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Pre-Paid Water Dispensing System using Turbine Flow Meter and GSM

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ABSTRACT

Water supply payment system is old fashioned has many problem and need improvement. In this paper a new approach was designed that is based on pay method where you buy amount of water in advance. Water companies have difficulties in accessing conventional water meters in remote places. Inefficiency is increased with growing number of population .It has high cost and difficulties in delivering water bills. This paper discusses a pre-paid SMS based water dispensing system that solves these problems by allowing the amount of flow of water pre-paid to pass through based on low cost intelligent control system that uses microcontroller, solenoid valve, turbine flow meter and GSM server. This system accurately controls the amount of water paid for in advance without human intervention or need for conventional water meters by turning solenoid valve on and allowing certain amount of water to pass through the flow meter until credit expires shutting the solenoid valve. The software application provides real time information about the credit left and quantity of water consumed both locally on LCD and remotely by SMS server as well as date and time and validity of credit if applicable.

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Introduction

Flow meters have proven excellent devices for measuring flow of water accurately and prevent water waste in case pipe is broken. Flow can be measured with contact type or non-contact type of sensor. Accurate flow measurement is an essential step both in the terms of qualitative and economic points of view. Previously a technique known as ultrasonic flow measurement a non-invasive type of measurement is widely used to calculate flow, because of its capability to avoid noise interferences in its output. Now a day due to its non-linear characteristics its use is restricted.[4]

There are many water flow measurement techniques as well as different types of water flow meters used to measure the volume of water flow in pipe lines but these all are too costly. This paper describes design and development of low cost automatic water turbine flow meter which supplies water based on pay as you go technique.[11]

A turbine water flow sensor is used as a sensing unit with a turbine rotor inside it whose speed of Rotation changes with the different rate of flow of water. The Hall Effect sensor outputs the corresponding Pulse train for frequency input to the microcontroller. The whole system comprises of PIC16F876A Microcontroller, G1/2 Hall Effect water flow sensor, Logic level MOSFET, a solenoid valve, 5V supply, LCD, Keypad and some passive components. The PIC16F876A microcontroller is programmed in Hi-Tech C compiler and MPLAB IDE.

Various types of flow meters are available in the market. Table 1 lists different type of flow meters based on various principles.

Some of the meters like velocity meters use a sensor which calculates the flow rate based on the speed of water, ultrasonic sensors which works on two different principles that is transit time measurement principle and other is based on Doppler Effect but these are having high cost of maintenance.

Table 1. Categorization of flow meters based on various principles

Principle	Types
Differential pressure	Orifice Plate type of meter, Rota Meter, Flow Nozzle, Pitot typeTube,ElbowTap,VenturiTube
Positive Displacement	Oval Gear type, Nutating Disc type, Rotary Vane type, Reciprocating Piston
Velocity	Turbine type, Vortex Shedding Electro-magnetic, Ultrasonic Dopplertype,UltrasonicTransitTimetype.
Mass	Coriolis,Thermal
Open channel	Weir,Flume

The Main Components of the System

1-Water flow meter: measures the water flow rate of passed through the pipelines.

2-Solenoid Valve: gets turned off after the amount of water is consumed by the user.

3-LED monitor: System Status shows.

4-Electronic circuit: It includes micro controller circuit and electronics components'.

5-GSM unit: transmission and receive circuit includes SMS

The aim of this paper is to develop a prototype of a low cost turbine type water flow meter which measures the water flow rate of passed through the pipelines. This type of flow meter is not only good for the consumer, but it is also good for the supplier because customer pays in advance and keeps credit in his account. Solenoid Valve gets turned off after the amount of water is consumed by the user. The system is fully user friendly, as it is shown in Fig.1 .

Selection of components

Turbine flow meter is the brains for the system it works on 5VDC power supply and has this equation for water flow:

$f = 8.1 \times Q - 3$ +- 10% where f : is frequency of pulses and

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Q: is the flow of water : Q = V x A where V: is the average velocity of water and A: is cross sectional area of the pipe.

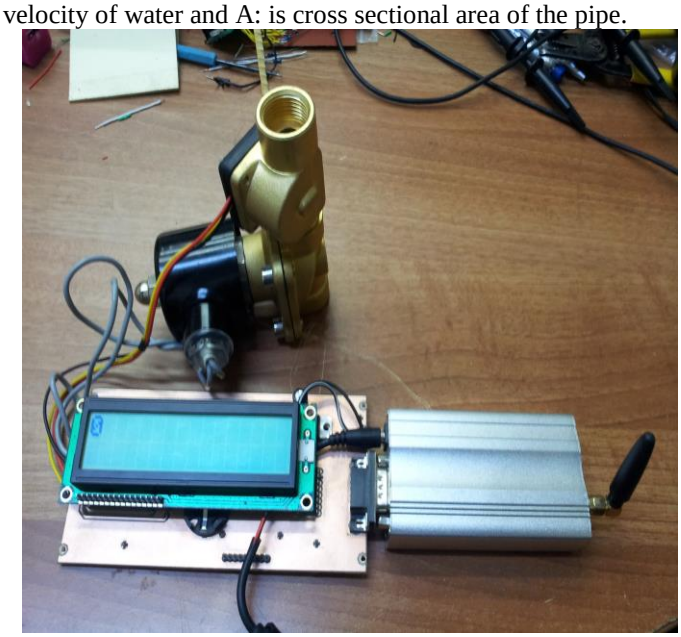

Fig 1. Main Systems Component

Turbine flow meter specs are shown in Table 2 below:

Table 2. Turbine flow meter specification

Parameters of Sensor	Value/Range
Working Voltage (Volts)	5vdc
Maximum Current (mA)	15
Flow rate range (L/min)	1-30
Operating temperature(ºC)	0–80
Liquid temperature(ºC)	<80 C
Operating humidity (RH)	35%-90%
Operating pressure (Mpa)	Under1.7
Store temperature (ºC)	-25to+80

Solenoid valve has the specs in table 3 below:

Table 3. Solenoid Valve Specs

Items No	2W200-20
Working Medium	Air,water.oil
Manner of Execution	Direct Operated type
Type	Normally shut
Flow aperture	20 mm
CV Value	48
Joint Pipe Bore	(3/4)

System Design and Development

The selection of a microcontroller plays very important role in any embedded system. According to the application and the system requirements a microcontroller has been chosen. Here in this system in order to design a low cost automatic water flow meter PIC16F876A microcontroller is used. It has the required hardware resources like external clock input timer to count the flow meter pulses which are measured to be about 264 pulses per Liter. It also has a USART used to communicate with the modem and enough input output pins to get data from keypad and drive the solenoid valve. We have designed and developed a low cost water flow meter mainly for water supply and auditing purposes to deliver only the paid for amount of water as per requirement to the customer.

Figure 2 below shows the block diagram system components:

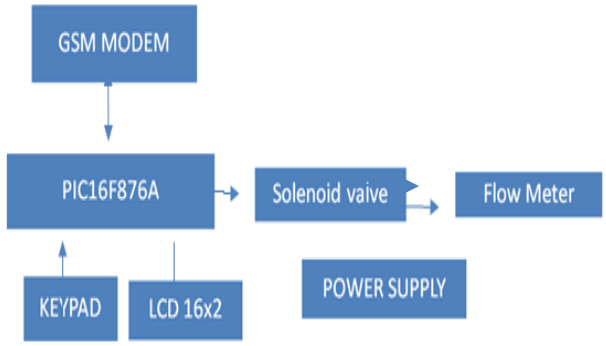

Figure 2. Block diagram for the system.

Project description

At startup the pic controller initializes the GSM modem to receive and display SMS messages from Mobile phone companies as shown in fig.(4). Once the SMS is received it checks that the sender number is 077 7775874 so that it only accepts commands from this number, then it checks for the amount to display which should be send between the * and the # symbols like this *1000# this water unit volume in cubic m or liter in our project is liter , then it takes this value of 1000 as the balance and appear on the LED screen. It keeps solenoid valve on while this balance is positive. As the flow meter produces pulses that are captured by the timer1 and converting pulses into volume value are liters it subtracts it from the total balance.

As shows in Figure.3 the flowcharts for our system.

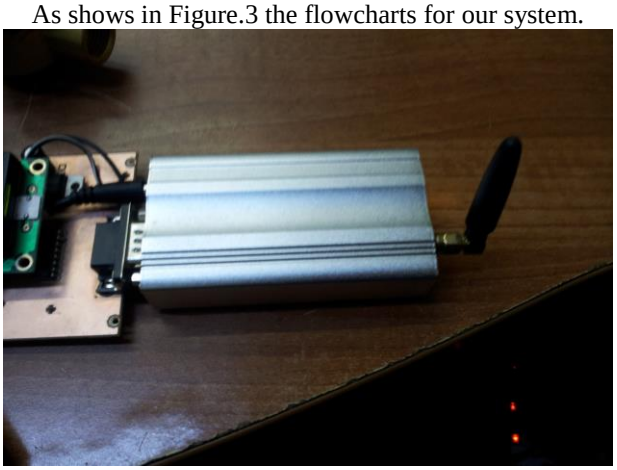

Fig 3. GSM modem

Operation Procedure

1. Connect 12VDC 1A power adapter to the GSM modem.
2. Connect 12VDC 5A power adapter to control board.
3. The LCD should power up and waits for 10 seconds until the GSM modem powers up and registers to the network.
4. To send amount of water allowed to pass send an SMS message to the number inside the GSM modem like between * and hash# like this *20# and send. 20 liters will be displayed on top line of LCD and turns the solenoid valve on allowing water to flow.
5. Once the water flows inside the flow meter the number of liters on bottom line of LCD will increase until it equals the amount programmed on top line by SMS then the solenoid valve will be closed waiting for further charge.

Results

1-The completion of the design and implementation of practical model.

2-The implementation of the operating system orders from the main center of the run and stop pumping water into force of the amount of money paid.

3-The system provides reduction of the number of employees in the company.
4-The system provides the possibility to get rid of social problems resulting from the entry of workers homes.
5-This study helped to get rid of the social problems resulting from frequent visits to the workers to read meters.
6-The system maintains the disposal of waste water and theft.
7-By using this study to get rid of the water supplied companies with debt problems.
8-Material cost of the project is low.

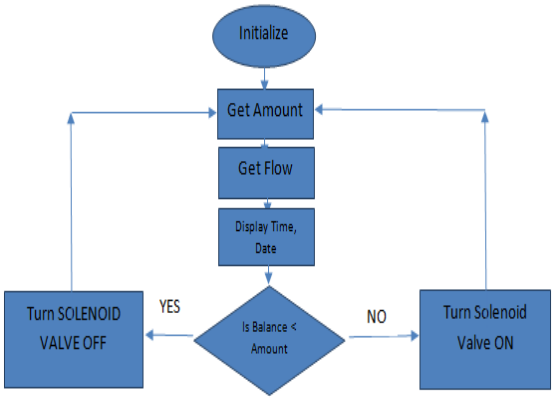

Figure 4. Firmware Flowcharts for our System

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