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Design and Development of GSM based Prepaid Water Meter

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ABSTRACT: A water meter is a device used to measure the volume of water usage. In many developed countries water meters are used at each residential and commercial building in a public water supply system. Water meters typically measure and display total usage in cubic feet (ft.3), cubic meters (m3) or US gallons on a mechanical or electronic register. Water meter is a cash register of a water supply authority. Consumption based water rates require periodic reading of meters. These readings are usually done by meter readers visiting consumer's premises one by one and noting down the indicator reading by the meter. These readings are recorded manually in books or on cards and later keyed in manually to a customer accounting or billing system. In some cases, meter readers use Hand held Data Entry Terminals to record meter readings. Data from these devices are transferred electronically to a billing system. The environment of meter reading usually is not favourable to the meter reader as most of the water meters are installed in underground chamber; these chambers are filled in many cases with water, reptiles or insects. Often access to these meters is also obstructed when these meters are installed in the consumers' premises. Sometimes manual work is involved for opening the chamber covers. Some consumers connect their electrical earth terminal to water utility pipe which endangers the safety of meter reader. If during the meter reading visit the consumer premises are not accessible the meter reader will have to visit it again which increases the cost of meter reading. The solution to above difficulties is to install pre-paid water meters. Because of development in integrated circuit technology and low powered radio trans- receivers this system to some extent is simplified.

KEYWORDS: Prepaid Water Meter (PWM), Flow Sensor, GSM, Solenoid Valve, AVR butterfly, VM Lab, Windows Hyper Terminal..

I.INTRODUCTION

A comprehensive literature survey was carried out at the beginning for the Conceptual understanding of the present water meter system and hence needed a system-

- To reduce wastage of fresh water.
- Compel every customer to pay for the exact amount of water used or wasted.
- Make every customer a self-interested guardian of the water supply.
- Prevent water shortage during dry seasons.

From the study it has been concluded that a Pre-Paid water meter is required from customer's and provider's point of view.

Customer's View:

- No Monthly Bills.
- All you have to pay is the first pre-payment.
- Easy Monitoring
- Customer can Easily monitor their use and spend as much as they can afford

Provider's View:

- To eliminate bill debt problems.
- Improved Cash flow

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- No Credit and Arrears Collection costs.
- All customers are paying.
- No Monthly Bills
- No need to send monthly usage bill.

II.LITERATURE SURVEY

The Mogale City municipality, which borders western Johannesburg in South Africa, is a pioneer of prepaid water, and possibly the first urban center to adopt prepaid water at scale. It installed its first prepaid system in 1999, and within three years had 30,000 meters in low and high income areas. Presently a prepaid water meter are available with smart card technology in which consumer spend amount of water loaded from credit sales office by loading the credit water meters via smart card

III.PROPOSED SYSTEM

The research work has been carried out with following objectives.

- To develop a system that keeps an eye on usage of water consumption.
- To design a sensing system that will generate electronic count equivalent to amount of water.
- To design a control mechanism that allows water usage only when there is amount of units balance.
- To develop a remote display device for consumer to see water usages at its location.
- Finally make the system as a Pre-paid Water Meter.

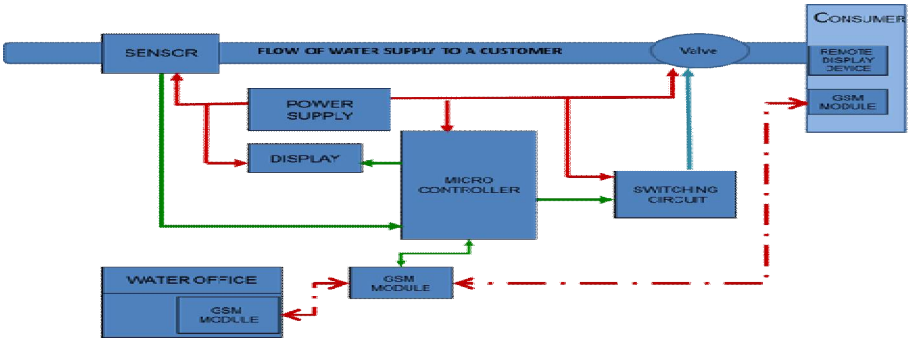

Fig 1: Block Diagram of the Proposed System

In our Project we use flow sensor, solenoidvalve, displaydevice, microcontroller& GSM. A flow sensor is attached in the pipeline to the customer which gives the output in pulses as consumption of water in litre. Microcontroller will count that pulses and decrement the balance count which is added by the SMS send through GSM by water authority by paying appropriate amount, when the balance count becomes less (threshold value) it sends a message “Balance is less” to the display device, and customer can recharge their account by recharging their account for uninterrupted water supply and if customer didn’t recharge their account and balance count becomes zero microcontroller will turn off the solenoid valve in the pipeline and water supply will interrupted to the customer.

IV.HARDWARE & SOFTWARE

Flow Sensor:

In our system pre-paid water meter we use a turbine based flow sensor that gives pulses directly proportional to the flow of volume through it. It measures flow rate by using the natural kinetic energy of the flow as it passes through the angled blades of the turbine rotor. This causes the turbine to spin and as the blades pass by a close pre-positioned magnetic (Or other technology) “pick up” coil. The resulting interruption of the coils magnetic field by each blade results in a pulse beingproduced. The flow sensor gives 470 pulses per liter of liquid.

Solenoid Valve:

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A solenoid valve is an electromechanically operated valve. The valve is controlled by an electric current through a solenoid: in the case of a two-port valve the flow is switched on or off; in the case of a three-port valve, the outflow is switched between the two outlet ports. Solenoid valves are the most frequently used control elements in fluidics. Their tasks are to shut off, release, dose, distribute or mix fluids. They are found in many application areas. Solenoids offer fast and safe switching, high reliability, long service life, good medium compatibility of the materials used, low control power and compact design. A solenoid valve has two main parts: the solenoid and the valve. The solenoid converts electrical energy into mechanical energy which, in turn, opens or closes the valve mechanically.A solenoid valve employs magnets and electrical current to effect operations at expense of very little electrical power. When electrical current is applied to coil, based on polarity of magnet and direction of current flow valve is latched or delatched.When current polarity is reversed, valve latches if in delatched position and vice versa.

Atmega169P Microcontroller (AVR Butterfly evaluation kit):

The ATmega169P provides the following features: 16 Kbytes of In-SystemProgrammable Flash with Read-While-Write capabilities, 512 bytes EEPROM, 1 Kbyte SRAM, 53 general purpose I/O lines, 32 general purpose working registers, a JTAG interface for Boundary-scan, On-chip Debugging support and programming, a complete On-chip LCD controller with internal step-up voltage, three flexible Timer/Counters with compare modes, internal and external interrupts, a serial programmable USART, Universal Serial Interface with Start Condition Detector, an 8-channel, 10-bit ADC, a programmable Watchdog Timer with internal Oscillator, an SPI serial port, and five software selectable power saving modes. The Idle mode stops the CPU while allowing the SRAM; Timer/Counters, SPI port, and interrupt system to continue functioning. The Power-down mode saves the register contents but freezes the Oscillator, disabling all other chip functions until the next interrupt or hardware reset. In power-save mode, the asynchronous timer & the LCD controller continues to run, allowing the user to maintain a timer base and operate the LCD display while the rest of the device is sleeping.Weused AVR Butterfly evaluation kit to design our system. It is design to demonstrate the benefits and key features of AVR microcontrollers.

GSM (Global System for Mobile Communications):

GSM is a standard set developed by the European Telecommunications Standards Institute (ETSI) to describe technologies for second generation (2G) digital cellular networks. SMS is a text messaging service component of mobile communication systems, using standardized communications protocols that allow the exchange of short text messages between fixed line or mobile phone devices. SMS as used on modern handsets originated from radio telegraphy in radio memo pagers using standardized phone protocols and later defined as part of the Global System for Mobile Communications (GSM) series of standards in 1985 as a means of sending messages of up to 160 characters to and from GSM mobile handsets. SMS messages are mobile-to-mobile text messages though the standard supports other types of broadcast messaging as well.

Software Platform:

Throughout the development of this project we used VMLAB and AVR STUDIO to write, assemble, execute, and debug programs. For testing GSM modem we use window's Hyper-Terminal program.Visual Micro Lab, generally referred as VMLAB, is a virtual prototyping design framework. It is a microcontroller's design tool that combines in a seamless environment:VMLAB provides a true virtual microcontrollers design lab, in which the hardware and the software are co-simulated, making unnecessary the in-circuit-emulator.VMLAB has nothing to do with some other software simulators, available from microcontrollers makers or other tools vendors. Although some of them talk about I/O simulation, by means of text scripts, they are far away to perform a full system hw/sw co-simulation, even more, if we talk about combining software simulation with analog simulation. The only possible comparison to VMLAB, as design tool, is a top class in-circuit emulator + a top class IDE + top class logic analyzer/digital scope, all working together.

V.DESIGN AND DEVELOPMENT

A simple flow of the actual functioning of the device GSM based Prepaid Water Meter (PWM) is define through the flowchart

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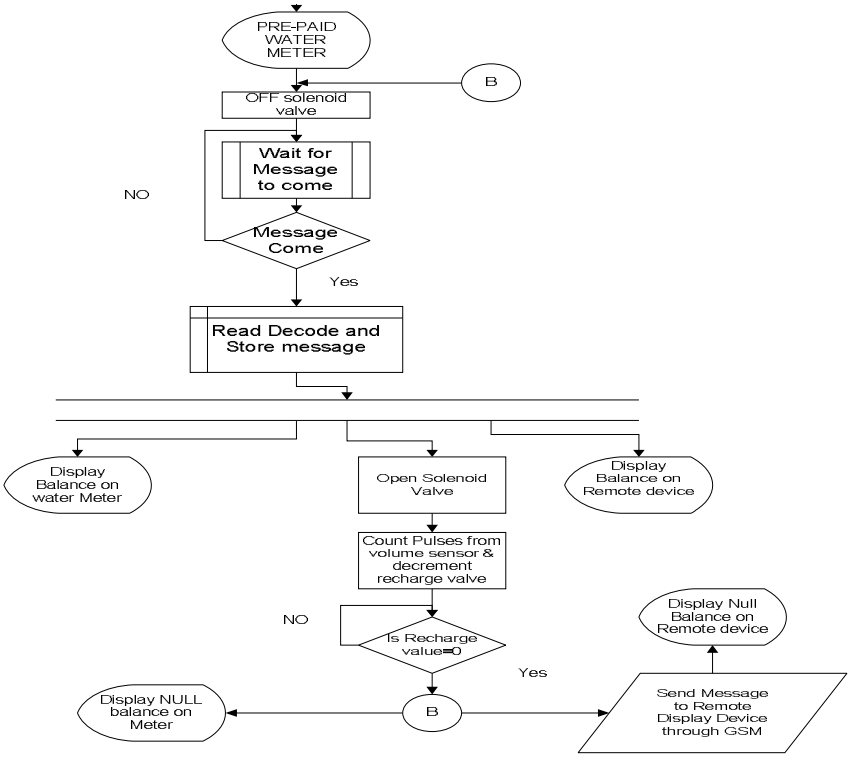

Fig 2:Flowchart for working of GSM based Prepaid Water Meter

Software Organizations

The software segment of the project involves algorithms in the following way:

- Configuration of the GSM modem
- Control of Solenoid valve
- Interfacing flow sensors to the controller.
- Data transmission through wireless GSM

To configure the GSM modem Controller takes the following steps

- Sets GSM modem in Text Format to send or receive messages
  - Sends an AT commands to check whether the connection between the controller and GSM is established.
  - If connection is there GSM will send an OK message to the controller otherwise it will sends an ERROR message.
  - Sets GSM modem for new message Indication
  - Sets message service center number

Control of Solenoid Valve

To operate solenoid valve it should be connected to one of the microcontroller's pin. Controller configures this pin as an output pin and sends signal on the pin as follow:

- ON-send high to the pin(High-1)
- OFF-send low to the pin(Low-0)

Interfacing Flow Sensors to the Controller

Flow sensor is connected to the PORT PIN.This pin is configured as a pin change interrupt input pin. Pulses given by sensor are counted by the controller. An algorithm is written in C to count the number of pulses proportionalto the water volume passes through the sensor. The unit of water is in Litre.

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Data Transmission through Wireless GSM.

An interrupt driven subroutine is written to receive the SMS through GSM modem on USART of the microcontroller. When there is SMS at GSM modem it will sends an interrupt, controller will detected this interrupt and receives the message simultaneously it will send this message to the remote display device also.

VI. TEST AND RESULT

Testing of Flow Sensor:

As flow sensor gives the output in the form of pulses/litre, following practical setup shows the output of a flow sensor which we can see on CRO as a pulses.

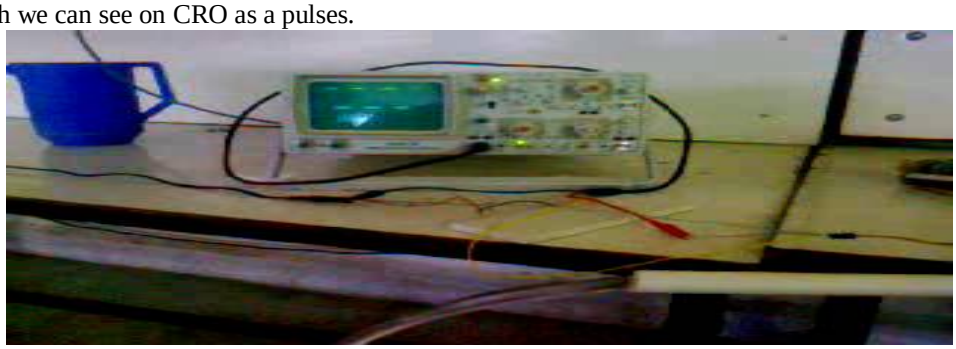

Fig 3: Testing of Flow Sensor

Output of Flow Sensor:
The flow sensor gives 470 pulses/litre, which means pulses are depend on amount i.e.in litre not on pressure. If pressure of water is more or less it gives 470 pulses/litre but at different frequency.

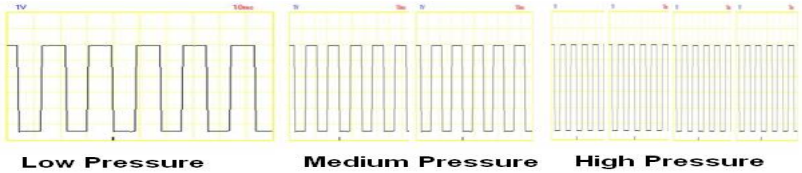

Fig 4: Output of Flow Sensor for Different Water Pressure

GSM Testing:

GSM is interfaced with Microcontroller (AVR Butterfly) and how GSM basedPrepaid Water Meter is recharged through GSM is shown through hyper terminal

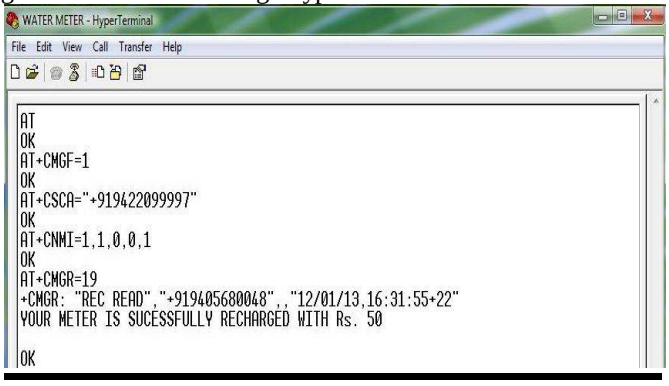

Fig 5: GSM Connections & Configurations

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Overall System:

Final product Prepaid Water Meter, which should connect to water supply pipe, Display to indicate the balance amount.

Fig 6: GSM based Prepaid Water Meter

Specifications: Specifications of the final product GSM based Prepaid Water Meter is indicated in the Table

Parameter	Ratings
Max Water Pressure	1.75 MPa.
Flow Range	0.5-25 L/Min.
Accuracy	±1%
Working Temperature:	10-120 Celsius.
Power Supply	5V
Pipe Size	½ inch

Table 1: Specification of GSM based Prepaid Water Meter

VI.CONCLUSION

The Study carried out in this report demands a house hold water metering system to save the drinking water. Hence we introduced a low cost pre-paid embedded system that incorporates features of remote monitoring and control of the water supply. The project discussed here is successfully designed developed and tested. The system can be further modified to incorporate security aspect regarding tempering of the water meter finding leakage and location of the leakage as future scope of the system.

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