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Automation of Residential Water Flowmeter

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Abstract

Today, in big cities people are suffering from scarcity of water. Judicious ways of using the present day resources can only be the pathway of a golden future with sustainable development. Inefficient ways of using water can introduce the world to the problem of water crisis. A well-automated water flowmeter with proper billing system can be an important alternative for water management. This paper describes about the automation of mechanical water flow meter, which ranges from 4 liters/min to 40 liters/min. It also describes about the accuracy of existing water meters and IOT has been applied for the process of its automation. A mechanical water flowmeter has a turbine, which rotates when the water flows through it. The turbine generates a magnetic pulse, which depends on the rate of flow of water. The other components that are required to carry the analog data to the micro controller is Hall Effect sensor. The micro controller uploaded with proper programming helps to determine the water flow. The calculated data is transferred to the cloud in real time. One can access the data by the help of the application.

Keywords
Node Mcu, Hall Effect sensor, Mechanical water flow meter, flow rate of water, microcontroller, flow meter, Irrigmatica Application.

1. Introduction

Water is one of the most important natural resources along with air. These are the fundamental building blocks. Even on the other planet, the very first thing that the scientist is in the search of is water. One can understand its importance in the present scenario by seeing the large lines beside the tankers in the hot summer with the sun overhead.

Clean water is the basic need of life without which this world cannot be imagined. The idea of water conservation and management emerged in the last two decades with the increase of demand for clean water. The industrialization that was started in the 19th century was completely hap-hazardous and only focused on profit making. This negative attitude of people broke the human nature eternal relationship that has been prevailing from the ancient era. It has also completely disturbed our past prevailing ecosystem and the contamination of water, degradation of soil and harnessing of air quality become major problems for the present survivability of humans as well as other living organisms.

Now, by putting a limit to our thoughts and coming to a smaller scenario. Everyone must have seen the opened tap of municipal water supply in his or her locality. Generally, nobody cares about this wastage. Everyone thinks that the water is free of cost, so there is no need to save it. This continuous wastage of water must be checked. So, in order to prevent this type of wastage a proper water billing system must be there. Hence, the automation of water meters with the help of IOT is very necessary.

2. Previous Works

Due to the increase in demand for pure water a group of environmentalists are moving toward research on water and thinking about measures to save it. Many research works are also dedicated to different water flow measurement techniques. The implementation of IOT (Internet of Things) has become common practice in order to compete with the product in the upcoming market. Janne alam et. Al (2010) introduced about implementation of AI on water meters, discussed about automation and provided a better result.

Ria Sood et. Al (2014) introduced about "design and development of automatic water flow meter". He used AT89S52 microcontroller, G1/2 Hall Effect water flow sensor, relay, optocoupler, a water pump, 5V supply, LCD, keypad and some passive components for the automation. The AT89S52 microcontroller is programmed in Keil development Tool. Butean Fabian-Manuel et. Al (2020) introduced about automation of water meter testing using stepper motors. The achievement of this electronic water meter adapter testing application is the simulation of water flow through the mechanical water meter using a stepper motor.

3. Methodology

Selection of flow meter

We have used mechanical water flowmeter for our experimental purpose because the mechanical water flowmeters are of low cost and their accuracy is also up to the mark. The 1 inch mechanical flow sensor can measure the water flow of 4-40 liter/min, and the residential flow lies between them.

Apparatus details

The various apparatus that we have used in our projects are:-

Water Flow Sensors. :- They are used for measuring the water flow. It has a turbine on the inner side which rotates when the water flows through them. The range of measurement of a 1 inch flow sensor is 4 to 40 liter per minute as shown in fig 1.

Fig 1:- Water flow sensor of 1 inch diameter

Node MCU :- It is a kind of microcontroller. It is used basically for quantization and sampling of data. In other words we can say that all the data processing and calculation take place in Node Mcu. It also contains an inbuilt Wi-Fi module which helps in transferring of processed data to the server as shown in fig 2.

Fig 2:-Node MCU

Jumper Wire: - They are simply the connecting wires used to establish the connection between the parts as shown in fig 3.

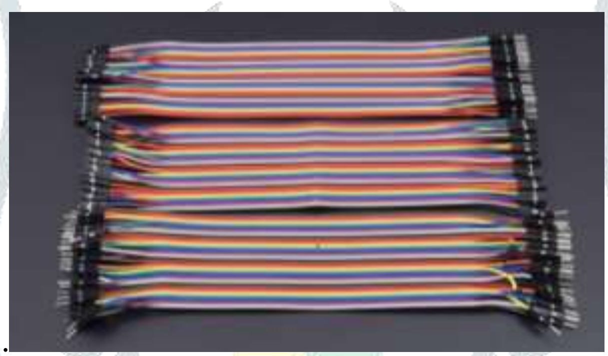


Fig:3 -Jumper wire

Battery and AC adaptor :- They are used for continuous power supply to the microcontroller.

Connecting cables: - They are used for power connection and data transfer as shown in fig 4.

Fig 4:-Battery & Adaptor

Assembling & Working

First of all the water flow sensor is attached to Node Mcu which is loaded with proper programming in order to calculate the water flow in real time. For the power supply we may use AC directly with the help of a normal smartphone charger or if the power supply is not continuous we can use a power bank in which one port is connected to the charging cable and the other one is connected to the Node MCU .
When the water flows through the water flow sensor, it rotates the turbine of the sensor. The angular velocity of rotation is related to the velocity of flow .Rather we cannot say that it is directly proportional but under a certain range the relationship becomes linear as a function of **y =mx+c** , where the value of m and c can be determined experimentally. The rotation is counted by the hole effect sensor and it gives the continuous analog form of data .This analog data is transferred to a microcontroller (we may use Arduino Uno, Tt Go or Node MCU). The microcontroller converts this analog form of data to a digital form by the process of sampling and quantization. then obtained data is rematches with the set of experimental data and the flow is calculated .the total discharge calculated by equation 1.

$$\mathbf{V=Q_1.t_1+Q_2.t_2+\ldots..+ Q_n.tn} \qquad \ldots(1)$$

Now, the calculated discharge and total flow is transferred to the server. Any user can abstract these data by the help of the designed application with their personnel credential. They can know the real time flow, total discharge, location of their device, alive time and meter status, signal strength and battery status by the help of an application.

Application Details

The data from the Node MCU is transferred to the cloud. The data is stored in the firebase real time data base. The relevant and processed data is fetched from mobile application which is compiled using the android SDK (Java) through HTTP protocol .The developed tool Irrigmatica interference is shown in fig 5. Application Dashboard is shown in fig 6 . This application can be logged through Facebook, Gmail etc. as shown in fig 6. Real time graph is shown in fig 7.The composition from both ends are (1) Front end: - Android SDK (Java)
(2)Back end: - Firebase

Fig 5:- Interface of Application

Fig 6:- Dashboard of Application

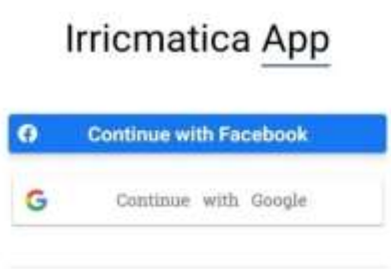


Fig7:- Get through

Fig 8 :- Real time flow graph

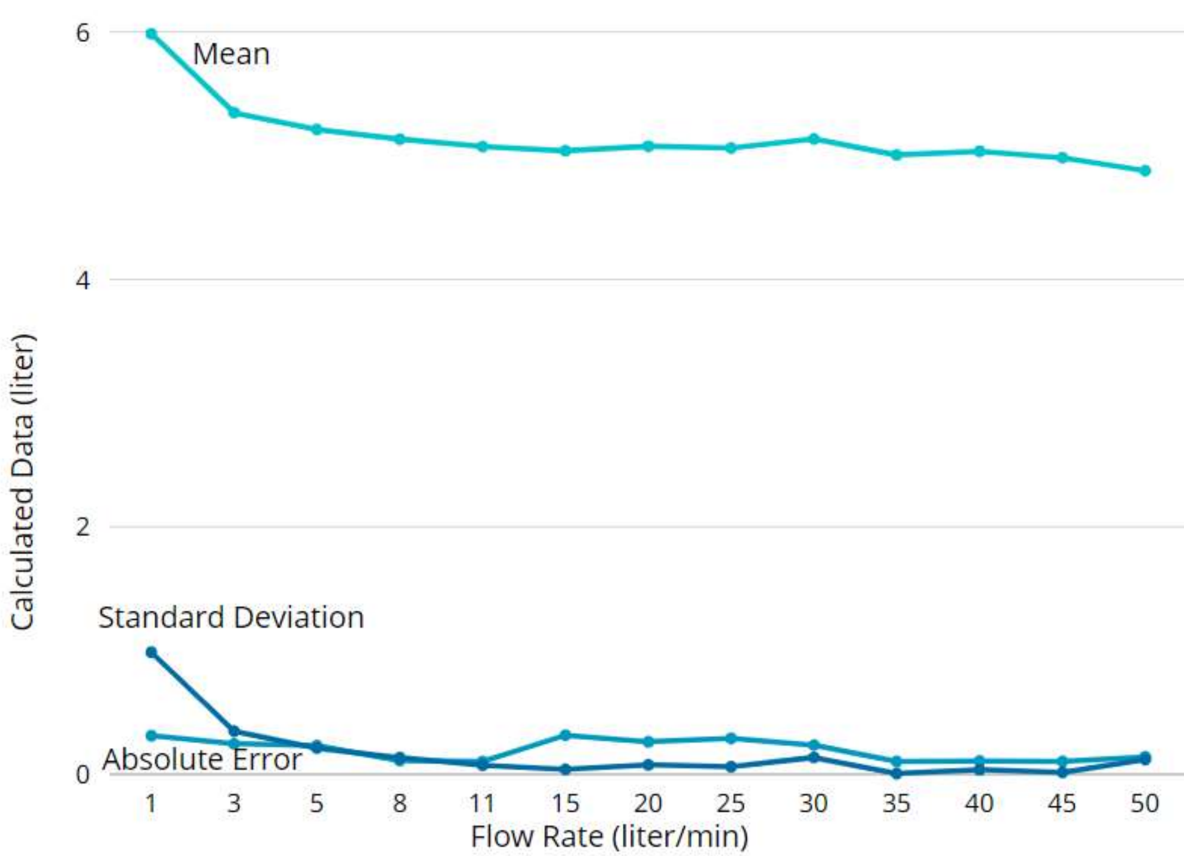
4. Result & calculation

If the water is flowing at different flow rates, the accuracy of the water flow meter also varies. These differences can be analyzed by the graph (a),(b) and (c). At the certain range the accuracy become maximum and started deviating when it is outside the range. For taking the reading at different flow 5 liter of water is passed each time and the calculated value by the flow meter is noted down.

Observation Table :-

Flow(l/min)	Obs 1(L)	Ob s2 (`Ll)	Obs3(l)	Obs 4(l)	Obs 5(l)	Mean (l)	Std. Dev.	Abs. Error
1	5.84	5.78	5.67	6.3	6.34	5.986	0.3113	0.986
3	5.63	5.21	5.54	5.02	5.34	5.348	0.2465	0.348
5	5.06	5.08	5.34	5.02	5.56	5.212	0.2318	0.212
8	5.09	5.21	4.96	5.18	5.23	5.134	0.111	0.134
11	5.11	5.12	4.89	5.13	5.12	5.074	0.1031	0.074
15	5.03	5.25	4.72	4.75	5.45	5.04	0.3158	0.04
20	5.04	5.26	4.79	4.87	5.42	5.076	0.2635	0.076
25	5.07	5.34	4.89	4.67	5.34	5.062	0.2906	0.062
30	4.9	5.2	5.45	4.9	5.23	5.136	0.2361	0.136
35	5.14	5.07	4.95	5	4.87	5.006	0.1045	0.006
40	4.98	4.9	5.12	4.96	4.89	5.036	0.1074	0.036
45	4.88	5.02	4.9	4.98	5.07	4.984	0.1043	0.016
50	4.7	5.04	4.89	4.99	4.78	4.88	0.1416	0.12

Graph :-



When water was flowing at rate of 15 l /min average value of observation was 5.04 with least error.

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5. Conclusion

This paper has several advantages such as user friendly, cost effectiveness etc. and hence it can be used as an alternative for saving water. This project rather makes a strong sense that in the new technical world no branch has its self-sufficiency. Civil must encapsulate IOTs in order to make a new product that will be outstanding and meet the future demand.

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