THE WATER FLOW MONITORING MODULE

RAHUL RAMESH IYENGAR

Research and Development Engineer, 560rahul@gmail.com

Abstract— As the world population is continuously undergoing an exponential rise, the ability to source clean water is becoming a pressing concern. The average water consumption of the world per person is estimated to be somewhere in between 120 – 140 liters. Hence it becomes a challenge to constantly generate the required quantity of water in order to sustain the population and cater to its needs. This paper aims at developing a cheap, portable and an on-the-go-plug-in kind of mechanism of a Water Flow Monitor Module to monitor the rate of water usage per household and keep a metric of it in order to keep tabs on the water usage on a weekly, monthly or a yearly basis. Metrics like Water Flow Rate per minute, per second and the total liters of water flow since the start of the day can be captured by this module and a graphical representation of these metrics can be obtained which will make the interpretation of the data much easier. By this means, a social awareness about the wastage and inefficient consumption of water can be brought about into the society so that necessary remedies could be adopted and steps could be taken to reduce the uncontrolled and ineffective use of water and water sources.

Keywords— Water Flow Indicator, Water Flow Monitor, Water Flow Sensor, Water Usage Indicator, Water Conservation, Awareness on Water Wastage.

INTRODUCTION

Water conservation highlights the methods and practices that one must adopt in order to conserve and put an efficient effort to make the usage of freshwater a very sustainable resource, to protect the water source and to meet the current and future human demand of consumption in a constructive way.

In the present scenario, where population boom across the world poses a real and an imminent threat to all the natural resources and bio-diversity, the scarcity of availability of fresh-water supply in a given locality with a high population density can be directly linked to wastage of water and in-efficient sourcing of water to the consumers. Cleaning and transporting water takes a large amount of energy. When this water is wasted, larger amounts must be cleaned and transported, and this requires the use of more fossil fuels and other non-renewable energy sources. The more water that is wasted, the faster these resources become depleted, and the more quickly their dangerous by-products such as carbon dioxide build up in the Earth's atmosphere. This further ends up taking a toll on the bio-diversity, which in turn has adverse effects on the natural habitats of plants and animals. Drastic wastage of water in household means there will be lesser amount of freshwater left for agriculture. This would yield a lesser crop produce which threatens the food supply for humans and the livestock.

Shortage of water supply would result in exploitation of underground aquifers. Already, aquifer reserves are getting depleted at an alarming rate due to reduced availability of freshwater on the surface due to drought and decrease in rainfall. The depletion of aquifers will further accelerate destruction of landscapes.

This calls for various measures that are pre-cautionary as well as provide an awareness regarding what could be the shortcomings of water wastage.

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Purpose	Litres/ person/day
Drinking	03
Cooking	04
Bathing	20
Flushing	40
Washing clothes	25
Washing utensils	20
Gardening	23
Total	**135**

Table [I] Average Consumption of Water per Person

GOALS

The goals that are aimed to be achieved by the "Water Flow Monitor Module" are as follows:

I. *Sustainability*: Water usage must not exceed a specified limit such that future generations are not affected.

II. *Energy Conservation*: Inefficient usage of water leads to a large quantity of waste water produced that would need further treatment which in turn consumes more power/energy. This has to be cut down at least by 15%.

III. *Habitat Conservation*: Minimizing human usage of water means more availability of water to the natural habitat of animals as well as reducing the building of dams and other man made structure that impact the bio-diversity.

OBJECTIVE OF THE PAPER

This paper aims at spreading the knowledge about the systematic steps and approach that could be followed in order to *install and use* a *Water Flow Monitor Module* such that each household can maintain a metric of the amount of water that has been consumed on a daily basis.

The *Water Flow Monitor Module* has been built keeping in mind the (i) *Cost Effectiveness*, (ii) *Ease of Usage*,

(iii) *Efficiency*, (iv) *Ease of Availability* and (v) *Ease of Interpretation of Data*.

To make available a detailed instruction set on how to *Setup*, *Install* and *use* the *Water Flow Monitor Module* on a day-to-day basis and keep tabs on the amount of water being consumed.

By this, a social awareness on the perks of conserving water so as to trigger a positive attitude towards water conservation is meant to be achieved.

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ASSEMBLING THE MODULE

I. The Water Flow Sensor

An accurate flow measurement is essential, both from a qualitative and an economic point of view. Keeping this in mind, the type of Water Flow Sensor used here is *YF-S201*.The sensor contains a pinwheel and sits in line with the water line such that water will pass through the sensor striking the pinwheel and rotating it to measure how much water has passed through it.

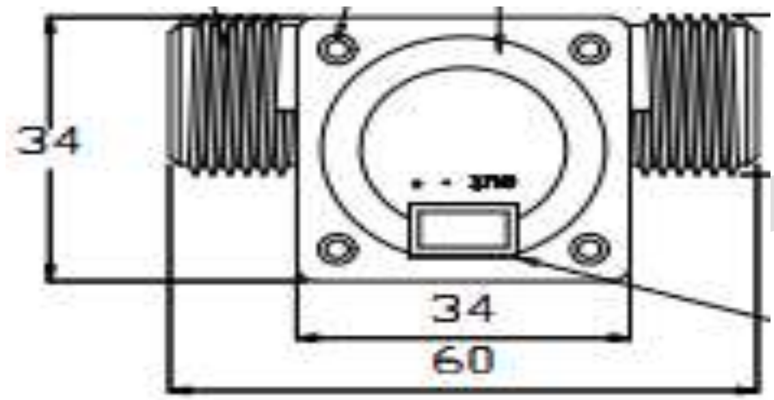

Fig. 1(a). The Water Flow Sensor

There is an integrated magnetic Hall-Effect Sensor that will output an electric pulse for every revolution of the pinwheel. By using a suitable conversion formula, we can translate the number of pulses into liters of water that has flown through it.

The Hall Effect Sensor - "The Hall effect is the production of a voltage difference (the Hall voltage) across an electrical conductor, transverse to an electric current in the conductor and a magnetic field perpendicular to the current."

Fig. 1(b). YF-S201 Water Flow Sensor

YF-S201 Water Flow Sensor can be used to measure the flow of liquids in both industrial and domestic applications. This sensor basically consists of a plastic valve body, a rotor and a Hall Effect sensor. The pinwheel rotor rotates when water / liquid flows through the valve and its speed will be directly proportional to the flow rate. The Hall Effect sensor will provide an electrical pulse with every revolution of the pinwheel rotor. This water flow sensor module can be easily interfaced with Microcontrollers, Arduino Boards and Raspberry Pi.

II. Circuit Diagram

The circuitry basically consists of three components namely The Water Flow Sensor, The Micro-Controller Board and a Computer that is used for processing all the raw data that is obtained from the Micro-Controller Board.
The operating voltage of the *YF-S201*lies anywhere in between 5V-18V. The signal pin of the sensor is given to the Digital I/O pin of the Micro-Controller which will produce a corresponding pulse for every value recorded by the sensor.
The Micro-Controller is connected to the Computer via a USB cable that ensures a fast paced transmission of data between both the devices.
The post processing is done on the Computer where raw values that have been obtained from the sensor is translated into corresponding liters of water that has flown though the sensor.
The values that have been obtained after post processing are periodically dumped into a text file so as to maintain a database of values through which a graphical interpretation of data is possible in the future.

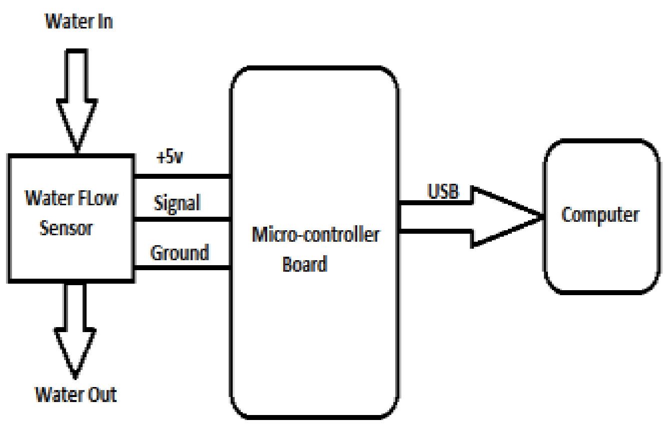

Fig. 2. Circuit Diagram of the Module

WORKING OF THE MODULE

The design and the type of circuitry involved in the Water Flow Monitor Module has been approached keeping in mind the ease of installation and a minimalistic hindrance. A micro-controller module that can communicate wirelessly with the computer can also be used instead of a USB connection.

Fig.3. The Circuitry

The *YF-S201* can measure a maximum of *30 Liters* of water flow per minute. Therefore the Flow Rate Characteristic of the sensor is:

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Frequency (Hz) = 7.5 * Flow Rate (L/min)

= 7.5 * 30 (L/min)

= 225 Hz

The sensor will output 450 Pulses for a Liter of water that will pass through it, hence if 1 Liter of water will flow through the sensor in a minute, we would be getting 450 pulses a minute. Therefore, for 1 second there will be approximately 3.75 pulses per second per Liter of water flow. Hence the calibration factor is set to 3.75. The sensor is connected to the Digital Pin 2 which uses an "Interrupt 0" and this is configured to trigger on a "Falling Edge". Since the calibration factor over here is considered for every second, there are cases in which the loop will not execute in a second. Hence we calculate the number of milliseconds that have passed since the last execution and scale the output according to that. We also apply the calibration factor to scale the output based on the number of pulses that the sensor outputs at that second.

This is given by the following formula:

FlowRate = *((1000.0 / (millis () - timePassed)) * pulseCount) / calibration;*

The time stamp at which the previous processing pass was executed is recorded. This is because the *millis() function*, that keeps a check on the number of milliseconds passed since the starting of the execution of the program stops counting when the interrupt is disabled. But it will return the time stamp at which the interrupt was disabled. A record of this is made.

oldTime = millis();

The number of Liters of water that has flowed through the sensor per second can be obtained by dividing the Flow Rate by 60.

*flowInmLiters = (FlowRate / 60)*1000;*

The total number of milliliters that have been flown since the start of the execution of the program can be obtained by cumulatively adding the FlowRate obtained from each iteration to its previous value. At first, the variable *totalFlow* is initialized to zero:

totalFlow = 0;

The value of flowInmLiters keeps on updating depending on the rate of flow of water through the sensor per second. This value is recorded and cumulatively added to the *totalFlow* variable such that the total amount of water that has flown through the sensor for a given period of time can be determined.

totalFlow = totalFlow + flowInmLiters

The graphs can be generated from the available data for Daily Usage, Weekly Usage and Yearly Usage .In this particular project, we use the *Data Driven Documents* for generating the graphs. It is an open source software with various number of interactive charts that could be used to improve the visualization of data.

```
Flow rate: 0.0L/min  Current Liquid Flowing: 0mL/Sec  Output Liquid Quantity: 0mL
Flow rate: 0.0L/min  Current Liquid Flowing: 0mL/Sec  Output Liquid Quantity: 0mL
Flow rate: 15.0L/min  Current Liquid Flowing: 251mL/Sec  Output Liquid Quantity: 251mL
Flow rate: 31.5L/min  Current Liquid Flowing: 525mL/Sec  Output Liquid Quantity: 776mL
Flow rate: 7.9L/min  Current Liquid Flowing: 133mL/Sec  Output Liquid Quantity: 909mL
Flow rate: 0.2L/min  Current Liquid Flowing: 3mL/Sec  Output Liquid Quantity: 912mL
Flow rate: 0.0L/min  Current Liquid Flowing: 0mL/Sec  Output Liquid Quantity: 912mL
Flow rate: 0.0L/min  Current Liquid Flowing: 0mL/Sec  Output Liquid Quantity: 912mL
Flow rate: 1.5L/min  Current Liquid Flowing: 25mL/Sec  Output Liquid Quantity: 937mL
Flow rate: 48.1L/min  Current Liquid Flowing: 802mL/Sec  Output Liquid Quantity: 1739mL
Flow rate: 39.7L/min  Current Liquid Flowing: 662mL/Sec  Output Liquid Quantity: 2401mL
Flow rate: 14.2L/min  Current Liquid Flowing: 236mL/Sec  Output Liquid Quantity: 2637mL
Flow rate: 2.6L/min  Current Liquid Flowing: 44mL/Sec  Output Liquid Quantity: 2681mL
Flow rate: 0.0L/min  Current Liquid Flowing: 0mL/Sec  Output Liquid Quantity: 2681mL
Flow rate: 0.0L/min  Current Liquid Flowing: 0mL/Sec  Output Liquid Quantity: 2681mL
Flow rate: 0.0L/min  Current Liquid Flowing: 0mL/Sec  Output Liquid Quantity: 2681mL
Flow rate: 5.3L/min  Current Liquid Flowing: 88mL/Sec  Output Liquid Quantity: 2769mL
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Fig.4. Output

GRAPHS

Graphs help to give a visual representation of the data to the consumer regarding the amount of water that has been consumed. Graphical data is always easier to interpret that raw text, hence for the ease of the consumer an option to view the graphical data is also included. These include individual graphs for Daily Usage, Weekly Usage and Yearly Usage.

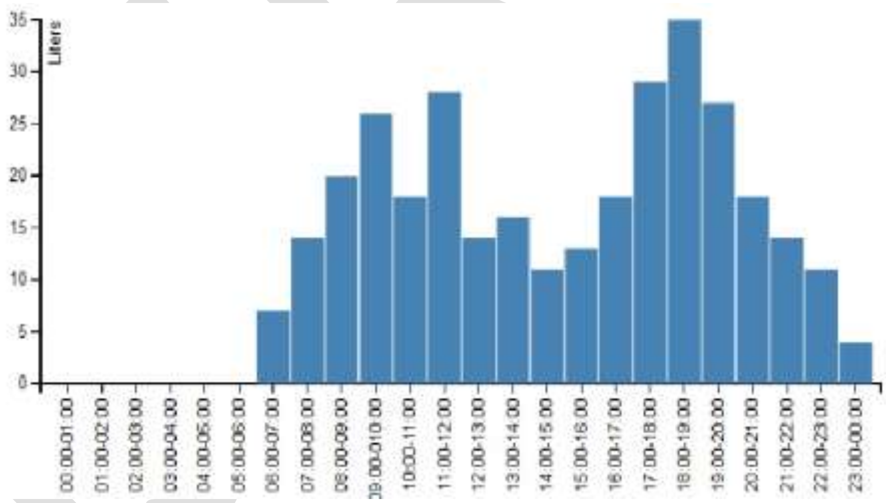

Fig.5(a). Graph For Daily Usage

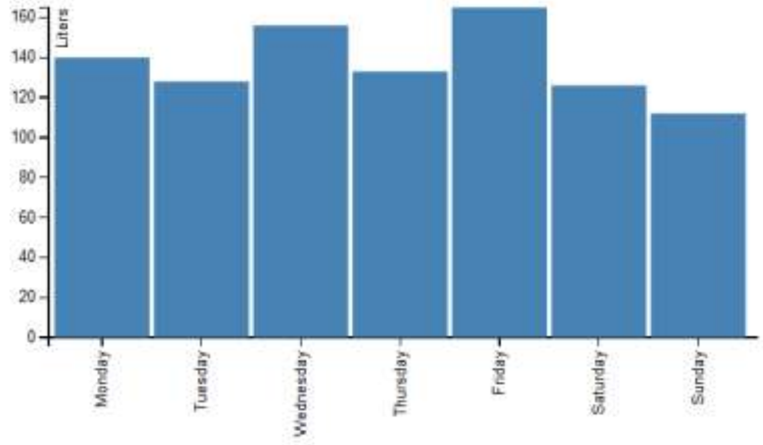

Fig.5(b). Graph For Weekly Usage

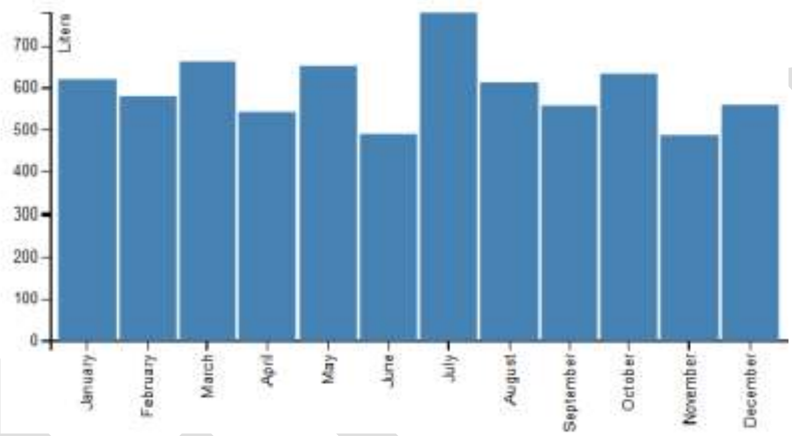

Fig.5(c). Graph for Yearly Usage

CONCLUSION

Hence, the necessary procedure needed to successfully install and use the Water Flow Rate Sensor Module are addressed by this paper. This paper also aims at spreading an awareness regarding the uncontrolled and ineffective means of supplying and using water resources and aims to reduce the practice of casual wastage of water by helping the consumer maintain a metric of the usage such that initial steps are taken to suppress the common trend to profligate water.

This paper aims at establishing a trend that results in water conservation. Households in both urban and rural areas will be able to create their own "Water Flow Rate Sensor Module" based on the guidelines that have been mentioned in this paper.

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