, and electrical substations and in other liquid storage systems.

Earlier, simple water level indicator conventional systems were used for monitoring the water level of overhead tanks. It uses three LEDs (LED1, LED2, and LED3) to indicate minimum, middle and maximum water levels in the tank. The sensor probes comprise A, B, C, and D, where A is the common probe and B, C, and D are common probe, minimum, middle, and maximum sensing levels, respectively. When water in the tank touches both A and B sensors, a small current passes from A to B through water and to the base of transistor T1 via resistor R1. As a result, transistor T1 conducts and LED1 will glow. Similarly, when water touches sensor C, LED2 will glow, and it indicates that the water has reached the middle level. Finally, when water touches sensor D, LED3 will glow, and it indicates the maximum level of water. Therefore, all three LEDs glow when the tank is full. Hence, these types of conventional systems provide only indication to the users and the user should present and control the motors manually, which is the main drawback of the conventional systems.

In this paper, we propose a novel idea of collecting and sharing real-time information about water levels to an authorized central command center through wireless Wi-Fi protocol. NodeMCU based system is developed to know the level of water and control the flow of water. This system monitors the water level in the field and automatically and results show on LCD and mobile also.

LITERATURE SURVEY

Using a few sensors and the internet of things (IoT), Siddula et al. [1] provided a framework for creating an information system based on the current systems. They also put out the innovative concept of using remote field communication to gather and transmit real-time data on water levels to a central command center that has been authorized. The authorized central command center then decides whether to keep the dam gates closed or open them to discharge the water. This centralizes and automates the operation of dams across the nation [1].

A wireless water quality monitoring device based on microcontroller was created by Asha and Srija [2]. It is made up of a Bluetooth module and an Arduino. Using pre-programmed level indicators, the Arduino tracks the water level after receiving level data from the sensors. The Arduino sends the command to the Bluetooth module, which then uses Bluetooth to send it to the registered mobile device. Additionally, they installed a buzzer as a backup signal. They show off various water level settings, tracking, and buzzer and SMS warnings. Their suggested approach conserves power while monitoring and regulating the surplus water flow [2].

To create an IoT-based water level surveillance system that can be used in India's future smart villages, Malche and Maheshwari suggested a prototype system conceptualization, implementation, and explanation of the necessary tools and capabilities [3].

SOFTWARE REQUIREMENTS

Software requirements definition is an abstract description of the services that the system should provide, and the constraints under which the system must operate. Only the superficial behavior of the system should be specified and is not concerned with system design characteristics.

- *Operating system:* WINDOWS IDE
- *Coding language:* C language.

CIRCUIT DIAGRAM

As can be seen in Figure 1, circuit diagram of the water level monitoring system is simple. The signal pin of the water sensor is connected to the A0 pin of NodeMCU. While the VCC pin of sensor is connected to 3V of NodeMCU. Also, the ground pin of NodeMCU and sensor relate to each other. All the data pins of NodeMCU are connected to the data pins of LCD. D5 pin relates to the enabled pin of LCD. 3V relates to LED+ and ground relates to LED-. In this circuit we used 12 V adapter for power supply [4].

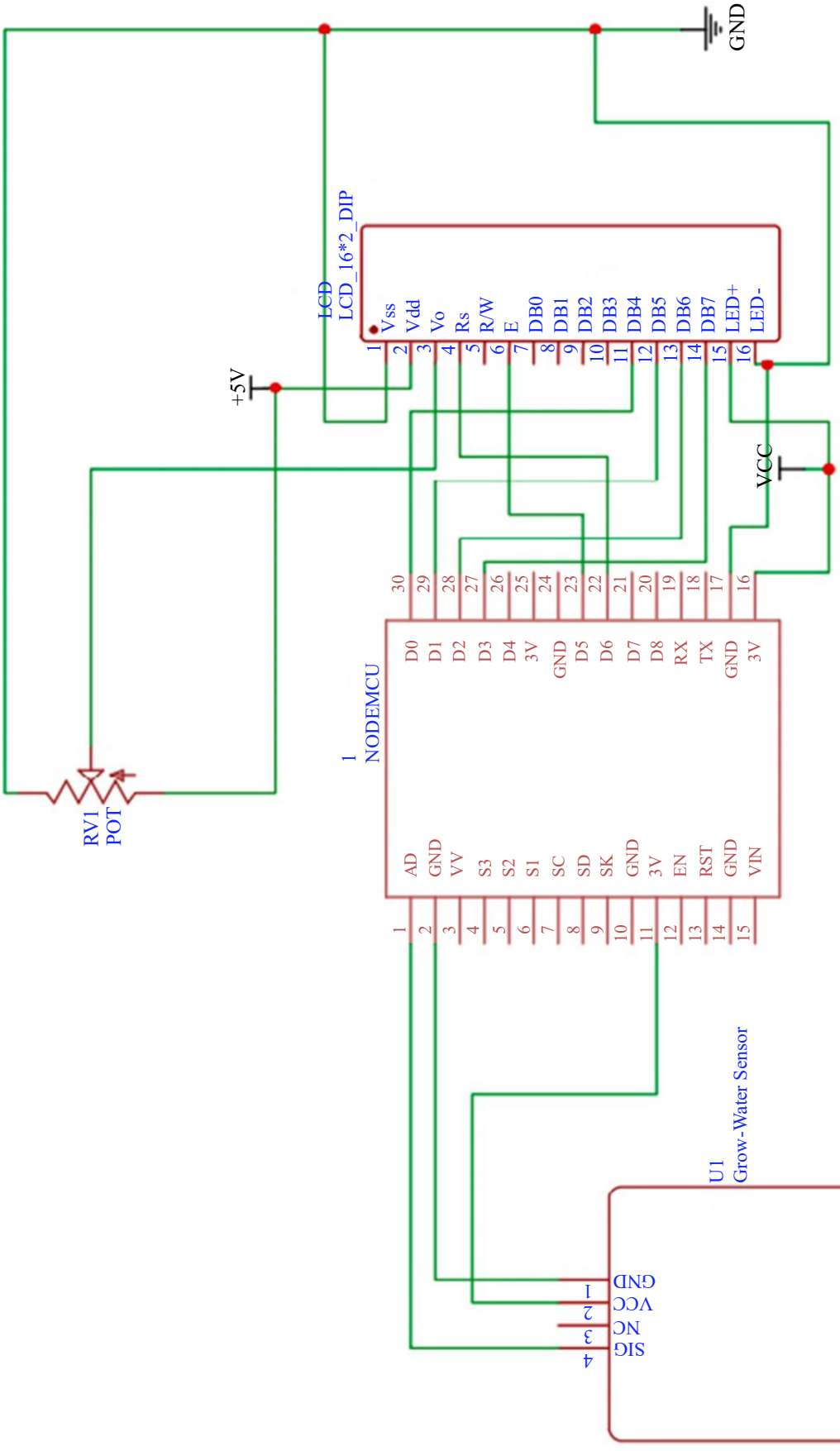


Figure 1. Circuit diagram of the water level monitoring system.

First, when we start the power switch, then the circuit will start, and the program will runn. The water level sensor senses the level of water in tank. If the tank is completely empty, then the output will show 0% on the LCD and mobile also [5]. If the tank is even a little full then it will show us the reading according to the water filled on that time like 10%, 15% 18%, 50%, 60%, etc. When water reaches the peak of sensor surface then it will be shown as 100%.

BLYNK IoT

Blynk is a hardware-agnostic IoT platform with white-label mobile apps, private clouds, device management, data analytics, and machine learning. Blynk is a hardware-agnostic IoT platform with white-label mobile apps, private clouds, device management, data analytics, and machine learning.

WATER LEVEL DEPTH SENSOR

The working of the water level sensor is straightforward. A water level depth sensor is shown in Figure 2. The series of exposed parallel conductors, together acts as a variable resistor (just like a potentiometer) whose resistance varies according to the water level. The change in resistance corresponds to the distance from the top of the sensor to the surface of the water [1].

Sensor Points

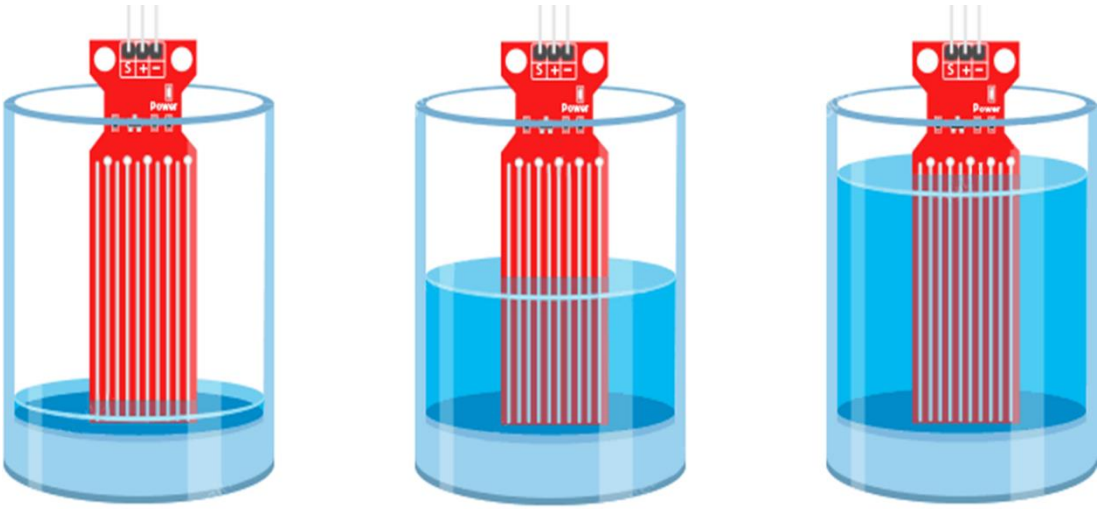
- S (Signal) pin is an analog output that will be connected to one of the analog inputs.
- + (VCC) pin supplies power for the sensor. It is recommended to power the sensor with between 3.3 and 5 V. Please note that the analog output will vary depending on what voltage is provided for the sensor.
- (GND) is a ground connection.

FLOWCHART

Principle of Operation

In this paper, we design a micro controller based wireless water level monitoring system, which consists of major hardware devices like NodeMCU, Wi-Fi module, water level sensors and LCD display. The flowchart is shown in Figure 3.

The water level sensors are used to monitor the level of the water and forward the same information to the cloud. Furthermore, NodeMCU processes the sensor information and the level of the water is displayed on the 16*2 LCD display [6].



Status: Dry
Test reading: ~0

Status: Partially submerged
Test reading: ~420

Status: Fully submerged
Test reading: ~520

Figure 2. Water level depth sensor.

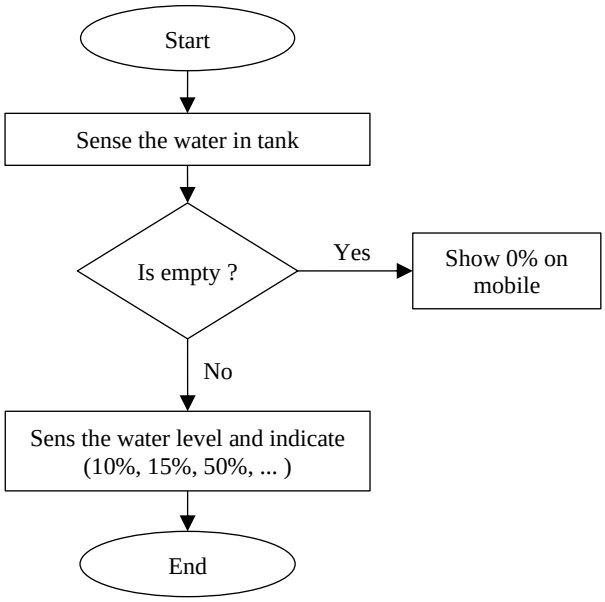


Figure 3. Flowchart of the proposed system.

The Wi-Fi module in NodeMCU receives the command from Node microcontroller and the same will be transferred to the registered mobile through Wi-Fi. Moreover, we place a buzzer as an additional indicator. Thus, smart phones receive information regarding water levels through wireless channels.

HARDWARE IMPLEMENTATION AND RESULTS

We have designed a water level monitoring system, and it consists of different sensor devices and other modules, their functionalities are shown in the Figure 3. In this implementation model, we used NodeMCU with inbuilt wi-fi module. Sensors are connected to the ESP8266 board for monitoring, ADC (analog to digital converter) will convert the corresponding sensor reading to its digital value and from that value, the corresponding environmental parameter will be evaluated. After sensing the data from sensor devices, which are placed in water [7]. The sensed data will be automatically sent to the Wi-Fi connection to the smartphone when a proper connection is established with the server device. By using this system any level value of any liquid can be observed. So, we performed different levels to find this. Here in this paper, we used four different levels which are given as follows:

1. 2% (initial stage).
2. 31% level of water.
3. 58% water level.
4. 82% water level.

The test results of these test cases are shown below:

- *Test case 1: Initial stage:* The initial stage setup is shown in Figure 4. From Test Case 1, we demonstrate that when the water is getting filled initially it displays on the LCD screen [8], and it sends a status of water level to the mobile through Bluetooth module, that is, 2% of water is filled.
- *Test case 2: 31% of water level:* From Test Case 2, we come to know that when the water is getting to touch another level, that is, 31% it displays on the LCD screen [9], and it sends a status of water level to the mobile through Wi-Fi module that is 31% of water is filled which is shown in Figure 5.
- *Test case 3: 58% of water level:* From Test Case 3, we observe that the water level is gradually increasing almost half and above the glass is filled and status in mobile is 58% of water is filled. Figure 6 shows that the water level is 58% [10].
- *Test case 4: 82% of water level:* Test 4 explains that when the water gets almost filled, It is displayed on the screen and sends a message to the mobile through Wi-Fi module which is shown in Figure 7.

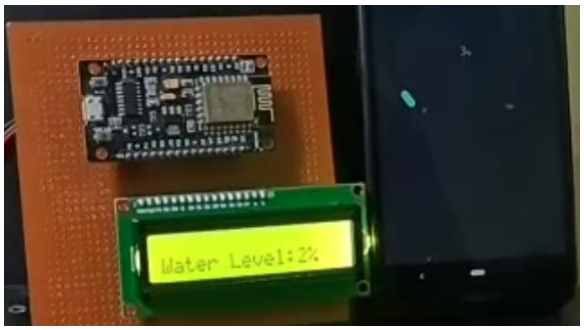


Figure 4. Hardware implementation test 1.

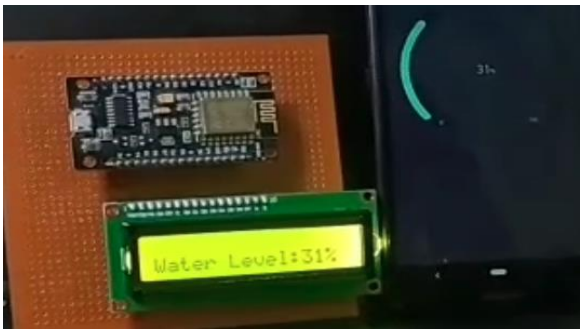


Figure 5. Hardware implementation test 2.

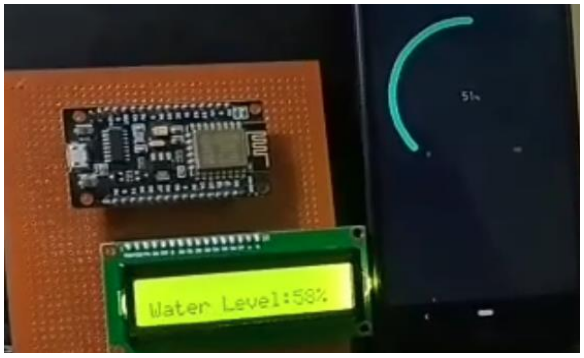


Figure 6. Hardware implementation test 3.

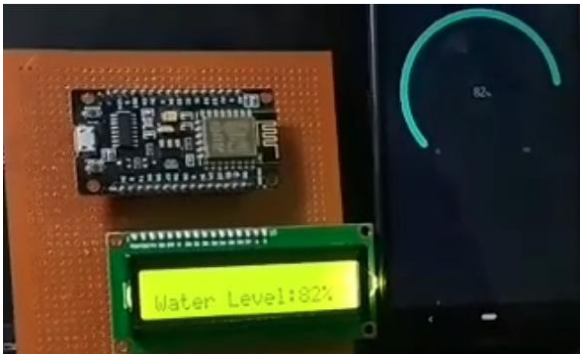


Figure 7. Hardware implementation test 4.

CONCLUSION

In this paper, we have presented a wireless-based water level monitoring system using NodeMCU and inbuilt wi-fi modules. It has been implemented using hardware components like NodeMCU, LCD, sensors, and 12V adapter. Here, we can monitor the levels of water present in any tank or container by observing the water flow. Furthermore, we can observe certain water levels through LCD and smart phone via Wi-Fi module. Initially, we programmed from 2%. The water pump starts filling from 2% to 100% after reaching 100%. Secondly, using highly advanced ICs and with the help of growing technology, the control system has been successfully implemented.

The internet has changed the dimensions of life involving virtual interaction. IoT has the potential to add new dimensions enabling smarter objects communications. The project proposes a simple water level monitoring system with different levels indicated. It also signifies when the water level is below and above the requirement. System design and architecture is as discussed, thus being a cost effective and simple strategy to monitor the water level system.

Future work can involve the analysis of water level in a particular area so that the wastage of water is prevented. We can also include the Global System for Mobile Communications (GSM)-based system where the message will be sent to the authorized person when the water level is below the required level.

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