Remote Monitoring and Control for Rural Water Distribution System Using GSM


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Abstract: In this paper we present a prototype for automatic controlling of rural water distribution system along with the water navigation and leakage detection. Prototype includes controller node, actuation node, sensor node and a mobile phone. In controller node SIM900A GSM module is interfaced with PIC16F77 microcontroller. In actuation node a motor drive circuit and three relay circuits along with three solenoid operated valves are connected with the microcontroller output port. In sensor node three sensors (leakage detection, pressure and pH sensor) that placed in the respective supply piping are integrated with the microcontroller. A registered mobile phone (SIM) is used to send the information about the required field to be irrigated in the form of SMS/Phone call. On receiving a SMS/Phone call, controller node will decide which valve to be kept on or off. The sensor node can be mounted in the distribution pipes for sensing the water leakage and pressure, and the sensed data is sent back to the controller node from where the water navigation path will be sent on the registered mobile phone (SIM) in the form of a SMS. Mobile phone can also be used for sending request to switch on/off the motor pump.

Keywords: Global system for mobile communication (GSM), water distribution, Microcontroller, solenoid water control valves, Short message service (SMS), water leakage sensor.

I. INTRODUCTION

In this paper we present a prototype for automatic controlling of rural water distribution system along with the water navigation and leakage detection. Prototype includes controller node, actuation node, sensor node and a mobile phone. In controller node SIM900A GSM module is interfaced with PIC16F77 microcontroller. In actuation node a motor drive circuit and three relay circuits along with three solenoid operated valves are connected with the microcontroller output port. In sensor node three sensors (leakage detection, pressure and pH sensor) that placed in the respective supply piping are integrated with the microcontroller. A registered mobile phone (SIM) is used to send the information about the required field to be irrigated in the form of SMS/Phone call. On receiving a SMS/Phone call, controller node will decide which valve to be kept on or off. The sensor node can be mounted in the distribution pipes for sensing the water leakage and pressure, and the sensed data is sent back to the controller node from where the water navigation path will be sent on the registered mobile phone (SIM) in the form of a SMS. Mobile phone can also be used for sending request to switch on/off the motor pump.

Depending on the decision taken by controller, an action signal will be sent to the relay circuits to operate the respective solenoid valve. Water leakage detection sensors are placed in the irrigation piping which are integrated with the PIC16F77 microcontroller. On receiving signals from leakage detection sensors, controller node will form a water navigation path in the programmed form and sends it on a registered mobile number as a message. Results show the proposed prototype is effective in automatic controlling of water distribution along with the water navigation based on the feedback of sensors and
corrective commands from mobile phone. Rest of this paper is organized as follows: Section 2 presents a literature study on present water distribution systems, section 3 is proposed system, section 4 is system components, section 5 is experimentation, and section 6 is conclusion.

This system is very helpful for switching ON/OFF to the motor and control valve open/close with the help of GSM by giving a command to the system. The micro controller used to control the system for entire features to be controlled and communicated on it. Here we are using a Bluetooth for communication control/command and monitor the entire system function.

II. LITERATURE SURVEY

Historically, drinking water supply in the rural areas in India has been outside the government’s sphere of influence. Community–managed open wells, private wells, ponds, have often been the main traditional sources of rural drinking water. Government of India’s effective role in rural drinking water supply sector started in 1972-73 with the launch of Accelerated Rural Water Supply Program (ARWSP). With the passage of time, the program was modified in 2009-10 and re-named as National Rural Drinking Water Program with the national goal to provide every rural person with adequate safe water for drinking, cooking and other domestic basic needs on sustainable basis. The basic requirement should meet minimum water quality standards and readily and conveniently accessible at all times and in all situation. The Program has now been modified with major emphasis on ensuring sustainability of water availability in terms of portability, adequacy, convenience, affordability and equity while also adopting decentralized approach involving PRIs and community organization. As per the strategy plan of ministry of Drinking Water and sanitation, Government of India, at least 55 % households shall be provided with service connection within their premises by 2017 and 90% households to be provided service connection by 2021. However the State Government may decide to provide more house hold connections depending on the feasibility.

Generally an operator is used to visit the motor shed periodically and remain present during the water distribution to manually navigate to the various locations. This method takes lot of time and effort, particularly when an operator needs to control water supply to multiple locations in different geographical areas. Automation in water distribution system makes the operator’s work much easier. GSM based automated water distribution system eliminates an operator where presence of an operator in the field is not mandatory to perform distribution process. We developed our project in order to operate the water pump and control valves remotely by using a GSM module.
Types of Rural Water Supply Schemes:
- Open wells/ Sanitary dug well/ rain water harvesting collections.
- Hand pumps schemes.
- Gravity flow piped water supply schemes.
- Power pump scheme.
- Hand pump fitted with mini power pump schemes or pump and tank scheme based on bore wells or sanitary dug wells.
- Single habitation and multi habitation piped water supply schemes based on surface and ground water.
- The sources of single village and multi habitation piped water supply schemes may be an open wells, sanitary wells, bore wells, infiltration wells, infiltration galleries, rivers, dams, reservoir, and canals.

Components of Rural Piped Water Supply Scheme (PWSS):
The Rural Piped Water Supply Scheme Comprises of following components…
1) Source/ intake works.
2) Raw water storages.
3) Transmission System.
4) Filtration unit.
5) Pumping Machinery.
6) Disinfection.
7) Balancing Reservoir.
8) Distribution system.

Water Transmission Systems:
The overall objective of a transmission system is to deliver raw water and treated water from the source to the treatment plants and treatment plants to the storage reservoirs respectively for supply into distribution networks. Transmission of raw water can be either by canals or by pipes whereas transmission of treated water is by pipes only. Transmission through pipes can be either by gravity flow or by pumping.

In the case of gravity a transmission line, where direct feeding in to OHTs is envisaged then it should be ensured that design head is developed. Otherwise water will be reaching only the OHT at lower elevation at the cost of OHT at higher elevation. This can be ensured by suitably regulating the sluice valves.

All valves installed in the transmission main should be inspected daily to ensure that there is no leakage otherwise leakage should be attended. If attending leakage requires stoppage of flow through pipes the same can be attended on a pre-fixed monthly shutdown day.

III. PROPOSED SYSTEM
In this section, we propose a prototype for automatic controlling of water distribution and its navigation remotely. The proposed system uses a mobile phone for controlling the water pump and solenoid operated valves based on the SMS/Missed call. In most of the existing systems mobile phone is used to switch on/off the water pumping motor. Figure 1 illustrates overview of the proposed system. The prototype includes: controller node, actuator node, sensor node and mobile phone. In controller node SIM900A GSM module is interfaced with PIC16F877 microcontroller. In actuation node a motor drive circuit and three relay circuits along with three solenoid operated valves are connected with the microcontroller output. In sensor node three sensors that placed in the respective irrigation piping are integrated with the PIC16F877 microcontroller. A registered mobile phone is used to send the
information about the required field to be irrigated in the form of SMS/Phone call. On receiving a SMS, controller node will decide which valve to be kept on or off.

![Figure-1 Block diagram for rural water distribution System using GSM](image)

**Problems in Transmission Mains:**

(i) **Leakage**

Water is often wasted through leaking pipes, joints, valves and fittings of the transmission system either due to bad quality of materials used, poor workmanship, and corrosion, age of the installations or through vandalism. This leads to reduced supply and loss of pressure. Review of flow meter data will indicate possible leakages. The leakages can be either visible or invisible. In the case of invisible leaks sections of pipeline can be isolated and search carried out for location of leaks.

Most common leaks are through the glands of sluice valves. Leaks also occur through expansion joints where the bolts have become loose and gland packing is not in position. Leaks through air valves occur due to improperly seated ball either due to the damage of the gasket or due to abrasion of the ball, through the gland of the isolating sluice valve or through the small orifice.

(ii) **Air Entrapment**

Air in free form in rising main collects at the top of the pipeline and then goes up to higher points. Here, it either escapes through air valves or forms an air pocket which in turn, results into an increase or head
loss. Other problems associated with air entrainment are: surging, corrosion, reduced pump efficiency and malfunctioning of valves or vibration. In rare cases bursting of pipes also is likely to occur due to air entrainment.

(iii) Water Hammer
The pressure rise due to water hammer may have sufficient magnitude to rupture the transmission pipe or damage the valves fixed on the pipeline. Water hammer in water supply systems occurs due to rapid closure of valves and sudden shut off or unexpected failure of power supply to the pumps. The care should be taken to open and close sluice valves gradually.

IV. SYSTEM COMPONENTS

1. Software Components:
Software components include embedded software written to the controller memory. It is specialized in the form of programming for the particular hardware which has time and memory constraints. There are varieties of programming languages that can be used to instruct the controller via Assembly Language, Embedded C, Java, Python etc. Embedded C is most commonly used programming language and hence it is used for this particular prototype.

1.1 Embedded C:
Embedded C is small and reasonably simpler and C compilers are available for all embedded devices existing. Unlike assembly, C has advantage of processor independence and offers more flexibility. It also supports low level bit wise data manipulation. Considering all these benefits Embedded C is been used as programming language for the microcontroller.

2. Hardware Components:
Hardware components includes interconnected electronic and electrical elements which perform analog or logic operations on received and already stored data to produce desired output. It includes various kinds of integrated circuits, relays, memory devices like microcontroller/microprocessors, amplifying devices, communication and interfacing devices etc. The hardware components that used for this prototype are listed below along with their functions.

2.1 GSM Modem:
GSM wireless modem works with GSM wireless network for transferring data between mobile phone and controller node. A GSM modem requires a subscriber identity module (SIM) card to operate. SIM900A is designed for global market and SIM900A is specifically for India. SIM900A is a Tri-band GSM/GPRS engine that works on frequencies EGSM 900 MHz, DCS 1800 MHz and PCS1900 MHz. SIM900A provides GPRS multi-slot class 10 capabilities. SIM900A has built in RS232 level convertor. It is 40mm x 33mm x 2.85 mm in dimension.

2.2 MAX 232:
MAX232 is compatible with RS232 standard and SIM900A has built in RS232 convertor. RS232 is required to each receiver converts TIA/EIA-232-E levels into 5V TTL/CMOS levels. Each driver converts TTL/COMS levels into TIA/EIA-232-E levels. RS232 is provided to interface the microcontroller with the GSM modem.
2.3 Leakage Detection Sensor:
A water detector is an electronic device that is designed to detect the presence of water and provide an alert in time to allow the prevention of water damage. A common design is a small cable or device that lies flat on a floor and relies on the electrical conductivity of water to decrease the resistance across two contacts. The device then sounds an audible alarm together with providing onward signaling in the presence of enough water to bridge the contacts. These are useful in a normally occupied area near any infrastructure that has the potential to leak water, such as HVAC, water pipes, drain pipes, vending machines, dehumidifiers, or water tanks.

2.4 Pressure Sensor:
A pressure sensor measures pressure, typically of gases or liquids. Pressure is an expression of the force required to stop a fluid from expanding, and is usually stated in terms of force per unit area. A pressure sensor usually acts as a transducer; it generates a signal as a function of the pressure imposed. For the purposes of this article, such a signal is electrical.

2.5 pH Meter:
A pH Meter is a device uses along potentiometric ally measuring the pH, which is either the concentration or the activity of hydrogen ions, of an aqueous. It usually has a glass electrode plus a calomel reference, or a combination electrode. pH meters are usually used to measure the pH of liquids, though special probes are sometimes used to measure the pH of semi-solid substances.

2.6 Microcontroller 8051:
Microcontroller 8051 is an 8-bit microcontroller which incorporates 4KB on chip memory and includes 12MHz Crystal with 1 Microsecond instruction cycle. 16 bit timers usually two, 3 internal and 2 external interrupts, 16 bit program counter and data pointer with on chip RAM of 128 bytes. Serial interface is programmable for three duplex UART modes for serial I/O. It has four I/O ports out of which first port is used to integrate with GSM module to receive and send the information; second port is integrated with DC motor operated valve to send the actuation signal while third port is integrated with water sensor to receive the monitored signal.

2.7 Other Components:
16 X 2 LCD is used to display message received by GSM module. Each character is displayed using 5 X 7 or 5 X 10 pixel matrix. Motor driver circuit is simply a switch for motor and 12V batteries are used for power supply along with transformers for suitable voltage transformation.

V. CONCLUSION
In this paper we present a prototype for automatic controlling of water distribution system along with water navigation. Prototype includes sensor node, controller node, actuator node and mobile phone. The sensor node is deployed in the piping system for sensing the presence of water leakage, pressure and pH level and the sensed data is sent to controller node. On receiving sensor signal the controller node which is interfaced with GSM module will send a message to registered mobile number which sent in the form of SMS to switch on/off the water pump. The experimental results show that the prototype is capable for automatically controlling and remote accessing of water pump and control valves based on the feedback of the operator. The prototype can facilitate an operator in monitoring and controlling water distribution activity remotely.
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REFERENCES


