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E-Water Supply System: Enhancing Water Efficiency through Smart Technology

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ABSTRACT

In urban areas the water supply to residence and commercial establishments are provided at a fixed flow rate. Some customers draw excess water by connecting motor pumps sets to the water lines which is considered as water theft. In this project it is proposed to develop embedded based remote water monitoring and theft prevention by recording the flow rates at the consumer/user end and also provide information about the water pH level and turbidity level in water to user way send message to user. In this project also display the water quality and water usage rate on a server page. In this project each consumer should be connected with the Wi-Fi router to know the water usage and different sensor readings and it 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[1] to stop the water supply whenever the flow rate exceeds a predefined limit.

KEYWORDS: Raspberry Pi[1], Embedded Systems, pH meter, Solenoid valve.

1. INTRODUCTION

The demand for water is increasing with continuous economic growth. The monitoring of water resource is essential in order to prevent theft and over exploitation of water. Therefore, monitoring systems for urban water supply should be implemented. Urban water supply networks form the link between drinking water supply and drinking water consumers. Water is vital for the survival of urban life, for maintaining a healthy level of economic development, and for the continuous operation of factories and hospi[1]tals.

In world, the recent interest in privatization has affected public enterprises like urban water supply system Even though privatization has been allocated for proper maintenance of the systems, water systems did not undergo any reforms.

Development of embedded based remote water monitoring and water flow recording at consumer end for theft prevention is proposed in this project. In order to implement the proposed water supply system, each consumer end should be provided with an electrically operated solenoid valve to supply water to the consumers, which will switch on and off automatically thus preven ting over usage of water by the consumers.

In order to implement the proposed water supply system, each consumer end should be provided with a web based mobile application by using Linux LAMP[9][10] consisting of so many options for the user to record the flow rate using a flow sensor, record the solid particle content in the water by turbidity sensor, record the Ph level of the water using Ph meter and to transmit the same to a remote monitoring station using GSM and it is also provided with an electrically operated solenoid valve to supply water to the consumers. The sensors are implemented by using Arduino UNO programming language. The valve turns on/off by the central processing unit Raspberry Pi[1] to stop the water supply whenever the flow rate exceeds a predefined limit. It is proposed to Employ GSM for wireless communication so that the information can be passed to many responsible officers cell phone for immediate action.

2. METHODOLOGY

Urban water is supplied to the home with the help of some man power in the existing system. The person in charge will go the place and then opened valve to that particular area. The person will go again to that place and close the valve once the time is over. This type of operation needs man power. As the person have to go and come often, it is a waste of time. People may steal excess water for their personal use with the use of motor. Due to water theft, many people will not receive sufficient water for their use.

Water is the basic need of the humans, therefore should be supplied properly at the right time. The theft can be prevented by informing the officials about theft .But informing to higher officers are rare .Thus it is difficult to prevent theft or to find out on who does the theft by using the existing system.

The objective of this project work is proposed that the usage of Anti-theft control system for drinking water supply and web-based water monitoring. In order to implement this system each consumer end should provide

with a web page and solid content level monitoring, pH level monitoring of the Implementation of this proposed system in a real time; will allow us to control the drinking water theft in the domestic areas and providing better quality of water to the users. In urban areas the water supply to residence and commercial establishments are provided at a fixed flow rate and provide the system is provided with an electrically operated solenoid valve to supply water to consumers end.

As per the block diagram, the main water supply tank will be provided with an ultrasonic sensor which has been used for the sensing of the water level in the tank. When the water content is less, then the Raspberry pi[1] drives the motor to refill the tank with the help of relay board. When the tank is full the Raspberry pi[1] turns of the motor. The ultrasonic sensors continuously measure the water level. The flow sensor which used for calculate the water volume used a consumer. Daily volume of water for a consumer is fixed and when exceeds the volume, the Raspberry pi[1] will close the solenoid valve. The pH sensor measures the pH value in the water, pH electrode that detect a current generated from hydrogen ion activity.PH meter is implemented by using Arduino programming language. Turbidity sensors is also implemented by using the Arduino programming language. It measure the amount of light that is scattered by the suspended solids in water. As the amount of total suspended solids (TSS) in water increases, the water's turbidity level (and cloudiness or haziness) increases. Web server is designed by using Linux LAMP[9][10], this provide a web based mobile application to the users, hence the users can continuously monitor the information about the water supply.

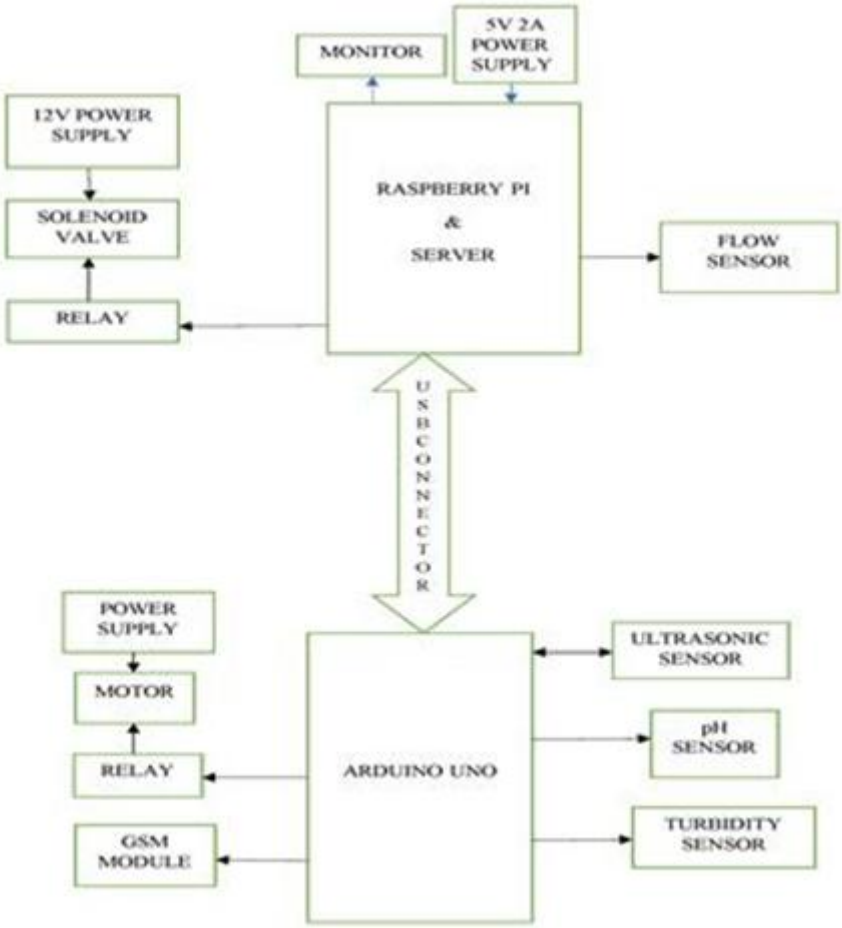

Fig. 1 Block diagram of the proposed project

3. MODULES

The different modules used in the device is as shown in Fig. 1. The modules used here are Raspberry Pi[1] as the processor, different sensors such as pH sensor, Turbidity sensor, etc. An analog to digital converter is required to comprehend the pH values for which Arduino is used. Different modules used in the proposed device are as given below:

A. Raspberry Pi[1]

The Raspberry Pi[1] is considered as a computer on its own as it can do everything a desktop computer can. It was developed in the United Kingdom by the Raspberry Pi[1] Foundation to promote the teaching of basic

computer science in schools and developing countries. Several generations of Raspberry Pi[1] have been released over the years. The Raspberry Pi[1] is extremely flexible due to its design, and because of this it will let you connect to it from another computer via a system called SSH (Secure Shell). The GPI[1]O port is one of the most powerful tools at the Raspberry Pi[1]'s disposal, allowing you to connect directly to an electronic circuit to control it. In such a system, the Pi[1] is referred to as a microcontroller. This is what makes the Raspberry Pi[1] great for big projects, as you can use it to program a machine or circuit. The OS to be used can be decided by the user however, Raspberry Pi[1] Foundation provides several versions of Raspbian, a Debian based Linux distribution for download, as well as third-party Ubuntu, Windows 10 IOT Core, RISC OS. Python and Scratch can be used as the main programming language but also supports many other languages

B. Arduino

Arduino is used in the project as an analog to digital converter. The Arduino board features an Atmel ATmega328 microcontroller operating at 5 V. The storage found is 2 Kb of RAM, 32 Kb of flash memory for storing programs and 1 Kb of EEPROM for storing parameters. The clock speed is 16 MHz that means the executing speed is about 300,000 lines of C source code per second. The pi[1]n definition is 14 digital I/O pi[1]ns and 6 analog input pi[1]ns. There are other feature such as a USB connector for talking to the host computer and a DC power jack for connecting an external 6-20 V power source, for example a 9 V battery, when running a program while not connected to the host computer.

C. pH Sensor[4]

pH meter measures the activity of the hydrogen ions in the solutions to determine the pH of the sample. This activity is compared to pure water (a neutral solution) using a pH scale of 0 to 14 to determine the acidity or alkalinity of the sample solutions. An ADC is interfaced with the pH meter in order to convert into digital values.

D. Turbidity Sensor[3]

Turbidity is the quantitative measure of suspended particles in a fluid. Turbidity is the cloudiness or haziness of a fluid caused by large numbers of individual particles that are generally invisible to the naked eye, similar to smoke in air. The measurement of turbidity is a key test of water quality. If the sensor senses turbidity as high, the module output will be low. Otherwise the module output is high.

E. Ultrasonic Sensor[5][6]

Ultrasonic sensors measure distance by using ultrasonic waves. The sensor head emits an ultrasonic wave and receives the wave reflected back from the target. Ultrasonic Sensors measure the distance to the target by measuring the time between the emission and reception. In this project, it is used to determine the water level in the tank by using the same principle.

F.GSM Module

Global System for Mobile communication (GSM) is an architecture used for mobile communication in most of the countries. GSM module consists of a GSM modem assembled together with power supply circuit and communication interfaces (like RS-232, USB, etc.) for computer. GSM MODEM is a class of wireless MODEM devices that are designed for communication of a computer with the GSM network. It requires a SIM (Subscriber Identity Module) card just like mobile phones to activate communication with the network. Also they have IMEI (International Mobile Equipment Identity) number similar to mobile phones for their identification. A GSM MODEM can perform the following operations:

1. Receive, send or delete SMS messages in a SIM.
2. Read, add, search phonebook entries of the SIM.
3. Make, Receive, or reject a voice call.

The MODEM needs AT commands, for interacting with processor or controller, which are communicated through serial communication. These commands are sent by the controller/processor. The MODEM sends back a result after it receives a command. Different AT commands supported by the MODEM can be sent by the processor/controller/computer to interact with the GSM and GPRS cellular network.

G. Solenoid Valve

A solenoid valve is an electromechanical controlled valve. The valve features a solenoid, which is an electric coil with a movable ferromagnetic core in its centre. This core is called the plunger. In rest position, the plunger closes off a small orifice. An electric current through the coil creates a magnetic field. The magnetic field exerts a force on the plunger. As a result, the plunger is pulled toward the centre of the coil so that the orifice opens.

This is the basic principle that is used to open and close solenoid valves. It is used to turn on and off the water pump.

H. Water flow sensor[7]

This sensor sits in line with your water line and contains a pi[1]nwheel sensor to measure how much liquid has moved through it. There's an integrated magnetic Hall Effect sensor that outputs an electrical pulse with every revolution. The Hall Effect sensor is sealed from the water pi[1]pe and allows the sensor to stay safe and dry.

J. Relay

Relay is used to isolates two circuits electrically and connects them magnetically by using electromagnetic properties. They are very useful devices and used for switching on of one of the circuit by another one while they are completely separate. They are often used to whenever interfacing of an electronic circuit working at a low voltage to an electrical circuit which works at very high voltage has to be done. For example, a relay can make a 5V DC battery circuit to switch a 230V AC mains circuit. Thus a small sensor circuit can drive, say, a fan or an electric bulb. It is used here to switch on and off the water pump.

K. Python[8]

Python is a popularly used general-purpose, high-level programming language. Python is very easy to understand emphasizing high code readability, and its syntax is very efficient allowing programmers to express concepts in fewer lines of code than in C++ or Java. Python is the language compatible with Raspbian Jessie OS. Python supports object-oriented programming, imperative and functional programming or procedural styles. It features a dynamic system and automatic memory.

4. WORKING

The proposed system circuit diagram consists of two section, master and slave section. Raspberry pi[1] is the master and Arduino UNO is the slave section. To avoid the wastage of water during supply to water distribution unit related areas, automated supply is formulated. It involves the process of supplying water to a particular area at particular time. Water supply will be stopped automatically after reaching fixed value limit. Over consumption can be intimated by measuring the flow of water to every connection in water supplying network. This measurement can be done by using flow sensor at every channel (connection). On the basis of this measured value, usage of water by every home unit is calculated. By comparing fixed value and measured value overconsumption can be easily formulated .Automated supply also focuses proper supply of water to all connections.

Water quality can be assured by employing pH sensor. If the supplied water is with desired quality then many issues will be avoided. Automated supply avoids the wastage of water and the quality of supplied water can be assured by utilizing pH sensor. Turbidity sensors is also implemented by using the Arduino programming language .it measure the amount of light that is scattered by the suspended solids in water. As the amount of total suspended solids (TSS) in water increases, the water’s turbidity level (and cloudiness or haziness) increases. By using GSM module, a wireless communication system is implemented here in order to creating mobile communication to users and a web-based communication is implemented by using Linux LAMP[9][10] server. Hence the consumer will get all information such that water quality level, over utilization of water.

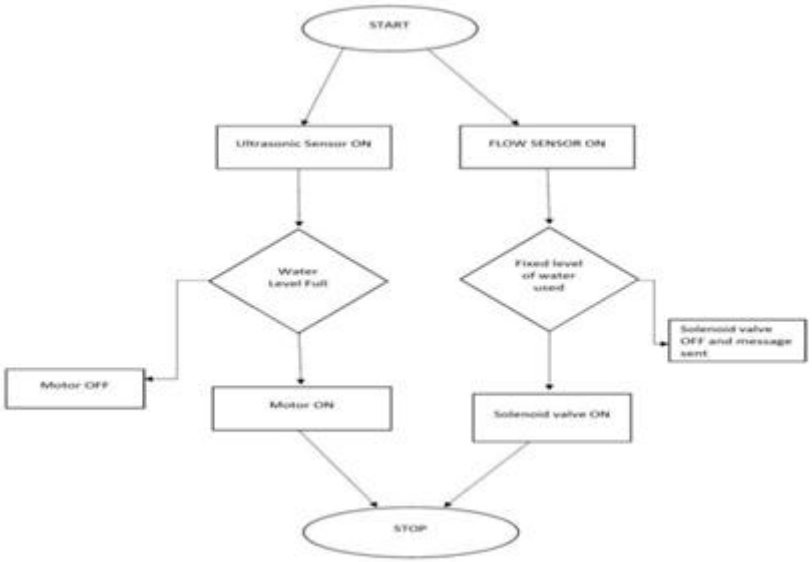

Fig 9: Flow Chart

5. CONCLUSION

The main objective of this paper is to design a fully automated monitoring system. The system provides a real time system which monitors soil pH, temperature and soil moisture efficiently. The system valves are turn ON or OFF automatically depending upon the moisture content. The system also provides the efficient information regarding the soil pH and soil nutrients. The system provides a real time analysis to the owner to monitor variation in the parameters. Using this system, one can save manpower, water to improve production and ultimately increase profit. We can add more environmental sensors to this module to make it more efficient.

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