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An Efficient Water Management and Monitoring System Based On IoT

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***Abstract*: Water is a vital resource for life and for the economy. Nowadays, one of the most serious challenges is to manage the effective utilization of water and its resources. Presently laborers are assigned for managing the water distribution in a locality (city). There is chance of improper distribution of water. To overcome this problem, a centralized control room equipped with a local computing machine and a Human Machine Interface (HMI) to monitor and control the city's water distribution system based on need/demand is proposed. One of the major problems faced in distribution system is theft and leakage of water. To avoid these situations, higher degree of theft and leakage was concluded using loss detection technique using the differential flow data. Here, a novel, cost-effective, real-time monitoring and controllable system is proposed with an analysis on a model simulation being performed for optimal water distribution. We are trying to implement IoT based water management. The sensors will sense the flow of water to each pipe which ultimately tells the usage of water at one block ideally. This water usage data would be sent to cloud using the IoT (Internet of things) space. A novel approach to performing automated water-meter reading for update of consumption information from field to the Utility office is described in this paper. The smart metering approach proposed differs from existing commercial methodologies by making use of low cost IoT hardware and smart phone app. This scheme permits both Meter Reader as well as individual domestic / industrial consumers to use regular smart phones to perform meter reading and update to utility's portal / database for billing and payment. The proposed scheme reduces overheads on Utilities in handling meter reading and billing for water distribution in metropolitan and large urban conglomerates.**

***Keywords*: Arduino UNO, Node MCU, Hall effect, Water flow sensor, Wi-Fi module, Solenoid, LCD, IoT.**

1. Introduction

Nearly the third quarterly portion of the earth which estimates up to 71% portion of it is covered with water. But out of which only 0.08% fresh water is available for human purposes and for living beings. The main sources of fresh water available for living purposes and for human use is the surface water available as a result of rainfall which also recharges the lakes, different water resources like aquifers. Water scarcity is the problem faced by the living creatures throughout the history and whose intensity has increased during the last centenary. It's estimated by next decade approximately 25% of the population of earth will live in perpetual scarcity of water.

Apart from agricultural purposes, the major share in utilizing available fresh water is industries. Industrialization and urbanization brought more use for water especially at nuclear plants for cooling and also at big factories. At this stage it is imperative, for proper management and distribution of water, to conserve the water resource, which will subsequently lead to not only to substantial improvement in human life and condition but also will benefit the different management organs of the biomes and ecosystems.

Water Pollution and water scarcity is a global problem, which requires ongoing modification of water resource guiding principle at the levels of international down to individual wells. Research has shown that after few years the quantity of useful water will be goes down to minimum level. One of the reasons for this happening is the unawareness of public and administration and the lack of water monitoring system which creates serious global issues. Natural effects such as volcanoes, algae tints, and earthquakes also change the quality and ecological status of water.

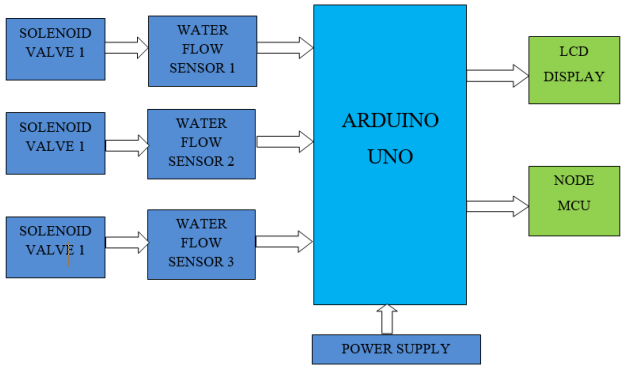

Fig. 1. Block diagram

The IoT based water supply management systems architecture is shown in the block diagram & circuit diagram of

Water Distribution Network is as shown in Figure. It consists water source, flow sensor and a solenoid valves for each home. The flow sensors measure the amount of water which is getting let out through them. There will be one main valve flow switch(VFS) and many home flow switch(HFS), the total readings of all the HFS's are measured and compared with the main VFS's by this way any leakages can be easily detected. The quota for different users is preset depending on user demand, the solenoids at homes are controlled by the Arduino, these solenoids are switched to begin the water supply. The flow meter values are read continuously once the switch is made on when the flow count reaches 90% percent of the quota an alert message is sent to the user, when the quota is 100% over solenoid will be switched off.

Also the readings of the flow meters of each home are uploaded to cloud platform from where the data can be analyzed for effective water resource management as shown in fig. When a user is on vacation or out of home they may not need water on holidays, for such situations a holiday mode service is proposed. Any user can update his holiday mode through web dashboard.

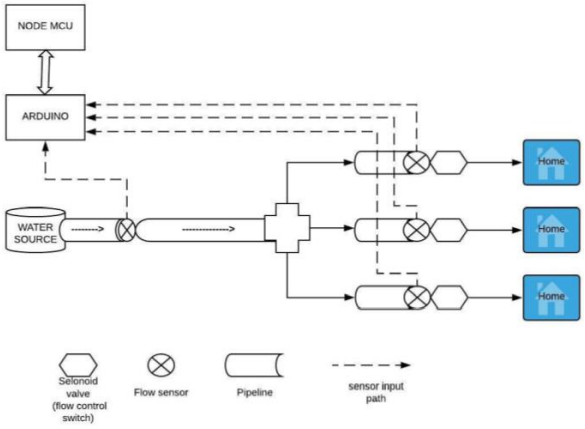

Fig. 2. Water Distribution Network

The flow chart shows the series of operations that take place during entire operating cycle. First the source switch or main switch is turned on and all the switches (solenoids) will be off. The flow meters will be continuously monitored by the controller. Once the quota of each home is completed before turning off the last valve, source valve is turned off first and then the last switch to avoid the bursting of the main pipe line.

The another objective of this is the flow meter is used to measure how much of water has been used. Here the water is made to flow on one side, so that rotor will start to rotate based on that Hall Effect sensor will take the pulses which are generated by rotor and it gives as an input to the controller based on that meter will get the reading. Furthermore, the water bill has been generated for each consumer.

2. Problem Statement

Water leakage-which is occurring due to the aging infrastructure of water pipelines. Water theft-there are incidents of excess water drawing by certain customers by connecting suction motor-pump sets to the water lines. Billing system-Most situations call for as precise reading as possible, making a digital meter the better choice. Customers' unawareness towards the amount of water being consumed.

3. Proposed Work

The main aim of the proposed model is to build an Internet of Things (IOT) based water management and monitoring system. Detection of water leakage, water theft and to include holiday mode and quota based system. Providing billing system using Blynk app.

4. Objectives

The goals are as follows:

1. To provide efficient monitoring of water supply using Quota based water system.
2. To provide efficient monitoring of water supply using holiday mode.
3. To design an efficient water leakage detecting system using flow sensors.
4. To design water theft monitoring system using solenoid valves.
5. To generate an effective billing system by using Blynk application.

Objective-1:

Initially the limit of water supply i.e., quota is set. First the source switch or main switch is turned on and all the switches (solenoids) will be off. Water flows through the pipeline to every house. The flow meters will be continuously monitored by the controller. Once the quota of each home is completed before turning off the last valve, source valve is turned off. If 90% of the quota has been used, then It will give an alert message after 100% the valve will be turned off.

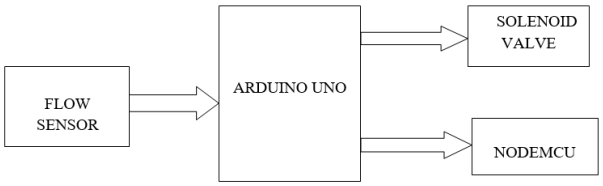

Fig. 3. Block diagram for Quota based system

Fig. 4, shows that if quota for the particular day is over, the valve is off. If quota is not over, then the valve is on and then the flow count starts, if 90% of it is over then the user gets an alert. If it's not, then it checks for the quota again.

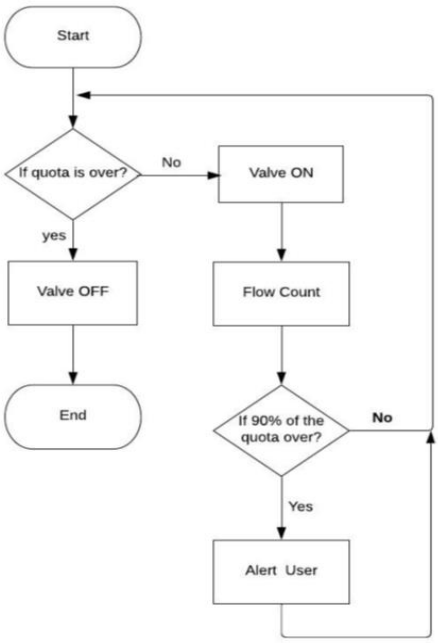

Fig. 4. Flowchart for Quota based system

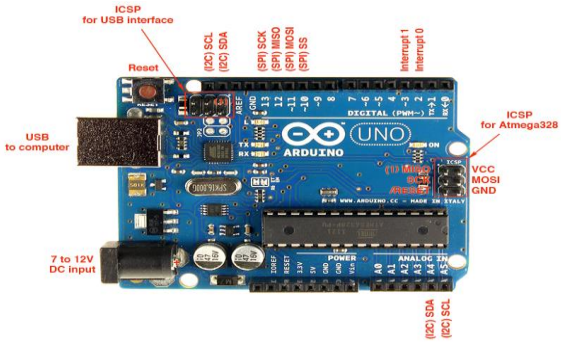

Fig. 5. Arduino Uno

Objective-2:

When a user is on vacation or out of home they may not need water on holidays, for such situations a holiday mode service is proposed. Press the holiday switch. The valve is off. Dissuade the holiday switch. The valve is on. It checks for the quota based system.

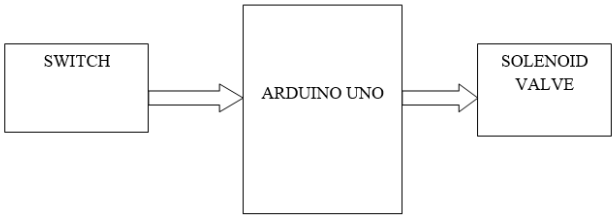

Fig. 6. Block diagram for holiday mode

Fig. 7 explains that if the holiday switch is on, the valve is off. If it's not, then it checks for the quota system.

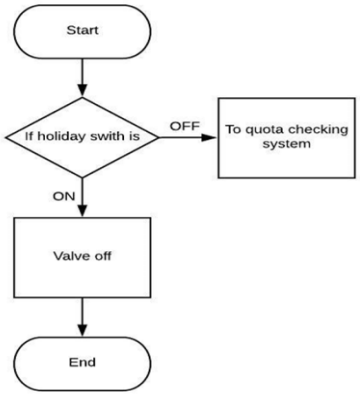

Fig. 7. Flowchart for holiday mode

Objective-3:

Initially the main flow count reading is measured after water distribution, water flows through the pipeline to every house. The flow rate is measured with the help of flow sensors. A pinwheel inside the sensor moves as the liquid flows through the sensor. A Hall Effect sensor within the sensor senses the rotation of the pinwheel, outputs a digital pulse for every rotation. Microcontroller converts the signal into flow rate. Flow rate is displayed over LCD (Liquid crystal display). The main flow rate is compared with total flow rate reading of every house. If the flow rate has more value variation, then the leakage is occurred in the pipeline and is displayed on LCD. If leakage is detected, automatically motor will turn off and the water supply for leakage pipe will be stopped. Fig. 7 explains flowchart of leakage detection.

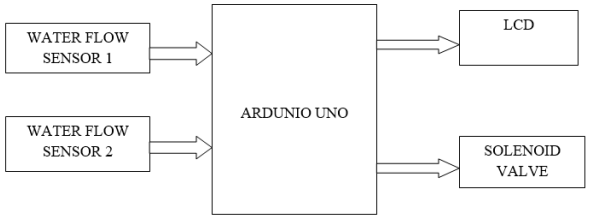

Fig. 8. Block diagram for leakage detection

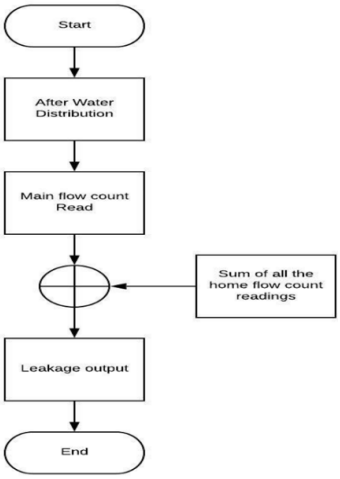

Fig. 9. Flow chart for leakage detection

Fig. 9 shows that initially the main flow count reading is measured after water distribution, water flows through the pipeline to every house. The main flow count is compared with the sum of all the home flow count and detects the leakage.

Fig. 10. Water Flow Sensor

Objective-4:

Solenoid valves are present at each pipeline. Water flow monitoring system consisting of a microcontroller records the flow rate. Check for the difference between sensor data at the source and the main distribution system. Then if there's any difference the theft is detected. Then the solenoid valve stops the water flow.

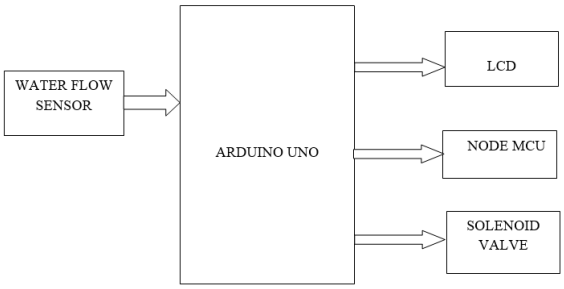

Fig. 11. Block diagram for theft detection

Fig. 12. Solenoid valve

Objective-5:

In this system we will install these Smart water meters to each and every home and in the Society. And these water meters are connected via the Internet enabled Wi-Fi Router which will take the data from those smart water meters and send it to the Cloud. Water Flow sensor will send it to the Microcontroller and microcontroller will process this incoming data and send it to the Display unit and to the Wi-Fi Module. Wi-Fi module then sends this data to the cloud using the http protocol. Based on the amount of water consumed, bill is generated at the end of every month and an SMS is sent to the registered mobile number of the consumer. Create a Blynk account to save the projects and have access to them from multiple devices. Create a new project. Choose the hardware model i.e., Arduino UNO Expect Auth token on the mail id with which the Blynk account was created or copy the Auth token manually and press "Create" button. Add the required widgets by mainly setting the "PIN" parameter and set the respective widget settings. Run the project by pressing the "Play" button.

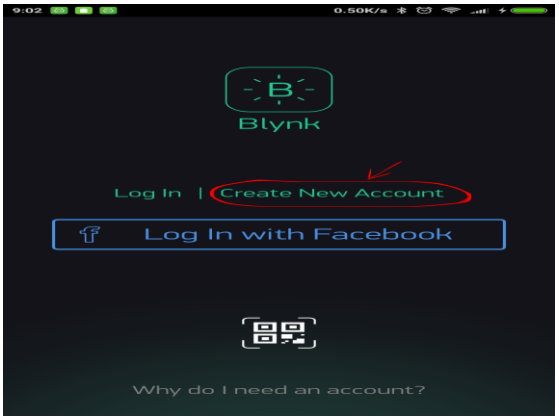

Fig. 13. Blynk App

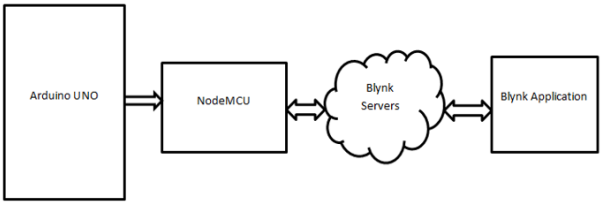

Fig. 14. Block diagram for billing system using Blynk Application

5. Advantages and Disadvantages

Advantages:

1. Leakage or theft can be detected at the earliest.
2. We can save water by setting limit in the quota based system.
3. Smart home water management is done successfully.
4. It helps the officers for easy delivery of water.

Disadvantages:

1. Internet connectivity for the devices must always be there.
2. Cloud attacks may occur.

6. Future Scope

1. The exact location of leakage through the pipelines can be detected.
2. The detected location co-ordinates can be sent to respective officer of the area.
3. Online web portal for customer services can be implemented.

7. Conclusion

In the proposed system a prototype for quota based approach

for the water supply management is implemented to minimize the wastage by optimizing the water usage. The holiday mode proposed can save the users money and water which is being wasted. Water leakage detection and theft detection is done efficiently. Water billing is done efficiently by using BLYNK application.

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