Domestic Water Supply Monitoring and Theft Identification System

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Abstract

A vital component of life is water. One of the most significant problems affecting the globe today is the inefficient way of consuming water. Water usage needs to be regulated in order to guarantee a reliable supply for domestic and other uses. This work presents the design of a low-cost system for the Internet of Things (IoT) real-time water supply monitoring. A system with several sensors is utilized to measure the water's flow rate. These sensors are controlled by a controller that has the ability to process the gathered data from the sensors. For the purpose of supplying water to the users, the system is additionally connected with an electrically controlled solenoid valve. The water flow rate is regularly monitored using the flow sensor and updated to the cloud platform which is implemented using Thingspeak. This platform is also monitored by government officials who perform data analysis and storage. When the water flow rate exceeds a pre-determined threshold, the solenoid valve that controls the flow of water is shut down and a water theft alert message will be sent to the customer to his registered mobile number using the telegram application. The excess flow rate is observed by government officials who can take up necessary legal action.

Keywords—ESP32, Solenoidal Valve, Flow Sensor, Thing speak, Telegram.

I. INTRODUCTION

In urban territories with enormous monetary development, the water request of individuals is additionally expanding. Water is a critical asset for every living being on Earth. Due to the uneven distribution of water, some individuals may not receive an acceptable amount of water. There are several causes of water waste, including the fact that we use drinking water for gardening and that water leaks are not properly detected. The flow meter, solenoid valve, and relay circuit are connected to the ESP32 controller in order to implement the suggested water supply structure. The relay circuit will be switched off and the supply to the valve will be interrupted at whichever point the water flow exceeds. The amount of water to be sent to the specified habitat may then be adjusted, and a solenoid valve with an electrical motor is provided to distribute water to the customers. When the flow rate exceeds a certain limit, the valve opens or closes to shut off the water supply. In order to regulate the flow of water as necessary for a predetermined period of time, the solenoid valves are also controlled by a relay circuit.

II. MOTIVATION

A revolutionary step towards a water-secure future is the Water Theft Identification System. This method attempts to efficiently prevent water theft, protecting our most valuable resource for both the current and future generations. It does by utilizing technology, involving the community, and cooperative efforts. The Water Theft Identification System will support an approach towards sustainable water management practices by developing a feeling of personal accountability and raising awareness while making sure that every drop matters in our joint path toward a more water-secure future.

III. LITERATURE SURVEY

B. Sasikumar et al, point out the extensive amount of water usage in the apartments. In this paper, a household water supply monitoring and billing system were implemented using Arduino Mega 2560 along with a double relay for the automation of the switching feature.

The water level sensor and valves were used for controlling the capacity of water usage on each floor of the apartment. Water flow sensors were used to detect the amount of water used and accordingly generate the bill. [1]

J.P. Shri Tharanyaa, A. Jagadesan, et al, used an Embedded based remote water monitoring and theft prevention system by recording the flow rates at the consumer end. A microcontroller was used to record the flow rate using a flow sensor and to transmit the same to a remote monitoring station using a wireless transmitter. It was also provided with an electrically operated solenoid valve to supply water to the user. The valve turned on/off to stop the water supply whenever the flow rate exceeded a predefined limit. An operator filled the tank automatically from the main water resources by using a DC pump. [2]

Anil Gantala, Paparao Nalajala, et al, point out the problem of water theft and irregularity of water supply. The automation and monitoring architectures contained a supervision and control system for the real-time installation, programmable logic controllers with basic functions communication systems, standard interfaces or dedicated ones with proximity sensors, electrical drive elements, measuring devices, etc. They have developed a PLC & SCADA-based water monitoring and theft prevention system. [3]

Thinagaran Perumal1 et al proposed an IoT-based water monitoring system that measures the water level in real-time. The model is based on the idea that the water level can be a very important parameter when it comes to flood occurrences, especially in disaster-prone areas. [4]

Perumal T, et al proposed that in recent times, the tremendous growth of Internet of Things applications is seen in smart homes. The large variety of various IoT applications generally leads to interoperability requirements that need to be fulfilled. Current IoT project is achieved using physical platforms that lack intelligence on decision-making. An architecture that implements Event-Condition-Action (ECA) method is proposed to solve the management of heterogeneous IoT in smart homes. [5]

N Vijaykumar et al proposed that drinking water quality needs to be monitored in real-time. They have proposed the design and development of a low-cost system for real-time monitoring of water quality in IoT (Internet of Things). The system comprised many sensors that were used to measure the physical and chemical parameters of the water. [6]

IV. COMPONENTS

A. ESP32 Controller

Figure 1: ESP32 micro-controller

Figure 1 shows an ESP32 controller which is an open-source, series of low-cost, low-powered systems with a chip microcontroller with integrated Wi-Fi and dual-mode Bluetooth.ESP32 has 34 GPIO pins each pin can be used as General-purpose input, output, or connected to an internal peripheral signal.

B. Solenoid Valve

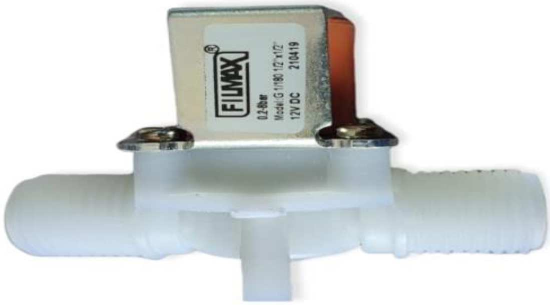

Figure 2: solenoid valve

Figure 2 shows a solenoid valve which is the same as the manual valve. In a manual valve. there is a lever that helps the user to on and off the supply, the interfacing of the Arduino interface to the solenoid lock is discussed later.

C. Flow Sensor

Figure 3: Flow Sensor

Figure 3 shows a flow sensor an electronic device that measures or regulates the flow rate of liquids and gasses within pipes and tubes. Flow sensors are generally connected to gauges to render their measurements, but they can also be connected to computers and digital interfaces.

D. Relay

Figure 4: Relay Module

Figure 4 shows a relay module which is an electrically operated switch. It consists of a set of input terminals for single or multiple control signals and a set of operating contact terminals. The controller may have any number of contacts in various contact forms, such as make contacts, break contacts, or combinations thereof.

E. LCD

Figure 5: LCD Display

Figure 5 shows a 4-bit data interface for compatibility with ARM boards

- LCD_E, LCD_RS, LCD_RW
- 2-line x 16-character Display
- Each character location consists of a 5-dot x 8-bit display.

F. I2C Serial Interface LCD Adapter Module

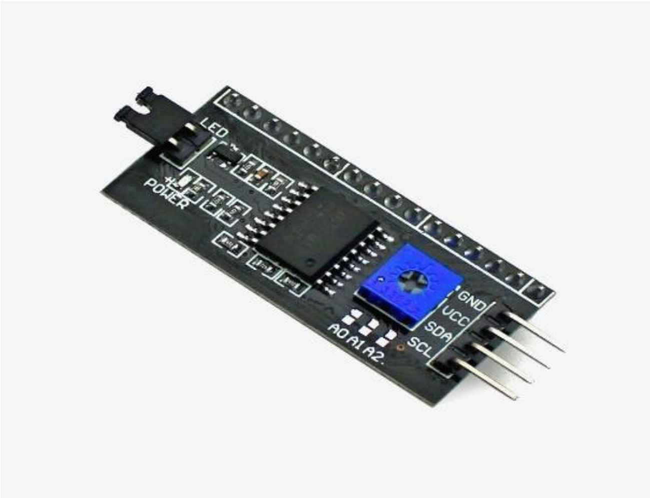

Figure 6: I2C Serial Interface LCD Adapter Module

Figure 6 shows a standard 16x2 LCD even when operating at 4-bit mode takes about 8 GPIO pins from the microcontroller to display information on it and in projects where GPIO pins are at a premium, it is a lot. That is why we need a serial to parallel data adapter so that we can reduce the number of pins needed to drive the LCD display modules.

G. Li-ion Rechargeable Battery

Figure 7: Li-ion Rechargeable Battery

Figure 7 shows an 18650 battery a Li-ion rechargeable battery with a 1200 Mah Battery Capacity. This is not a standard AA or AAA battery but is very useful for applications that require continuous high current or high current in short bursts like in cameras, DVD players, iPods, etc.

V. IMPLEMENTATION

A. BLOCK DIAGRAM

Figure 8 shows the block diagram containing a microcontroller (ESP32), flow sensor, solenoidal valve, relay, and LCD. The ESP32 is the main processor of the system which controls and processes the data generated by the sensors. The flow sensor helps to measure the flow rate when the water flows into it. The solenoid valve is an automatic on-and-off valve to control water flow automatically. If there is high flow than mentioned, by the customer side then the message is then passed to the solenoidal valve through the relay to stop the water flow, and the flow is disconnected.

The message is always displayed on the LCD in the model. The message with the total water flow rate and the disconnected message is sent to telegram and Thingspeak for storage. This process continues till the operator turns the system off. The data is stored in the cloud (Thing speak) and the result is shown in the graph format. The data from the cloud can be exported into CSV files and other forms.

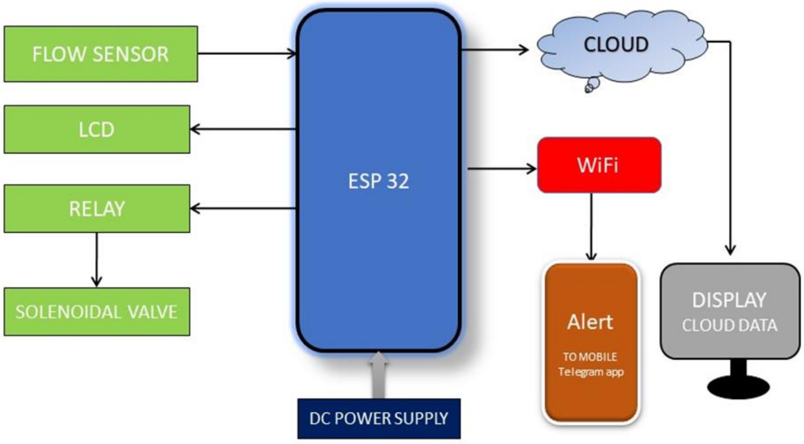

Figure 8: Block Diagram of Proposed System

B. FLOW CHART

Figure 9 shows the flowchart of the proposed system. The system is initiated with a regulated supply of water. The flow of water is then monitored and assigned a threshold based on the survey and data analyzed. It is manually provided by the authoritarians and the supply of water is initialized. The supply rate and quantity of water consumption are displayed on the LCD.

The water is observed to flow at a normal flow rate. Based on the condition that if it exceeds the flow rate, the solenoid valve is set to shut down automatically. It is automatically invoked to generate a notification to the customers via the telegram application bot. It automates a message to the consumers with the registered ID. The notification provides the consumers with the disabled water supply due to the proposed system experiencing water theft.

This data is further updated in the cloud platform Thingspeak, when the disconnection of the water supply and the system identifying theft on the consumer's end is observed.

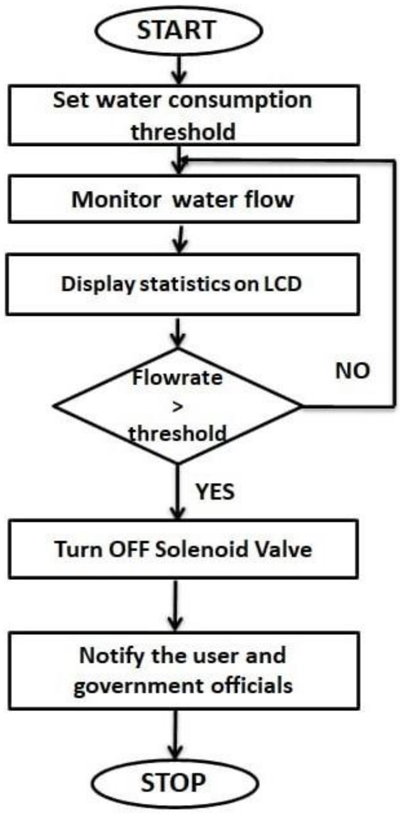

Figure 9: Flow Chart of the Proposed System

C. CIRCUIT DIAGRAM

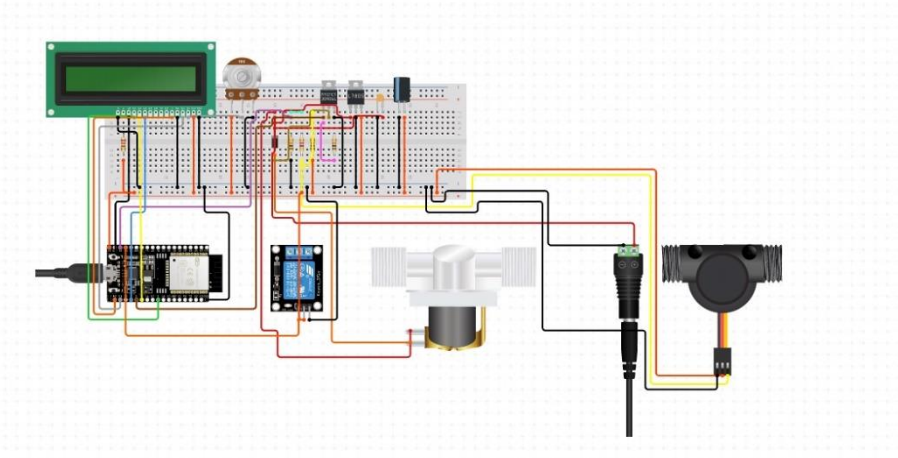

Figure 10: Circuit Diagram of Proposed System

Figure 10 shows the circuit diagram of the proposed system. It illustrates the steps of connection used to interconnect the multiple components used to perform the water theft identification.

The connections starts with the battery of 8V connected to the switch on the positive terminal and the Relay connected at the negative end of the terminal. The relay. The flow sensor is connected to the 3V pin on the circuit(red), a wire is connected to the ground connection (Black), and another pin is connected to G34.

The LCD is capable of displaying the output message on the screen that is connected to the VCC of 5V, a ground pin of G22, and another pin-to-pin number G21. The relay pin of 12V is connected to the supply of 5V and a ground pin is to the grounding. The relay input is connected to the G5 pin of ESP32. A buzzer is used to notify the surrounding in case of theft identification detected by the system. The buzzer is connected to the system by connecting the positive terminal to the G12 pin on the ESP32 kit and the negative terminal of the system to the Ground pin of the system.

D. ARDUINO IDE SOFTWARE

An official software introduced by Arduino. cc, which is mainly used for writing, compiling, and uploading the code in almost all Arduino modules/boards. Arduino IDE is open-source software and is easily available to download & install. Arduino IDE is an open-source software, designed by Arduino. cc and mainly used for writing, compiling & uploading code to almost all Arduino Modules. It is an official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process. It is available for all operating systems i.e., MAC, Windows, and Linux, and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role in debugging, editing, and compiling the code. A range of Arduino modules are available including Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino Micro, and many more.

VI. RESULTS & DISCUSSION

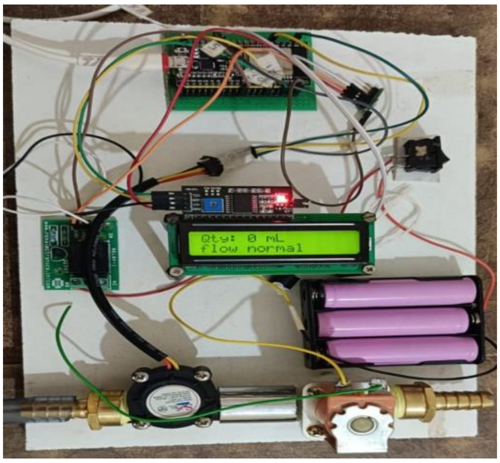

Figure 11: Model Image with Normal Flow

Figure 11 shows the proposed system that is used to monitor the flow rate in the system. The above picture depicts the normal flow of water and its readings on the LCD.

Figure 12. Model Image with Flow Disconnected

Figure 12 shows the model of the proposed system that depicts the disconnection of the water flow in the system. The message is displayed on the LCD upon reaching the threshold.

A. Telegram

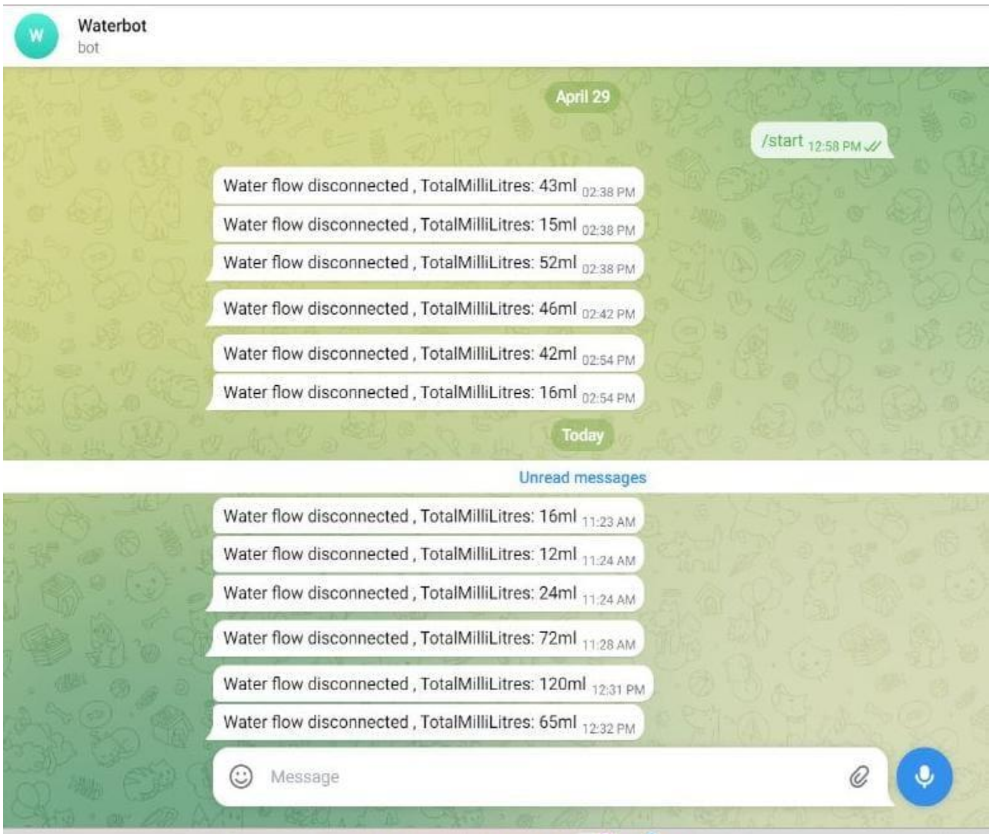

Figure 13: Flow rate and disconnected notification in Telegram

Figure 13 shows the telegram application interface that provides the notification of the water supply system being shutdown when the flowrate of water exceeds the threshold.

B. Serial Monitor

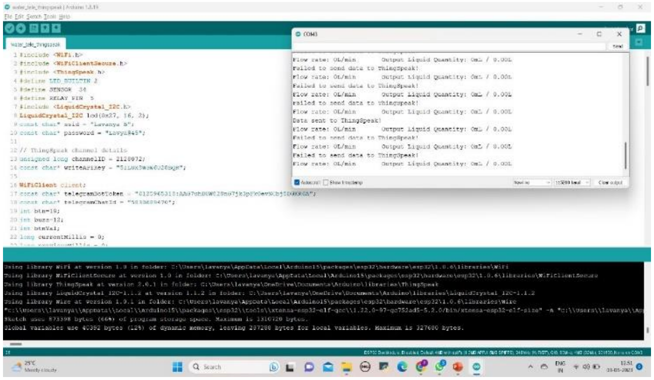

Figure 14: Serial monitor showing output readings

Figure 14 shows the serial monitor that is used to fetch the live data of the output used in the Arduino IDE capable of feeding the data into the controller and getting the updates of loading and running the relevant code into the system.

C. ThingSpeak

Thingspeak is an IoT analytics platform service that allows you to aggregate, visualize, and analyze live data streams in the cloud. This platform will store the result data and represent it in the form of a graph.

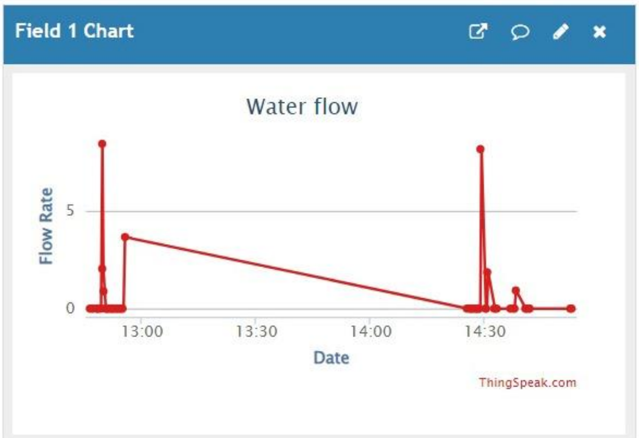

Figure 15: Flow Rate stored in the cloud.

Figure 15 depicts the graphical representation of a data analysis on the cloud platform Thingspeak in the system. It provides the graph of Flow rate v/s date chart and consumption data.

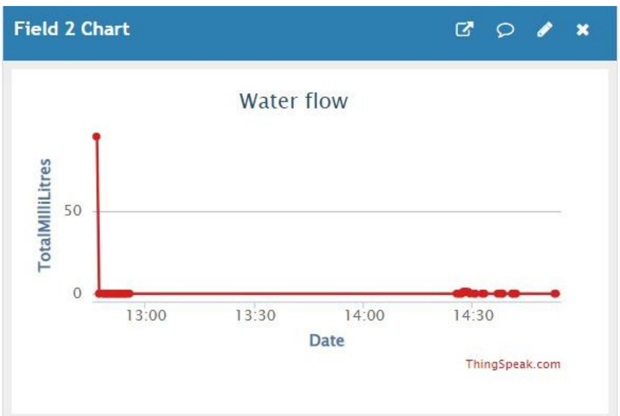

Figure 16: Total milliliters v/s date graph in Cloud

Figure 16 shows the graphical representation of the quantity v/s date graph that presents the total water quantity considered to be used by the consumers. The data is updated to the Thingspeak cloud platform that is observed by the authoritarians under the access of these data analysis.

VII. CONCLUSION & FUTURE SCOPE

In this work, a prototype water monitoring system using IoT is presented. For this, flow sensors are used. The collected data from all the sensors are used for analysis purposes for better solutions to water problems. The data is sent to the cloud server via the Wi-Fi module ESP32. This prototype is very much helpful in urban territories and in areas where water scarcity is the biggest problem. By incorporating this prototype in real-time, the government can assist its citizens to obtain water distribution equally and also can avoid disputes among them. It will bring peace and harmony among people and also aids in saving the water for the present and future generations.

The work can be further enhanced to help in theft identification of other liquid supplies like liquid petroleum gas, fuels etc. by the government.

VIII. REFERENCES

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