The SBMAC System for the Prevention and Detection of Water Leakage

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Abstract: Water is one of the major needs of human life and in the agricultural field. So, water should be effectively utilized in all the fields without wasting a single drop of water. If water is not utilized properly, in the future we may face massive challenges. There are several research challenges in the utilization of water, such as the overflow of water, leakage in water supply pipes, utilizing more water in agricultural crops, and so on. To overcome these challenges, the SBMAC prototype in this proposed work will help to effectively utilize water and overcome other research challenges. The proposed work is IoT-based, which will have task-oriented sensors and microcontrollers to monitor and control the wastage of water. Because manual monitoring of these tasks is time-consuming and sometimes not able to detect easily. Proposed work can be deployed in any area of water utilization, such as homes, agriculture, industry, and so on. It will also solve the problems of water theft and regularize the water supply equally or according to the requirements.

Keywords: IoT, monitoring and control system for effective utilization of water, sensor.

1. INTRODUCTION

Water is one of the most important natural resources on earth. It is essential for all forms of life, and it is a limited resource. Despite this, water is often taken for granted and not given the attention it deserves. So, there is a requirement for the detection of water leakage and informing the concerned person to take the appropriate steps. If its not monitored and controlled properly and in time, the result will be the wastage of water, utility costs, and surrounding environments. The proposed prototype will help early detection of leakage, which enhances water savings, reduces electric consumption, and reduces other utility costs involved in water supply. The proposed SBMAC prototype provides data and analytics that offer insights into water usage patterns, potential vulnerabilities, and areas for improvement in water distribution systems. It can also help to detect water theft using the same hardware cost. One of the primary objectives of water leakage detection in apartments is to prevent damage to buildings, infrastructure, and property. Water leaks can cause structural damage, mold growth, and erosion, leading to costly repairs and maintenance.

2. LITERATURE SURVEY

The automatic water level sensor and controller system presents the design and

implementation [11] of an automatic water level sensor and controller system aimed at maintaining optimal water levels in various applications, such as water tanks and reservoirs. The system uses sensor technology to monitor water levels and a control unit to manage water input and output automatically. The objective is to prevent overflows and dry running of pumps, ensuring efficient water management. Experimental results demonstrate the system's reliability and effectiveness in maintaining desired water levels with minimal human intervention. The paper [12] presents a novel Internet of Things (IoT)-based solar-powered system designed for automated water level indication and distribution. It used IoT and solar power systems to manage the water usage effectively.

3. PROPOSED SBMAC SYSTEM

The proposed SBMAC (Sensor Based Mobile Application and Cloud Agriculture) system for the prevention and detection of water leakage can help reduce water leakage and usage. The SBMAC Prototype uses several sensors to control and monitor the flow of water; these sensors include flow meters, pressure sensors, and moisture sensors and are connected with a microcontroller. Microcontroller programmed in such a way that it takes input from the sensors continuously for a time gap; according to the input, it sends an alarm to the concerned person or official for water misuse/theft/leakage/overflow. The SBMAC also allows users to control the water motor via a mobile application. It also automatically TURNS OFF or TURNS ON the water supply for particular water sources/pipe in an agricultural farm, building, or home, which minimizes the wastage of water using the control signal from microcontroller. Integrating mobile applications along with the sensors using microcontrollers helps to remotely monitor and control irrigation systems through mobile applications, facilitating efficient water management even when off-site. In SBMAC mobile applications, provide easy access to real-time data on water usage and leak detection, enabling informed decision-making. Cloud platforms also play a major role in SBMAC to store sensor data securely and facilitate analysis to identify trends and patterns in water usage and leakage. Cloud-based solutions can scale to accommodate large agricultural operations, making them suitable for both small-scale and large-scale farming.

4. Deployment of SBMAC Prototype

The SBMAC prototype is mainly divided into two parts: effective water utilization in irrigation and water leakage detection. The first part is completely dedicated to our farmers and helps them to use water effectively concerning the crops. The second part deals with prevention steps to reduce water wastage due to pipe leakage or water theft.

4.1 Effective Water Utilization in Irrigation: Efficient water management is a critical issue in both agricultural and residential contexts, particularly in regions facing water scarcity and unreliable power supplies. Traditional water management methods, which often rely on manual monitoring and control, can lead to significant water wastage, suboptimal resource usage, and increased labor costs. Additionally, the increasing global demand for sustainable and eco-friendly solutions necessitates the adoption of technologies that can enhance water conservation efforts.

4.2 Water Leakage Detection: In this, two kinds of leakage detection will be considered: 1. leakage due to overflow from the water tank and 2. leakage in the water supply pipe.

4.2.1 Leakage due to overflow from the water tank: The SBMAC prototype will give the status of water tanks such as low, medium, or high. If the water tank status is low, the sensor will trigger the motor to switch on automatically. Once the status becomes high, the sensor will trigger the motor to switch off automatically and send a message to the owner for appropriate action manually, as shown in the first of Figure 2. *Major hardware integrated into the proposed prototype:* Water Level Sensor, WI-FI MODULE (Esp8266), Relay and microcontroller shown in below figure 1

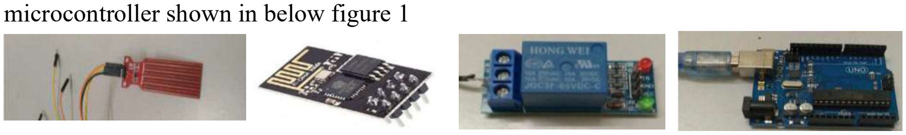

Figure 1: Water Level Sensor, WI-FI MODULE (Esp8266), Relay and microcontroller

4.2.2 *The SBMAC Prototype:* The SBMAC will detect the leakage in the pipe and inform the owner of its location using a GPS module, shown in the below figure 2.

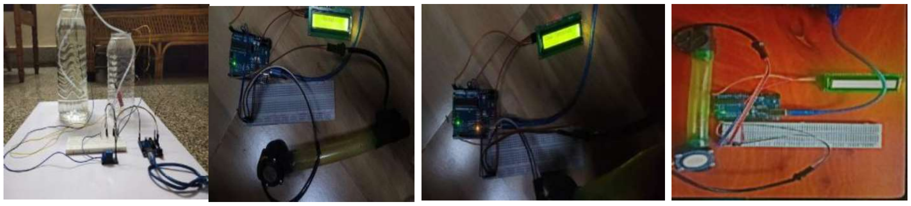

Figure 2: The Working SBMAC Prototype of Leakage detection

In the first of Figure 2, the proposed system will give the status of water tanks, such as low, medium, or high. If the water tank status is low, the sensor will trigger the motor to switch on automatically. Once the status becomes high, the sensor will trigger the motor to switch off automatically. The owner will get an alert message about the water tank through mobile applications. In the second of figure 2 , initially, when water goes through the pipes, the flow rate will be the same on both the water sensors; therefore, the LCD screen displays normal as the output, which means there are no differences in the water flow rate in both the sensors. After some time, the LCD screen displays "leak detected, " which means that there is a difference in the flow rate values of the water sensors, shown in the third of figure 2.

4.3 The SBMAC Algorithm

1. Import required library for WaterLevelSensor, FlowSensor, Relay, WiFi, AcousticSensor , UltrasonicSensor, PressureSensor;
2. Initialise all imported sensors
3. Assign pin WaterLevelSensor=A0, FlowSensor=3, Relay=7, AcousticSensor=4, PressureSensor= A1;
4. Set username and password for WiFi to connect to server;
5. Set pin INPUT: WaterLevelSensor, FlowSensor, PressureSensor, AcousticSensor; Set pin OUTPUT: Relay; Set Threshold value to each sensor WaterLevelSensorT=500; FlowSensorT=100; PressureSensorT= 20; AcousticSensorT=5;
6. Read input: WaterLevelSensor,FlowSensor,PressureSensor, AcousticSensor;
7. If waterLevel > WaterLevelSensorT: SendNotification("HIGH Water Level"); Relay: HIGH;

Else If flowRate > FlowSensorT: SendNotification("Water Leakage"); Relay: HIGH;

Else If pressure < PressureSensorT: SendNotification("Water Leakage"); Relay: HIGH;

Else If acousticNoise > AcousticSensorT: SendNotification("Water Leakage");

Relay: HIGH; ActivateBuzzer() ;

11. Else: SendNotification("Water Leakage"); digitalWrite(RelayPin, HIGH)

4.4 Major hardware integration in the proposed SBMAC prototype:

1. Water flow sensors : It will be installed at key points in the plumbing system to monitor the flow of water, as shown in the first figure 3. If any abnormal flow patterns or sudden spikes in usage are detected, it indicates a leak and triggers the alert to a microcontroller.

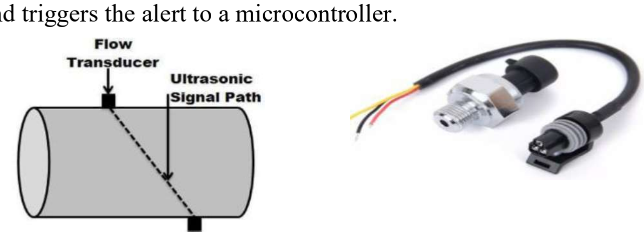

Figure 3: Ultrasonic Water flow, Pressure, Acoustic Sensor and block diagram

Pressure sensors: In this proposed work, individual water supply pipes are monitored using pressure sensors to monitor pressure within pipes and fixtures, as shown in the second of figure 3. A sudden pressure drop could indicate a leak, prompting an alert. *Acoustic sensors :* Acoustic sensors can detect the sound of running water or dripping. It can be placed near pipes or fixtures to listen for leaks and send alerts when unusual sounds are detected, as shown in the third of figure 3. *Smart water meters:* The major role of smart water meters is to achieve equal water distribution in every home. They will provide real-time data on water consumption and usage patterns in individual homes to control rooms through cloud-based platforms. These sensors will all connect to a microcontroller and create an Internet of Things (IoT) system for remote monitoring and alerts, as shown in the fourth of figure 3 below from existing work. All the real-time data will be collected from the microcontroller and updated to the cloud automatically. The user and control room will have cloud access as well as a water control application installed on smartphones, so they are able to see the uses of water from anywhere at any time. The proposed app will be user-friendly, so anyone can access it without technical knowledge.

6. Conclusion:

The SBMAC prototype can be deployed in any field for water-controlling and monitoring purposes. It also performs a quick response for any kind of leakage in the pipe so the user can work on the leakage and reduce manpower for checking manually every time. In agriculture, it also uses only the required water for irrigation with the help of sensors. GSM and GPS modules can integrate this prototype to accurately locate leaks via SMS. **Application:** 1. Prevention from Water Theft and Leakage, 2. Effective and equal water distribution to every home, and 3. Borewell Water Utilization Monitoring and Control System:

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