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Digital Control Mechanism for Water Supply Management

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Abstract: In all the cities or societies the water is supplied by the municipal corporations. Still, there are certain cities where the water supply is done manually by the operator. The operator opens the valve for a particular period of time and the water is being supplied to all the houses. The water supply is provided at a fixed flow rate. Certain consumers/users draw excess water by connecting motor-pump sets to the water lines which is considered as water theft. Also issues occur when the user requires additional water in his tank, but the water supplied to the houses is at fixed timings of the day. To solve the above issues we came up with this idea of developing an embedded system for monitoring the water supply system. In this project, we are developing an embedded based remote water monitoring and theft prevention system by recording the flow rates at the consumer/user end. To implement the proposed water supply system, each consumer end should be provided with a web-based application consisting of various options for the user to record the flow rate using a level sensor(ultrasonic sensor) and to transmit the same to a remote monitoring station using IoT and it is also provided with an electrically operated solenoid valve to supply water to the consumers. The valve turns on/off by the central processing unit Raspberry Pi to stop the water supply whenever the flow rate exceeds a predefined limit. Also the user has the option to request for additional water whenever required. This eases up the task both of the operator as well as the user.

Keywords: Water Supply System; IOT; Water Level Sensor; Flow Sensor; Turbidity Sensor; Raspberry Pi; Moisture Sensor.

I. INTRODUCTION

Water is an essential element of life. Still, there is a lack of enough fresh water resources to meet water demands. Many people daily face the situation of an inadequate supply of water. The inadequacy in the supply and access to water has only recently taken centre stage in global reflection as a serious and threatening phenomenon. The water that exists today would be sufficient to address human issues just on the off chance that it were even handedly conveyed.Since it isn't, there emerge circumstances of shortage; some due to natural causes and others due to a range of human activities. The water services in many countries are however still plainly inadequate in providing safe water supplies. Many people living in poverty, daily face enormous hardship because of improper water supply. The root cause of water difficulty today is not because of scarcity, but rather of the distribution system. Water crisis is much more related to management than to a real crisis of scarcity. The complexity of the water crisis is due to real problems of availability and increased demand, and to the
management process that responds to problems without a systematic approach that tries to foresee them. Due to improper water supply systems, distribution of water does not take place in an even manner. This results in some consumers getting extra water on a daily basis and some not even getting enough to fulfill their daily requirements. There are other problems while supplying the water, such as water thievery. These problems can be eliminated if proper management of water supply is done[1],[2].

PROBLEM STATEMENT & OBJECTIVES

• Monitoring the water tank level: This problem is being rectified using the ultrasonic sensor which has been connected at the top of the tank. First, let us talk about the method being used by the ultrasonic sensor for the fluid lever measuring. The main idea behind all contact-less methods is to measure the distance between the transceiver and fluid. It transmits short ultrasonic pulse and we measure travel time of that pulse from the transceiver to fluid and then back to the transceiver. Ultrasonic pulse will bounce from fluid level because of the change in density of the ultrasonic pulse travel medium (ultrasonic pulse first travel through air and bounce of the fluid with higher density than air). Because water has higher density, majority of pulse will bounce off. So, the distance travelled by that pulse wave is twice the distance between the sensor and the fluid, which can be calculated using some standard formula.

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• Water thievery: The problem of water thievery is being rectified using pressure sensor which is been installed at the inlet point of the tank. This pressure sensor is calibrated in such a way that if a user tries to steal water using a motor pump, the operator will get the notification immediately. The mechanism behind this is that, when the motor pump is attached by the user, the pressure increases. This pressure is sensed by the pressure sensor and the solenoid valve closes automatically and a notification goes to the operator.

• Need for additional amount of water: Every user gets water in his tank at a particular time of day and for a certain duration. The problem occurs when the user 3 requires extra water. In this case, our application gives the perfect solution. A user has the option to request for extra water through our application. The application will generate a bill for the requested amount which he needs to pay and thereafter water will be supplied to the user's tank for his requested amount.

System Module

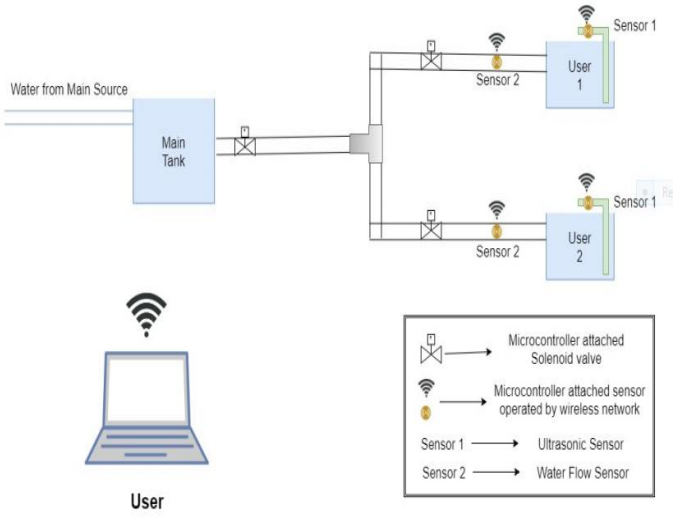

Fig. 1 System Module

The above system module is the diagrammatic representation of the water supply management system. This explains how the main tank is connected to all the houses in a particular society (in the above figure only two houses are connected to the main tank). Ultrasonic sensors attached to the Raspberry pi 3 are connected at the top of each tank which are used to measure the water level. Water Flow Sensors are connected internally on the pipe to check the whether any pump or motor is been used by the user to fetch extra amount of water. This prevents from the water thievery. Next we have solenoid valves attached to the pipe which controls the flow of water. User end has an application through which user can check water level, request for water, pay the bill and can manage his/her own profile.

Embedded System

The above is the embedded system of our application. Broadly there are three modules in our project. The first one is an embedded module which connects to water supply pipe. This is the main module of the project. Next is the IoT server, which stores the information about the flow of the water and time period of the water flow. The last one is the web application which is operated by user end. In this project we have used two sensors and one electronic valve. All devices run on different voltages, like Raspberry pi-3 processor operates in 5V, similarly the sensors operate with 5V, solenoid valve operates in 12V. A power supply board is installed to provide supply for all devices. The Ultrasonic sensor is installed near to the water tank and is connected to the raspberry pi processor. The raspberry pi continuously receives the signals from the sensor. The whole control of sensor is taken care by processor. As shown in the figure the valve is also connected to processor. A relay is connected between the processor and the valve. The main role of this relay is it acts as a switch between these two devices..

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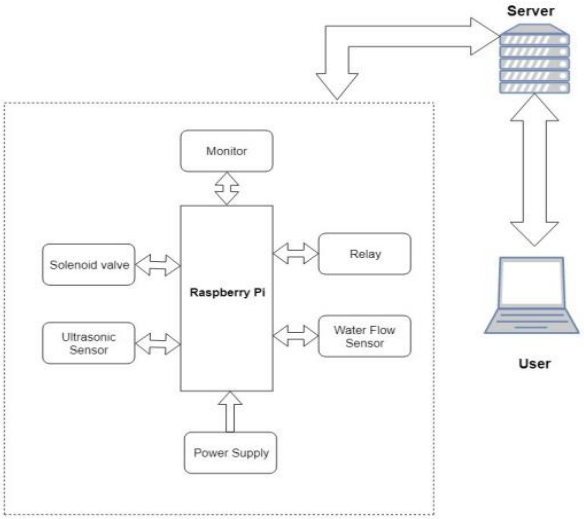

Fig. 2. Embedded System

IMPLEMENTATION

The components of the system are:

1.Hardware

• Raspberry Pi 3: Raspberry Pi is a mini processor that plugs into a computer monitor and uses a standard keyboard and mouse. It may also be used with USB storage, USB to MIDI converters or any other device/component with USB capabilities.

• Ultrasonic Sensor: Ultrasonic sensor is a device which is used to measure the distance of an object by using sound waves. It calculates the distance by sending a sound wave with a particular frequency and waits for the sound wave to come back. By recording the time between the sound wave being generated and the sound wave bouncing back, the distance can be measured between the sensor and the object.

• *Water Flow Sensor:* Water Flow Sensor is a component for measuring pressure in fluids or gases. The sensor senses the pressure and converts it into an electric signal where the amount depends upon the pressure applied.

• *Solenoid Valve:* Solenoid valve is an electronically operated valve. The valve is controlled by an electric current. In the case of a valve with two ports the flow is switched ON or OFF and in the case of a three-port valve, the out flow is switched between the two outlet ports. The task of solenoid valve is to shut off, release, dose, distribute or mix fluids.

•*Relay* :They are basically used as switch for the raspberry pi controller.

• Moisture sensor: They have been used to provide an leakage detection.

2. Software Requirements:

• Linux Operating system
• Python
• HTML
• CSS
• Java script
• PHP

We went through the plethora of tutorial modules on Python and PHP. Python language is used to interface all the hardware components such as sensors, relays, solenoid valves to the Raspberry Pi. PHP is being used for the backend of our application to make it responsive. We started with the user-interface designing of the application for the user using Html, CSS and Javascript

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APPLICATIONS

• The circuit can be implemented for effective usage of water. It can be used in Municipal Corporation (or) water board to avoid water misuse.

Web Page

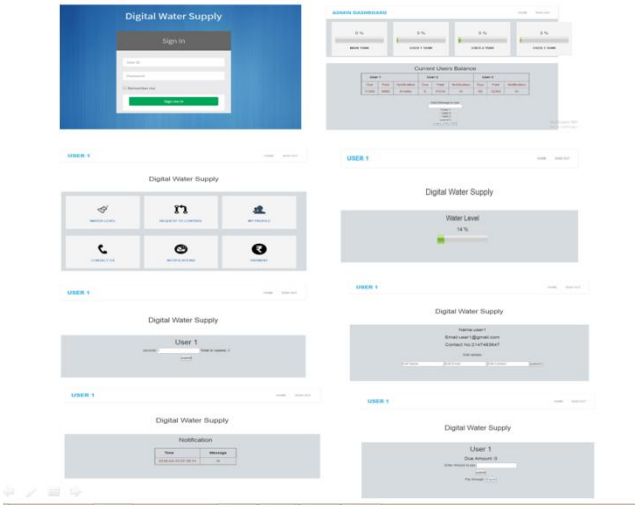

Fig 3.Web Page

1.LoginPage,2. Admin Page ,3. Home Page , 4. Water level 5. Request to control ,6. My Profile,7.Notification , 8.Payment

CONCLUSION

The web application for digital control mechanism for water supply management is designed and implemented by using ultrasonic sensor, Solenoid Valve, Raspberry Pi board etc. The designed system eliminates the manual work of the human to control the valve and intimates the water level through the server automatically. The user can also request for extra amount of water whenever required. With the help of this system user can pay the bill and control the water flow with a single click. The operator can have a look on all the user details such as water tank level, bill and can send notification to any user. Also the issues of water thievery is been resolved by installing the pressure sensor near the tanks which will detect any external pressure to fetch more water and will turn OFF the corresponding valve.

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