AN INTELLIGENT INTERNET OF THINGS (IOT) SYSTEM FOR ENHANCED WATER MANAGEMENT AND DISTRIBUTION

Abstract

All living organisms, including humans, rely on water for their survival. However, the rapid advancements in human development have led to shortages and wastage of water, causing imbalanced distribution and scarcity. The primary objective of this project is to ensure equitable water distribution among all households, preventing wastage and obstructions. Additionally, it aims to enable the calculation of water consumption for individual households through IoT platforms. To implement this concept, Arduino technology will be employed. Water sensors and a valve mechanism will be utilized to regulate the amount of water drawn from the reservoir. The flow sensor will generate electric pulses proportional to the water usage, allowing the monitoring of water quantity and flow rate. By employing embedded development and IoT strategies, this project aims to effectively address the challenges associated with equitable water distribution.

Keywords: IOT, Smart Waste Water Management, ThingSpeak, WaterFlow.

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I. INTRODUCTION

The primary driving force behind shifts in direction and control is centered around the imperative of conserving water. Currently, one of the most pressing global challenges revolves around water scarcity. Despite Earth's abundant water resources, a mere 1% is accessible for human sustenance as surface and groundwater, with 97% trapped in the ocean, rendering it unfit for use. Even within ice structures like ice sheets, only 2% of water is held. Recent expert estimates indicate that India requires over 1.3 billion gallons of water daily, yet residents receive a mere 900 million liters, due to factors such as outdated pipelines, insufficient erosion protection, unauthorized water connections, and inadequate maintenance, leading to wastage through leaks and excessive flow. Addressing this water wastage could bridge the supply-demand gap.

In urban, rural, and town environments, water is distributed from a central framework to consumers. Presently, water distribution [1]–[2] hinges on bill payment rather than consumer needs or historical usage patterns. Moreover, advanced technology [3] to detect leaks, floods, and water levels is not fully integrated into public distribution systems. Sensor-based water quality monitoring systems have been examined in [4-6], but practical implementation of water distribution management is absent. The role of IoT [7] in smart cities is explored to establish focal points and key components for successful urban development. A water quality monitoring framework based on IoT [8] is introduced, also encompassing several geographical boundaries [9]. Real-time flow and pressure measurements underpin status assessment in water distribution [10]. In [11], a system capable of calculating water levels and sending SMS alerts is proposed. This article advocates for the installation of sensors to identify leaks, floods, and low water levels, with the collected data centralized for decision-making. Water distribution across different zones is then tailored to consumer data and needs, reducing waste through appropriate remedial measures.

India has faced increasing water scarcity due to various macroeconomic cycles, driven by excessive exploitation of groundwater and water bodies, resulting in a deficit.

This essay underscores the importance of a judicious water supply that minimizes wastage. The quantum of supplied water, flow rate, and client water usage are regulated by a sophisticated architecture utilizing flow sensors to generate electric pulses. This proposed system continually monitors the water level in the main tank, activating or deactivating pumps accordingly. A flow sensor and control valve collaborate to manage water flow. The IoT platform "Think Talk" can facilitate this process. Data can be collected over time and employed for automated billing, resource assessment, and future estimation. Water levels and billing information will be visible on the screen.

II. LITERATURE SURVEY

As per the analysis provided concerning water management systems, this approach has already been implemented and applied across various investigations. Key features of the proposed model encompass distribution, tracking, and computation of tank water levels, alongside a somewhat analogous billing assessment. This endeavor also entails the examination of water flow, continuous surveillance of water levels, and transmission of data to homeowners and administrators for the purpose of billing, facilitated through the IoT platform ThingSpeak. The core emphasis of this study revolved around regulation and continuous monitoring utilizing flow sensors. The pulses emitted from all channels are aggregated upon user activation of the device. A microcontroller is responsible for overseeing and controlling the water consumption of individual users. Water level sensors are deployed to gauge the quantity of water within the primary tank.

III. PROPOSED METHODOLOGY

The primary objective of this endeavor is to achieve equitable distribution of water among all residences, thereby averting wastage and obstructions in the water supply. Additionally, it aims to facilitate the generation of individualized water bills for each household through the utilization of IoT platforms.

To implement this framework, we will employ the Arduino/Node MCU. Water sensors and a valve mechanism will be harnessed to regulate the extraction of water from the reservoir. A flow sensor will produce a sequence of electric pulses, enabling the computation of dispensed water volume, flow rate, and client consumption.

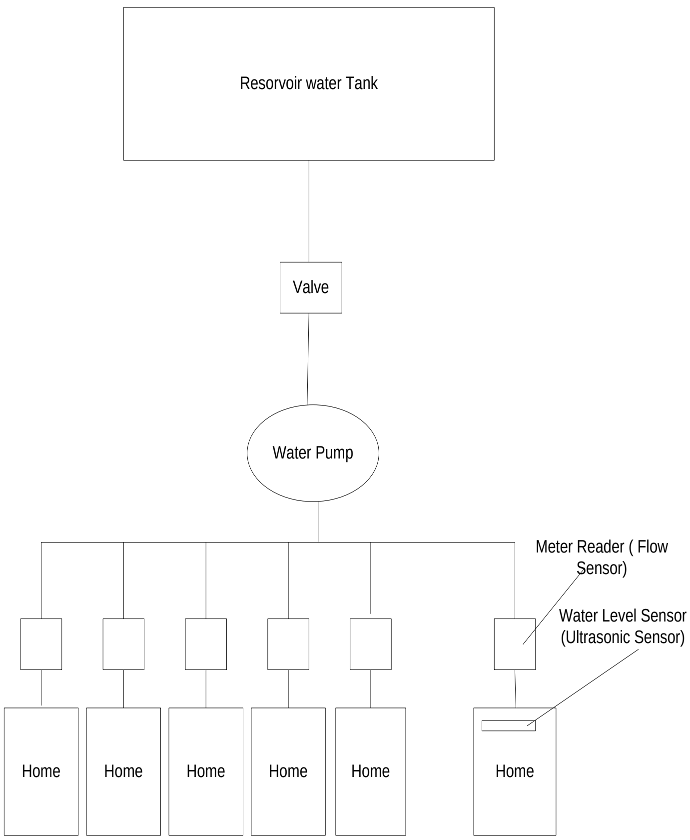

Figure 1: Block Diagram

Hardwares:

1. **Arduino:** Arduino consists of programming elements and an actual programmable circuit board. The water flow measurements from a flow meter to a specific household's

predefined level are managed by a regulating device referred to as an Arduino. The illustration in Figure 3 displays the Arduino board. This regulating device orchestrates the entire embedded system, governing the operations of the IoT valve and facilitating data communication. The microcontroller encompasses all essential components for the smooth execution of this system. It can be linked to the device using a USB cable, and power for the microcontroller can be supplied through a battery or a connector.

Figure 2: Arduino

2. **Ultrasonic Sensor:** This sensor employs ultrasonic sound waves to gauge the distance separating two objects. In this scenario, it serves the purpose of assessing the water level in the main tank. As the water level within the tank gradually increases, the sensor computes the quantity of stored water. The transmitter releases ultrasonic waves through piezoelectric crystals, and the receiver captures the returning sound waves reflected from the target. This process ensures a continuous monitoring of the water level.

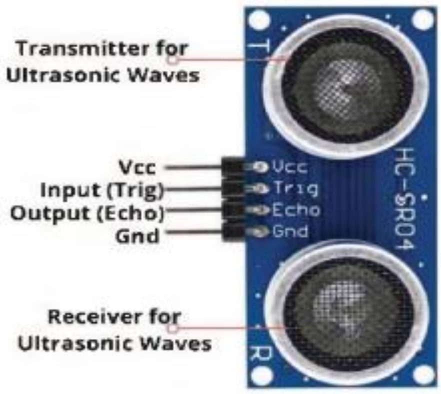

Figure 3: Ultrasonic_Sensor

3. **Flow Sensor for Water:** The flow measurement apparatus was constructed using a copper body, a water rotor, and the principle of corridor impact. As water flows through the line, it causes the rotor to spin, which in turn measures the changing flow rate. This flow sensor computes the quantity of water passing through the line.

Figure 4: WaterFlow Sensor

4. **ESP8266 Wi-Fi Module:** The ESP8266 Wi-Fi Module is linked with an Arduino, and it's this specific module that sends the sensor's characteristics to the IoT platform. This Wi-Fi module operates within the 2.4GHz frequency range. The microcontroller receives the essential input. Operating at a voltage of 3.3 V, the ESP8266 handles all Wi-Fi networking tasks, freeing the other application CPU from these responsibilities. The transmission of information to both clients and administrators proceeds smoothly without any complications.

Figure 5: WIFI Module

5. **IOT-Platform-Thing-Speak:** Thing Speak, a cloud-oriented IoT platform, enables the storage and visualization of up-to-the-minute data pertaining to water flow. Moreover, the attributes acquired are exhibited on the LCD display at the user's end. The data exhibited on ThingSpeak can be accessed from any device and location.

IV. IMPLEMENTATION

Figure 1 depicts the schematic representation of the proposed intelligent water distribution and management framework. Due to its larger memory and greater I/O pins compared to other available boards, the Arduino Mega 2560 microcontroller is employed as the primary control unit for executing all crucial control operations. This microcontroller is responsible for detecting signals from sensors and transmitting control signals to valves, the IoT platform, and the pump, thus carrying out the essential electronic hardware functions of the project.

The distribution of water to end users is determined based on the water availability in the Main Dispersion Tank (MDT). The MDT is divided into three distinct levels:

- When the tank is completely filled, it's designated as 100% full.
- Half of the tank's capacity is considered full at that point.
- When the water level drops to 25% of the tank's capacity, it's categorized as an edge value.

To gauge these three different water levels within the MDT, three separate water level sensors are positioned corresponding to each level. These sensors are linked to the basic pins of the Arduino board. A raindrop sensor, functioning as a leakage sensor, triggers a connection within its circuit when water droplets are detected. As more water comes into contact with the sensor, the voltage increases. The Arduino interprets this signal to activate a solenoid valve. Upon activation, this valve opens, allowing water to flow through the port.

When the MDT is fully filled and water level sensor 1 indicates a high reading, all four valves are opened, enabling water to be dispatched to the four end consumers as depicted in Figure 1. Similarly, when the tank reaches half capacity and water level sensor 2 records a high reading, the first two valves are opened, providing water to consumers 1 and 2. However, when the MDT reaches a low water level of 25% (edge level) and water level sensor 3 registers a high reading, all four valves close. Consequently, none of the end consumers receive any water supply. During this scenario, a subsiphon is utilized to transport water from the source to the main dispersion tank. This subsiphon is activated once the hand-off is switched on and prevents cavitation in the syphon, offering a significant advantage.

To minimize spillage during water distribution from the main tank to the end users, a raindrop sensor is positioned near each end-user tank. This sensor detects water through its interaction with nickel lines, reducing blockage as water droplets make contact. This diminished blockage leads to a voltage drop, which the Arduino detects through both analog and digital outputs. Consequently, a solenoid valve near a separate sensor closes, halting water flow. This data is then transmitted via a Wi-Fi module (ESP8266) to the ThingSpeak IoT platform, providing real-time updates on water spillage.

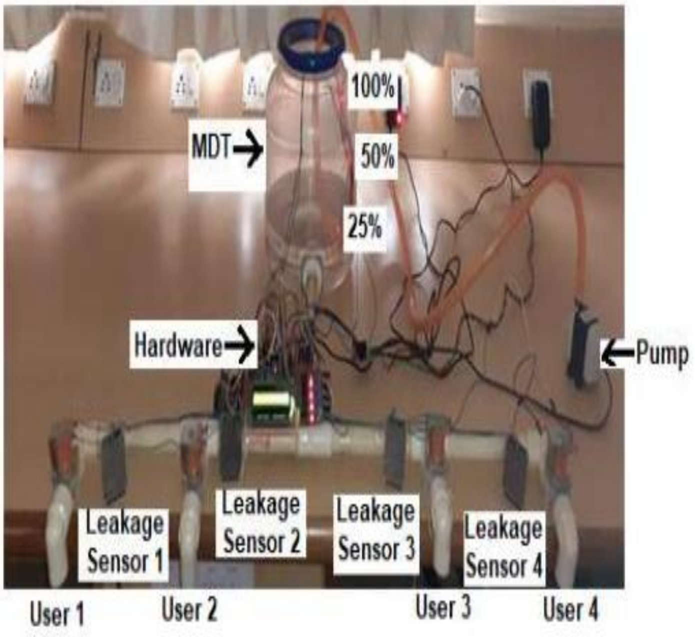

Figure 6: Hardware Setup

Authorities are promptly notified about water flow leakages through the following steps:

- Upon identifying a leak, the information is sent to the ThingSpeak program using the ESP8266 module via Wi-Fi.
- The program stores this data.
- It logs the precise time, location, and nature of the leakage incident, offering a valuable reference for future use.

The setup illustrated in Figure 6 concludes the comprehensive arrangement for effective water distribution.

V. CONCLUSION

This research has successfully accomplished a pivotal component within the Water Conveyance Framework for Spillage Detection. By processing sensor signals and relaying spillage data across various framework components to the authorities through the ThingSpeak IoT platform, water leaks are promptly addressed. Precise details regarding the spill's location and timing are accessible. The water distribution process is fully automated, contingent on the Main Dispersion Tank (MDT) levels and individual user needs.

An endeavor has been undertaken to establish intelligent water distribution in a hypothetical setup with limited end users, sensors, and valves. This logical approach can be extrapolated to scenarios encompassing multiple consumers and dispersion tanks. Urban areas characterized by advanced infrastructure can adopt this proposed design for sophisticated water distribution and management. The data gleaned from the IoT platform holds potential for further analysis, such as consumption estimation, and beyond. This system can be operated using level sensors, ensuring accurate water level assessment, and can even integrate with advanced mobile devices.

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