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Arduino Based Water Billing System for Domestic Purpose

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Abstract— Water is precious available natural resource on the earth. However water is considered as the primary need of human beings. Population growth causes uneven distribution of drinking water in cities and need to monitor and control the consuming of water on minimum requirement base so proposed system improve the water supply monitoring and consuming of water for domestic. The available water billing system is tedious and time consuming process. Error in water billing can occur because of human interference. An arduino development board as central console of embedded system, it reads the sensor to monitor the water usage for houses or domestic purpose. The billing of the water usage will be done automatically and the same will be sent to the user using SMS facility. System gives adequate security support as it uses Short Message Service (SMS) service and also gives an accurate water bill as the entire process will be automatic.

Keywords— Arduino, sensor, GSM, SMS

I. INTRODUCTION

Water is the renewable and an abundantly available natural resource on the earth. Water covers 70% of the Earth's surface. Out of this, only 3% of the water is portable. Water has its utility in domestic purposes, industrial usage, agricultural field etc. Population growth causes insufficient and uneven distribution of drinking water [5].

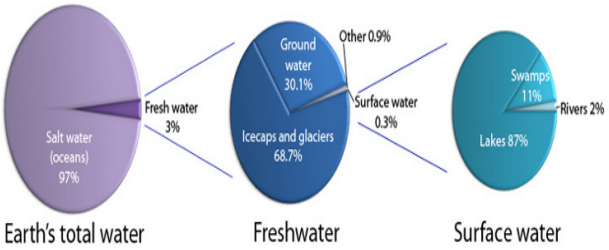


Fig 1.1 Water Distribution on Earth's Surface

Fig 1.1 shows the chart of water distribution on the earth's surface. Earth consists of 97% of salt water and 3% of fresh water in total. Of this 3% of fresh water, 68.7% constitutes of ice caps and the glaciers. 30.1% consists of ground water, 0.9% of other water and 0.3% of surface water. Of this 0.3%, 87% consists of lake water, 2% of river water and 11% for swamps [5].

The rapid development of science and technology improved the sensors and flow meter designs to achieve proper water supply through storage tanks, pipes etc [7]. To facilitate the domestic and industrial water supply needs, government has formed water boards which monitor the proper supply of water throughout the nation. It acts as the regulating body abided by the rules framed by the government. Water acts as a primary source in the industries; hence, there arises a need of accurate measurement of water flow. In the domestic sector, water is used for all household activities. Excessive usage of water needs to be avoided and a system is required to monitor the over usage of water.

In the present water billing system, water board representative should need to travel to customer premises to read the generate the water bill form analog water meter on monthly basis [1]. The

present water billing system is tedious and time consuming process. Human interference based water billing can cause faults in billing. This is undesirable error. Automation in the water billing reduces the process time and avoids human errors.

The material in this paper is organized as follows. In section II, brief discussion on design methodology and design of hardware and software is given in section III and in section IV observations and results is discussed .At the end conclusion is given in the section V.

II. METHODOLOGY

At the user premises, the water flow through the pipe is measured using the flow sensor and sensor is read by the Arduino board. Based on the flow sensor calibration factor (CF), the number of liters of water consumed is determined. This is a continuous process until the water flow stops through the pipe. The liters consumed data is transmitted to the control station through Radio Frequency (RF) Transmitter as shown in **Fig 2.1**.

At the control station, using RF receiver the data is received which is connected to Arduino controller. Based on the liters of water consumed, amount will be calculated using the Arduino controller. The bill will be stored in the controller and is updated as and when the data arrives on the RF receiver. Using LCD display the bill is shown, which is interfaced to Arduino. Meanwhile the same is sent to the customer using GSM technology as shown Fig 2.2.

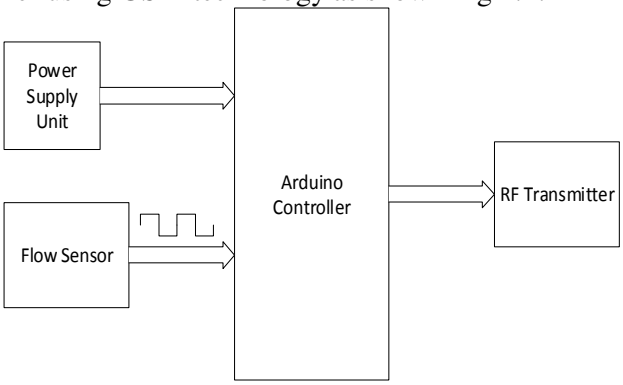


Fig 2.1 Consumer Premises

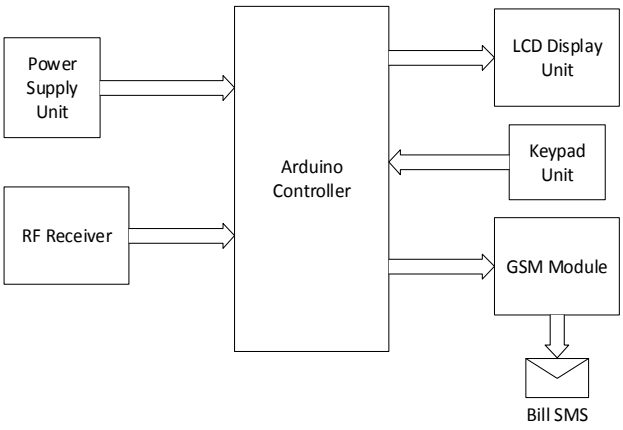


Fig 2.2 Control Station

Transmitter section consists of a power supply unit, water flow sensor, Arduino controller, RF transmitter unit and the receiver section consists of RF receiver, Arduino controller, LCD display, keypad and a GSM modem. Brief descriptions of the blocks are given below.

Arduino board: The Arduino UNO is a microcontroller board based on the ATmega328 with 16Mhz operating frequency. It has 14 digital input/output pins and six analog inputs, it also supports USB

connection, and many more features in proposed system it is used as master controller to keep record of water consumed and calculation of bill and connecter to transreceiver and GSM module [10].

RF Module: This is a transreceiver module operates at a frequency of 433 MHz an RF transmitter receives serial data and transmits it wirelessly through RF through its antenna. The transmission occurs at the rate of 1Kbps - 10Kbps [12].it is used to establish communicate between consumer premises and control station

LCD Display: A 16*2 LCD display unit is interfaced with Arduino controller at service provider region [12] used to the user ID and bill amount.

Keypad: A keypad is interfaced with Arduino at service provider unit to facilitate services like sending SMS and clearing the due bill when a particular key is pressed [12].

GSM Module: The GSM module SIM300 uses AT commands to establish communication. SIM300 is a Tri-band GSM/GPRS engine that works on frequencies EGSM 900 MHz, DCS 1800MHz and PCS1900MHz [11]. The GSM module is required to establish a communication link between the service provider and user. Bill SMS is sent to user through SMS in pre-determined format.

Flow sensor : Flow sensor is the integrated module of pin wheel, circular permanent magnet, Hallf-effect sensor. An inlet and outlet provision is made for water flow. Diameter of the inlet and outlet valves varies with different flow sensors. In this project 0.5 inch diameter flow sensor is used [6] as shown in fig2.4 and fig 2.5.

Fig 2.4: Water Flow Sensor

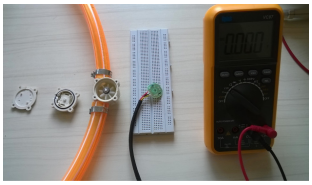


Fig 2.5 Flow Sensor Components

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. It uses a pinwheel sensor to measure how much liquid has moved through it. 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. This method allows the sensor to stay safe and dry [12].

Calibration of Flow Sensor: Every flow sensor has its own calibration factor. The C.F value will be specified in the data sheet of the component. The C.F value signifies the number of pulses produces in a second when the water flow rate is 1 ltr/min [6].

1. Calibration Factor (C.F) of flow sensor = 7.5
2. Flow rate = (pulse count) / (calibration factor) in Litre/min
3. Determining number of pulses per litre:

Set the flow rate to 1 Litre/min then determine the number of pulses generated for 1 Litre water flow. The value obtained is 450 pulses/ Litre.

III. IMPLEMENTATION

3.1 Flow Sensor Interfacing with Arduino

The sensor comes with three wires they are power supply line, ground line and a data line. Red (5V DC), Black (ground). And yellow (Hall-effect pulse output).

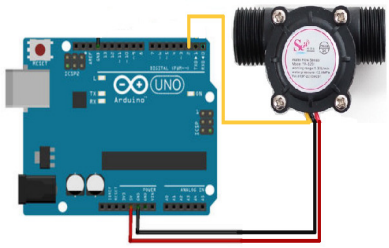
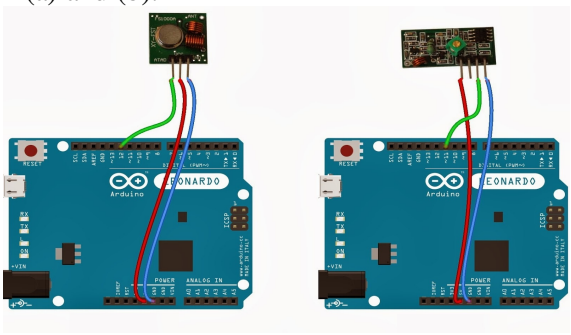


Fig 3.1: Flow sensor – Arduino Interface circuit.

+5V supply and the ground connections for the flow sensor are connected from on board regulator. The Flow sensor output is a digital signal, digital I/O pin D0 of Arduino [6] . The interfacing circuit of flow sensor with controller is as shown in Fig 3.1.

3.2 RF Module Interfacing

Two Arduino boards are required to transmitter and receiver separately. Through programming the data pin for RF modules are defined and interfacing circuit of RF transmitter and RF receiver with Arduino as shown in Fig 3.2 (a) and (b).



(a) Arduino- RF TX (b) **Arduino- RF RX**

Fig 3.2: RF module and Arduino interface circuit

3.3 LCD Interfacing

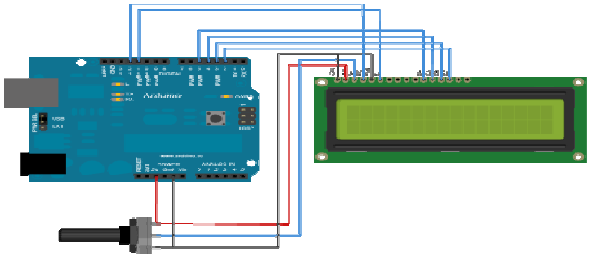


Fig 3.3: LCD – Arduino Interface Circuit

LCD Display is interfaced to Arduino Uno. 5V supply and ground are taken from Arduino Uno board. DB4, DB5, DB6, DB7 pins are data bits used. The pins can be defined through program as shows the Fig 3.3.

3.4 GSM Interface

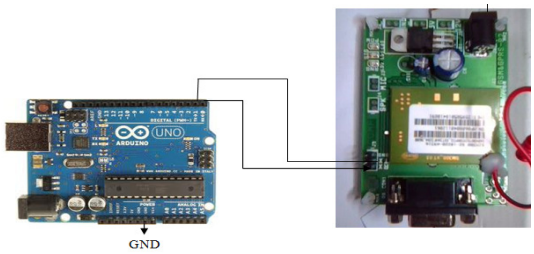


Fig 3.3: GSM-Arduino interface circuit

Fig 3.3 show the interfacing of GSM module with the controller, where in Tx (PIN 1) and Rx(PIN 0) of arduino bord are connected to Rx and Tx of GSM module respectively.

3.5 Keypad interface

Pin 1 high. This means that a contact has been made between column 4 and row 1, so button 'A' has been presse

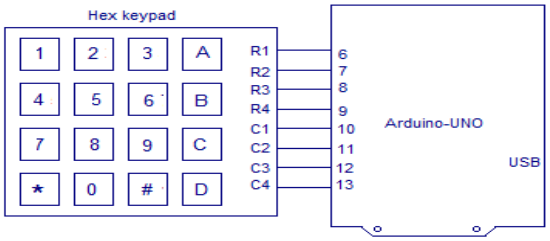


Fig 3.4: Keypad Arduino Interface

The digital pins 6,7,8,9,10,11,12 and 13 of controller board are connected four rows (R1 R2 R3 R4) and four column (C1 C2 C3 C4) pins of Key pad of size 4*4. The row and column pins can be defined through programming [12].

3.5 Flow Chart of the Code

The controller unit at consumer premises as water flow starts through the pipe, the square of pulses generated by the flow sensor read through pin D0 of controller unit. Once the pulse count matches with predefined count per liter that is 450 counts per liter. Once it searches to define count, sends the information to receiver section as shown in Fig.3.5

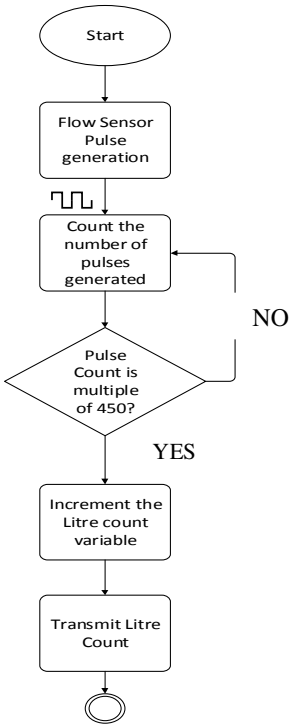


Fig 3.5: transmitter section

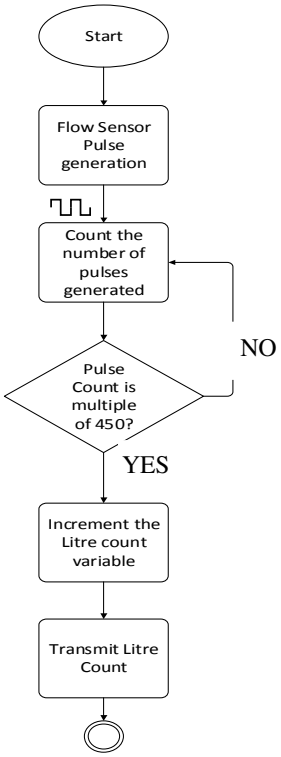


Fig 3.6: Receiver Section

When it reaches to the specified count a signal will be sent to the control station. Based on these counts, in the control station water consumed will be calculated and the usage will be sent to the user using SMS facility

IV. RESULTS

As per the data sheet:

1) Number of pulses/Ltr = 450.
2) Accuracy of sensor = +/- 10%.

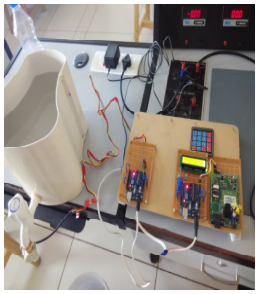
This signifies that flow sensor produces:
(10/100)*450 = 445 to 455 pulses/ Ltr.

From the case study results, it is observed that flow sensor has produced pulses well within the range. Thus accuracy is maintained. Sensor calibration has conducted with placing of the water tank at different height and number of pulse count and time was observed for a and more liter of water, as show in table 4.1

Table 4.1: Flow sensor calibration table 2

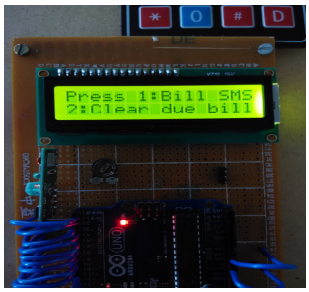
Hight Container (Tank) (Meter)	Pulse Count/Ltr	Time Take /Ltr
0.5 meter with 5 Ltr of water	448	15.1s
	451	14.9s
	449	14.8s
1 meter with 5 Ltr of water	452	15.3s
	449	15.1s
	441	14.9s
1 meter with 10 Ltr of water	900	35.2s
	902	35.0s
	898	35.6s
1.5 meter with 10 Ltr of water	902	36.3s
	899	35.8s
	900	35.5s

Implementation of design is as shown in fig 4.1 which show the hardware setup with water container in fig 4.1(a). Display of liter consumed and options for getting bill through SMS or deleting previous data for user friendliness of the system is shown in fig 4.1(b) .



(a)

Fig 4.1: Implementation of project



(b)

Fig 4.2: Output on LCD Display

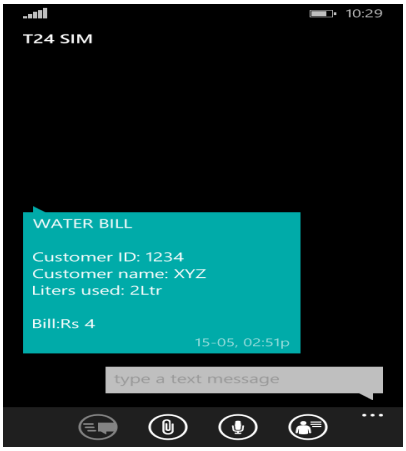


Fig4.3: SMS of Water Bill

Once button 1 is pressed from keyboard of the system water bill generate and sent to the consume as shown in fig 4.3.

V. CONCLUSION

The present water billing system uses analog water meters. Modern electronic device such as water flow sensor can be used to overcome basic limitations of analog meter such as less accuracy, human error while billing etc. From the case study, it is evident that flow sensor can produce very accurate results. The proposed system is a cost effective and reliable system compared to present water billing system. The process of monitoring water flow rate, transmitting the usage, calculating the bill etc. is through preprogrammed Arduino controller and hence no errors as it avoids human intervention.. Also, Billing information is sent through SMS which is a reliable and secured communication technique and also helpful for the user as the user gets the bill ontime.

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