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Secured and Automated Water Management Powered by Arduino

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Abstract – The water crisis everywhere on earth today, with the current state, correct measures can still be taken to avoid the crisis from worsening. There is an increasing awareness that the water resources are limited and need to be protected both in terms of quantity and quality. In recent years, the number of people deprived of access to clean drinking water has increased substantially. So, there is a need for proper measures aiming at the preservation of water resources in terms of quality and quantity. In this project taking a locality to reduce the water wastage problems. This model going to make use of different tools like Arduino board, GSM module, sensor and solenoid valve to supply the water to a locality as per their requirements. This will help so that there won't be any wastage of water and illegal use of the water for one's own profit.

Index Terms: Android, Arduino, GSM module, Sensor.

I. INTRODUCTION

Water is the most important component of our planet's survival.96.5% of the Earth's. Water is stored in salty rivers and lakes that cannot be consumed for any use every day. The remaining 3.5% can be found in lakes, frozen fields and tops of ice. Just 0.3 percent of this is appropriate for use. Water is such a precious commodity nowadays, to the extent that about one billion people need access to safe drinking water. Therefore, it is also assessed that the larger part of the total population should continually experience water-based vulnerability in 2030. The water problems of the world stem from our failure to meet basic human needs, inadequate systems and leadership, and our failure to meet the needs of the common world. These diseases are for the most part established in inefficient utilization of water, described by poor administration frameworks and inability to apply existing advances[1].

It is the lack of adequate water-assets available to meet a region's needs. Climate changes-such as altered weather, increased water pollution and overuse of water may cause the depletion in potable water. It affects every continent and around 2.8 billion people worldwide for at least one month out of every year.

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This provides access to clean drinking water for more than 1.2 billion people. Nonetheless, people with access to safe, clean drinking water take it for granted and do not use this wisely.

Water shortage will prompt impacts, for example, – absence of access to drinking water, hunger, sicknesses, sanitation issues, destitution, and so forth[2,3].

II. EXISTING SYSTEM

Water is essential need of the people. So, it should be supplied properly and at the correct time. The existing systems supply water which doesn't have any limit. Due to this there is lot of wastage of water. People may take excess water for personal use or for other purposes, which means that many people do not get enough water to use it. These existing systems make use of water meter or embedded technology which is difficult to install and time consuming. The water also is sent directly which uses a sensor to detect the water content and as per that the billing is done[4].

In this model make use of Arduino, GSM module, flow sensor; solenoid valve. This model is supplying the water by calculating estimated water required for each house so that limited water is supplied to each house. Therefore, easily reduce the water wastage[5].

III. MATHAMATICS BEHIND ARDUINO

In order to measure the quantity of water being passed in particular time through the water flow sensor it was first passed through the water flow sensor which was taken as input interface in the flow. Formulas are applied in order to measure the number of rotations/pulses in a minute of rotation[6].

Flow rate can be determined inferentially by different techniques like change in velocity or kinetic energy. Here we have determined flow rate by change in velocity of water. Velocity depends on the pressure that forces the through pipelines. As the pipe's cross-sectional area is known and remains constant, the average velocity is an indication of the flow rate. The basis relationship for determining the liquid's flow rate in such cases is $Q=V*A$, where Q is flow rate/total flow of water through the pipe, V is average velocity of the flow and A is the cross-sectional area of the pipe (viscosity, density and the friction of the liquid in contact with the pipe also influence the flow rate of water).

- Pulse frequency (Hz) = 7.5Q, Q is flow rate in Liters/minute
- Flow Rate (Liters/hour) = (Pulse frequency x 60 min) / 7.5Q

In other words:

- Sensor Frequency (Hz) = 7.5 * Q (Liters/min)
- Liters = Q * time elapsed (seconds) / 60 (seconds/minute)
- Liters = (Frequency (Pulses/second) / 7.5) * time elapsed (seconds) / 60
- Liters = Pulses / (7.5 * 60)

IV. PROPOSED SYSTEM

As all know about 71% of the Earth's surface is secured by water, and the seas hold about 97% of all Earth's water, leaving behind with 3% of fresh water. Water is one of the main sources for survival is being used for various purposes by everyone. This chart shows the average domestic usage of a person[7,8].

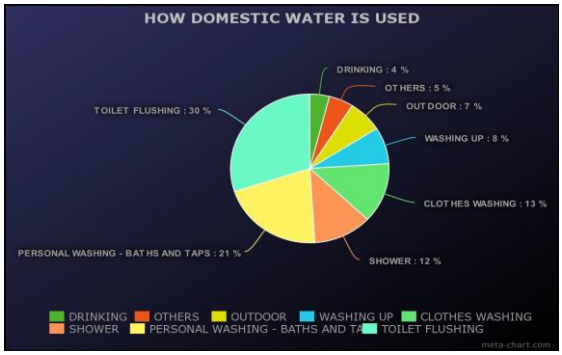

Figure 1: Domestic Usage of a Person

In this model an application wherein the users have to sign up. The sign up asks the user for his/her details like name, email, no of people in the house, phone number, status. The users sign up should be approved by the admin. Once the admin approves it, an email will be sent to the user with a password. Using that password, the user has to login to the app. So, the user need not login every time. When the application is open, it will directly take you to the main page. Now this application consists of different tabs. Each tab has a purpose, like complaint tab wherein the user can complain anything about the services given, additional requirement tab wherein the users can ask for extra water supply, profile tab wherein the profile details are there and the billing tab where the usage details with the amount is given.

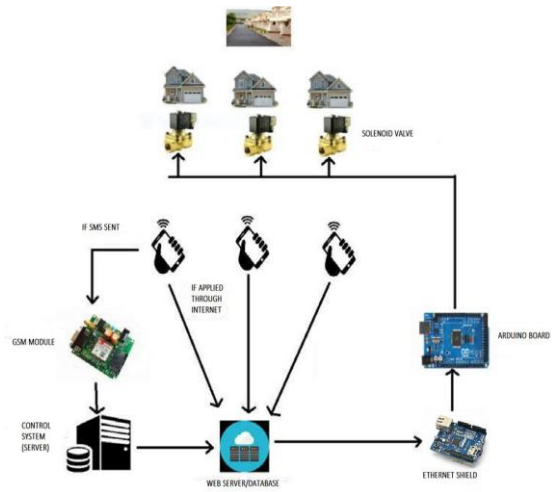

Figure 2: Schematic Working Diagram

V. OVERVIEW OF THE COMPONENTS

The overview of the components is explained here. There are different components used which are as follows: -

A. *GSM Module*

GSM module is used as a communication between the PC and the GSM. It stands for Global System which is used for mobile communication in a large portion of the nations[9].

A SIM card should be inserted in the slot given in the GSM module. GSM module device is used for sending and receiving the SMS. It works the same as a mobile phone.

Figure 3: GSM Module

B. ETHERNET SHIELD

It permits the Arduino to connect to the internet. It supports up to four simultaneous socket connections. Place the Ethernet Shield firmly on the Arduino hardware. An Ethernet Shield stacked on the Arduino hardware is shown in the following figure[10].

Figure 4: Ethernet Shield

C. ARDUINO

This is a microcontroller board**.** It has 14 I/O pins, 6 analog I/P, 16MHz quartz-crystal, a USB-connection, a power-jack, a reset switch.

It is an open source electronic platform based on flexible, simple to-utilize equipment and programming. It is used to read inputs like in our project the amount of water and gives the output like turning on the LED[11].

Figure 5: Arduino Uno

D. SOLENOID VALVE

It is electromechanical incited valve to control the stream of liquids. Their undertaking is to stop, discharge, parcel and scatter or mix the liquids found in various specific applications. Solenoids deliver fast and safe exchanging, high dependability, long administration life, high medium similarity of the materials used, low control power and conservative arrangement. In our project it is utilized to supply water to each house[12].

Figure 6: Solenoid Valve

E. FLOW SENSOR

The water flow detector consists of a body of a plastic tube, a water rotor and a sensor for the hall-effect. Rotor rolls at the point where water flows through the rotor. The velocity varies with different stream speed. The corresponding pulse signals are the hall-effect sensor out-put.

Figure 7: Flow Sensor

VI. SYSTEM DESIGN

The system design is the way toward characterizing the structure, parts, modules, interfaces and data for a framework to fulfil necessities. It could be viewed as the use of systems theory to item development.

The proposed smart water management figure in the bellow. The model mainly depends upon the Arduino. In this case, a power supply is being used.

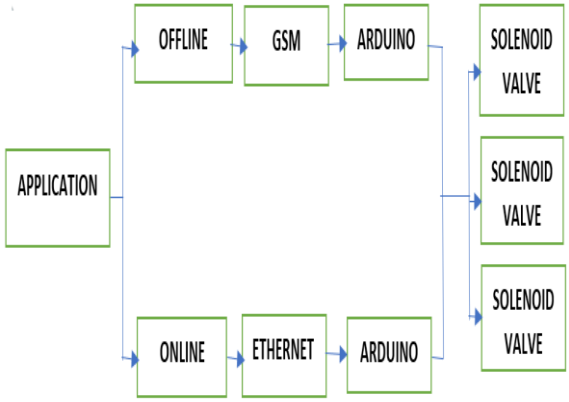

Figure 8: Block Diagram of Model

Below is the sequence diagram of the water management. First the user must sign up and get the password. Then the users have to login using the password and request for the water required. Once the admin approves the request, the valve will get open and requested amount will be sent to the user. A bill will be generated depending on the usage. The bill will be sent to the user on monthly bases. The user has to then pay the bill from time to time.

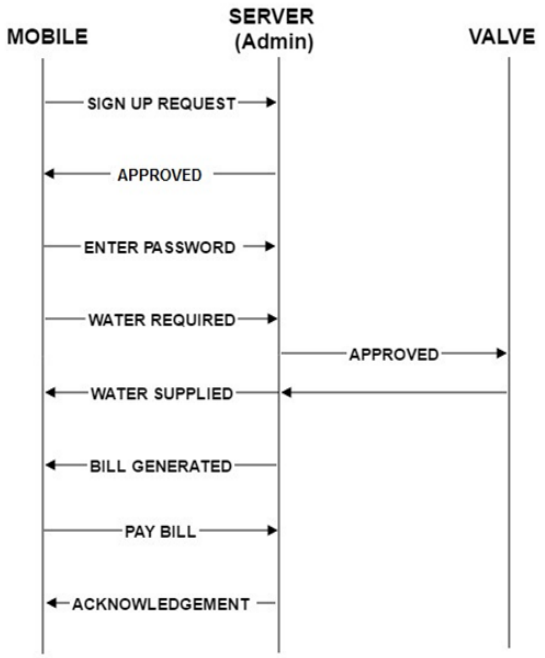

Figure 9: Sequence Diagram of Model

These are the flow chart of the water management system:

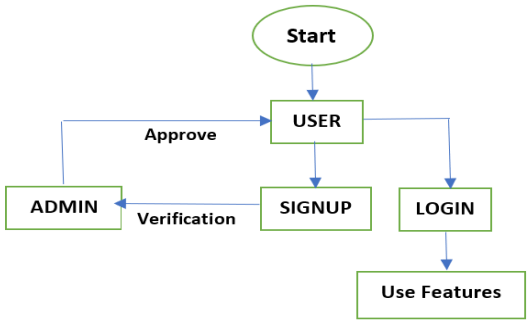

Figure 10: Flow Chart- Sign Up/Login In

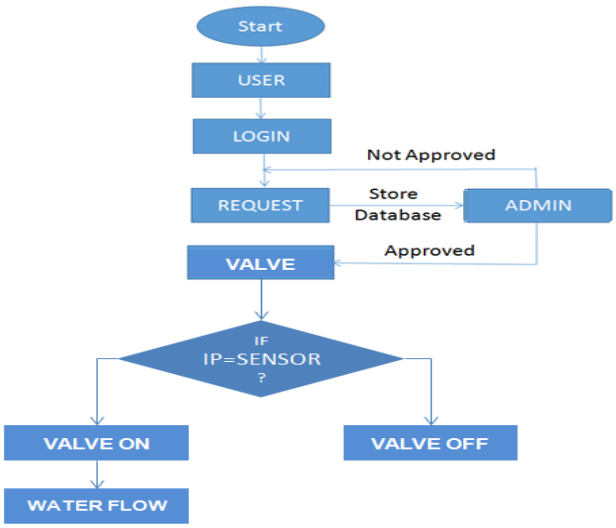

Figure 11: Flow Chart-Water Request and Delivery in Model

VII. SECURITY MODEL

Developed security algorithm is based on modified RSA cryptosystem. RSA is considered as one of the famous Public Key cryptographic algorithm. Nevertheless, a few fruitful assaults are created to break this algorithm because of specific confinements accepted in its derivation. The algorithm's security is principally founded on the issue of factoring large number. If the process factorization is done then, at that point the entire algorithm can end up fragile[11].

Here the security model is used to authenticate the user when he is requesting for the water from the admin. The algorithm makes use of cubic power of Pell's equation for generation of public key here instead of sharing public key exponent 'e' we are sharing 'S' which is formed by using Pell's equation pairs x and y, encryption key 'e' and phi(n). The algorithm is explained in paper for the security by making use of cubic power of Pell's equation[12]. The algorithm is explained bellow.

I. Key Generation Process:

- Select "D" which is prime number.
- Integer pair (X, Y) is selected satisfying the equation

$$X^m - DY^m = 1 \text{ , where } m > 1 \qquad (1)$$

- Select two distinct prime numbers p and q.
- Calculate $n=p*q$.
- Calculate $\Phi(n) = (p-1)*(q-1)$.
- Choose e in range $1<e<n$ and $GCD(e, \Phi(n)) = 1$
- Calculate alpha (α) value using

$$\alpha = [\Phi(n) + X]^3 - D[e+Y]^3 \qquad (2)$$

- Calculate $d \equiv e^{-1} \pmod{\Phi(n)}$
- Calculate public key exponent, S using alpha (α) from Eq. (1)

$$S = [\alpha + De^3 + 3DY^2e + 3DYe^2] * d^3 \bmod \phi(n) \qquad (3)$$

- Private key $=e^3$ since power of equation=3

II. Encryption Process

- Receives public key (S).
- Represent input message(M)
- Encrypt M using key S using Eq(4)

$$C(M) = M^S \bmod n \qquad (4)$$

- Send encrypted message C to receiver.

III. Decryption Process

- Recipient does the following: -
- Private key (n, e^3) to compute original message using Eq(5)

$$M(C) = C^{e3} \bmod (n). \qquad (5)$$

- Extracts the plaintext M

The data what user sends from user mobile will be encrypted using security model using Eq(4) and decrypted at the admin sideusing Eq(5). So only the legitimate user can request the water depends on how much amount of water he needs. Once the admin approves the request, the valve will get open and requested amount will be sent to the user. A bill will be generated depending on the usage. The bill will be sent to the user on monthly bases. The users must pay the bill from time to time.

VIII. RESULTS AND ANALYSIS

This section explains the encryption and robustness execution of our proposed scheme along with a comprehensive discussion about the investigation.

Math Security

The immense size of our encryption key shields the framework from ruthless assaults. At the same time, the self-assertive piece of the information makes it difficult to open the encryption framework applied to a given data, which manufactures the assault inconvenience. It is commonly acknowledged that OTP is checked every time. Similarly, the high affectability to beginning conditions guarantees that the recreation of the information is hard to decide in a crucial time.

Water consumption analysis at home Figure 12 shows the consequences of the test and the count of water utilization utilized in home every day. A family comprising of 4 individuals expended 259.2 liters of water in a day. It implies that they consume 64.8 liters/individual/day

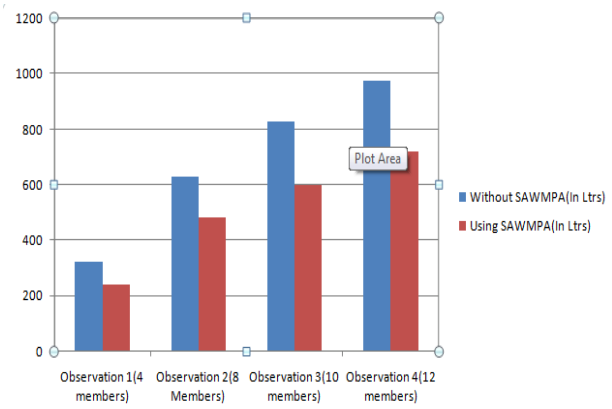

Figure 12: Water utilization graph in home every day

The Secured and Automated Water Management Powered by Arduino(SAWMPA) system has been developed and tested on a small scale condition using 4 different observations. By testing the conditions proposed system plainly express that arrangement of this system in enormous scale condition can yield better results by making use of limited water for the daily usage.

IX. CONCLUSION AND FUTUREWORK

Each house will get safe water time to time without any issues. Even if there are any issues people can let us know through the application. Therefore, this makes the water supply management system more efficient. The water wastage problem can be reduced using this strategy and water can be used efficiently in that locality. Every person in that location is assured to get fixed amount of water to fulfill their basic needs.

In future, this method can even be implemented for greater purposes and can be a part of 'Make in India' initiative. Even using humidity sensor, the water can be supplied depending on the climate changes as the consumption differs.

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