IoT based smart water distribution system

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Abstract:

Water is one of the most important natural resources on the earth to life, prosperity and wealth. Water scarcity issues pose a clear threat to the livelihood of living things. It estimates that one in nine people do not have access to safe and clean drinking water. As water is a natural resource, each and every individual is equally responsible for its effective management. It is necessary to have an effective and efficient water management system to overcome water scarcity problem. The proposed system embeds the sensor and Internet of Things to develop intelligent monitoring system. This system uses Arduino Uno as the main controller, flow sensor to measure water flow rate and Bluetooth module to provide wireless communication. It replaces the traditional water metering system which is manual and time consuming process. The system is made from low cost devices and it is user friendly. It allows the measurement of water flow rate and billing at different households and industries. It is an attempt to build a water management system using IoT to provide the real time efficient water distribution management at affordable cost in developing countries with limited resources.

Keywords **— water management system, IoT, sensors.**

I. INTRODUCTION

Water is the most precious and valuable resource which is a basic need to all human beings. Due to the rapid increase in global population, development in industrial and agricultural sectors water scarcity is one of the major problems faced by all countries. According to united nations world water development report released in 2015, there will be 40% shortage of drinking water in the world by 2030, which is only 12 years from now [1] .

Water management is defined as the activity of planning, developing, distributing and managing the optimum use of water resources [2]. Limited water availability, conservation, sustainability policies and infrastructure complexity make water management a challenging problem. This situation indicates the need for an advanced mechanism to monitor and control the water distribution networks. Technology based decision-support system provides useful guidance for operating a complex networks like water distribution networks [3].

The current paper focuses on implementing a smart water management system to assist the water distribution Corporation and the consumers by monitoring the water supply and also collecting real-time data for billing and real-time analysis. The system measures the consumer water consumption in real time and also creates various visual graphs of the collected data and represents them in a readable manner to the customer. The scope of this work is to applying Smart Solutions such as IOT (Internet of Things) combined with sensor technologies to overcome water stress issue and to evaluate the performance of water distribution network. Internet of Things for smart environments is defined as the interconnection of sensing and actuating devices providing the ability to share information across platforms through a unified framework, developing a common operating picture for enabling innovative applications [4].

The incorporation of recent advances in the information and communications technology (ICT), reliable and cheap sensor and actuator components

has a significant potential in monitoring and management of water [3]. Water consumption in individual houses is calculated by flow sensor and this system uses the YF S201 flow meter sensor to measure the usage of water in hours/liters [5] and NFC tag is used for the unique identification of sensor module [6]. NFC tag can also be replaced by RFID tag which facilitates the automatic wireless identification for long distances than NFC tag [7].

The consumed quantity of water is collected in android application via wireless link and it is transferred to the database. The flow data collected can also used for future planning on water need and distribution. This smart water management system provides a simple solution to automate flow rate metering by replacing manual metering which is error prone, tedious and time consuming process. This device is most suitable for developing countries because of its affordable cost and easy management.

II. SYSTEM DESIGN

The methodology used for smart water distribution management embeds sensor technologies with the IoT. It can be used to measure water consumption in individual houses as well as industries. The system architecture is shown is shown in figure 1. The major components of the system are listed in table 1.

The working procedure of the proposed smart water management system is described as follows. The water flow sensor is positioned in line with water supply pipe line and the water flow through pipe pushes the rotor vanes of the flow sensor.

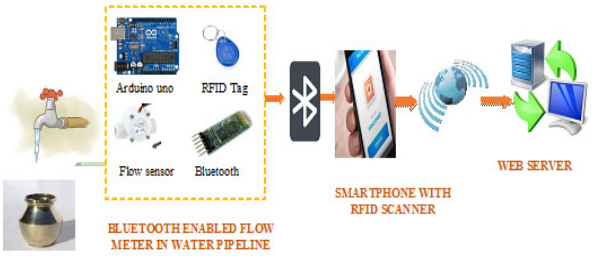

Fig. 1 Architecture of Smart Water Management

The pin wheel has a little magnet attached, and there's a hall-effect magnetic sensor on the other side of the plastic tube that can measure how many spins the pinwheel has made through the plastic wall. Hall Effect sensor attached to G½ water flow sensor is a transducer that passes the pulse train in the form of electrical signal to the microcontroller that is programmed to convert it to flow rate. The sensor will be safe and dry as they are temperature resistant and stress resistant sensors especially suited for electronic computation.

TABLE I
SPECIFICATION OF COMPONENTS USED IN SMART WATER MANAGEMENT SYSTEM

Components	Type	Specifications
Flow sensor	YF S201	1～30 L/min under 1.2Mpa
Microcontroller	Arduino Uno	ATmega328 with operating voltage 5V
Bluetooth	HC-05	V2.0+EDR (Enhanced Data Rate) 3Mbps GFSK Modulation
RFID Tag	Active	Contain chip, memory and antenna

To process the signal received from flow sensor an arduino uno (ATmega 328) microcontroller is used as a master controller. It is a single-board microcontroller that allows quick prototyping for engineering and educational projects [6] . It has 6 pins for analog input, 14 pins for digital input/output and USB connection. The flow sensor is interfaced with the controller for acquisition of data in real time. Arduino IDE software can be connected to the arduino to upload programs and communicate with interfaced devices.

This system also includes the RFID (Radio Frequency Identification) module for unique identification of each sensor module. It works at frequency 13.56 MHz and short-range (1m) communication which permits the exchange of data

between devices. An active RFID tagging system includes the tag itself, a read/write device, battery and a host system application for data gathering, processing, and communication.

The person who is responsible for taking reading should use the Bluetooth technology to virtually connect the controller and android Smartphone. For this purpose a Bluetooth enabled mobile application is installed on the android Smartphone to receive data from microcontroller via Bluetooth module**.** Since the Bluetooth module in all Smartphone is of Master type, the one we need for Arduino must be a Slave. So the connection between Arduino and the Android phone should be a Slave Module. When the RFID tag is scanned using RFID reader the app shows the consumer details and the Bluetooth is enabled to fetch the reading from the microcontroller Bluetooth is a short range wireless technology that operates in the 2.4 GHz band. This system use Bluetooth module type HC-05 which is low-cost and simple to use [8]. Moreover, it consumes low power of 3.6 volt. The HC-05 Bluetooth Module can be used in a Master or Slave configuration, making it a great solution for wireless communication. In case of industries GSM module can also be used for long distance wireless transmission [9].

The proposed system used MySQL software to create database. MySQL is an open source database management system. It uses MySQL software to create relational database to store end user information. The parameters are stored in the form of table which includes consumer name, ID, liters consumed and billing amount. MySQL has advantages such as it is open source, fast, reliable, client-server model and works in embedded system [10].

III. RESULTS AND DISCUSSION

The proposed monitoring system has been designed in order to calculate consumers water usage details in real time. Fig 2 shows the initial prototype design with HC-05 Bluetooth module. The smart water distribution management system is implemented in hardware with Arduino Uno, flow sensor and Bluetooth module. The measured flow rate is transferred via Bluetooth module to the android Smartphone. The data received in the Smartphone is transferred to the web browser for further processing and analyzing.

The code for the flow rate measurement is written in the c language and it is uploaded into the Arduino Uno microcontroller using the Arduino IDE software. Arduino IDE is compatible with windows and linux OS. The output contains the total flow rate in liters and also the current flow of water through the pipes in liter per minute. Thus in each households or industries the consumed water is calculated in the reliable and accurate manner.

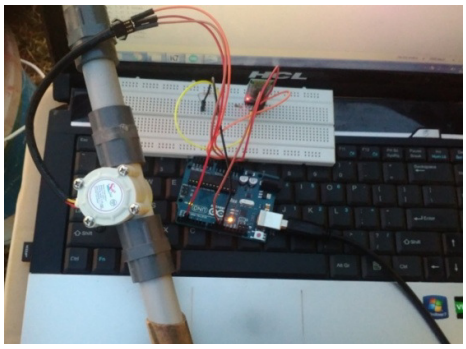

Fig. 2 Prototype Design

HC-05 Bluetooth module helps in the transfer of data from serial monitor to mobile app via wireless link. Bluetooth is used for wireless connection because of its distance and speed. A database is necessary for maintaining the information about the sensor module. If the sensor module is not included in the database system, the water flow data cannot be paired and received.

The output of the application is received from the HC-05 module and is displayed on the screen. To receive the data from the main controller the Bluetooth in the android Smartphone is turned on and the mobile application is scanned to connect to the controller. Then the data is received in the mobile app in real time and reliable manner.

To test the performance of water monitoring system, the flow sensor was tested by fitting the

prototype at 1000 liters water tank and it gave the result of 150 ml deviation for each 100 liters. From the results obtained, it is observed that flow sensor has produced pulses well with water flow inside the rotor. Thus accuracy is maintained with +/- 0.15%. Some of the mobile app features for water consumed is shown in fig 3.

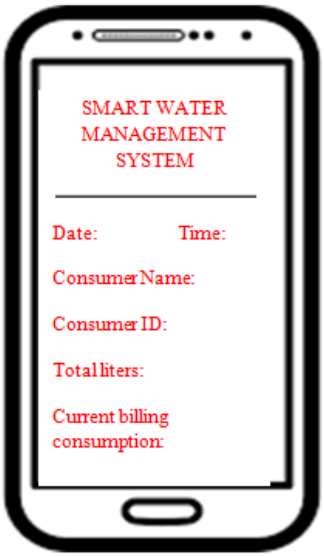

Fig. 3 Sample features in mobile app

IV. CONCLUSIONS AND FUTURE WORK

This proposed system addresses the most serious drinking water management issue in the developing countries and provides a solution to the problem in a easy and affordable manner. The electronic components used are of low cost, reliable and suitable for water management. The system is built using Arduino Uno and flow sensor. The programming is done on Arduino IDE. Bluetooth module is used to transfer the flow rate in the wireless manner. The data is transferred to the mobile application and the billing is done based on the water consumption. Thus it is a device that provides transparent and effective water distribution system for industries and households and also it creates awareness among the people about the water management. This system can be improved by providing flow control and indicating the consumer about the water consumption at different households and industries to provide efficient water management. GSM technology can also be used which avoids manual operation and it is most suitable for smart cities.

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