Digital water metering and Automatic Bill Generation System

Venkatesh Kakalwar, Balasubramanian V

Abstract*: Water is one solitary indispensable natural resource, we use it for drinking, cooking, cleaning including all the necessary activities and industrially. If there is no water no life and no work can be done absence of water. For this core factor we need to save water in all the aspects possible and here we reduce the manual calculation and calculate the amount of water used by each apartment digitally. Here we present water flow sensors that are used industrially for calculating the liquid flow through it. In residential areas where people living at same home unit with number of apartments pay for their water consumption without the knowledge of the amount of water used. Not only in apartments but also for multi-specialty flats have their toilets in different places where the calculation of cumulative flow becomes difficult. In the traditional meters there is lot of chance for getting wrong results and early failure is also possible. It takes much more man power. To solve this problem, we are introducing a digital water meter system so that we can be able to get the consumption of each and every inlet of the flat in the big apartment though the digital flow meter so that person can only pay how much he has used it and simultaneously generate the bill according the usage per flat leading to the fair billing practice. It also has a special advantage of open tap and leakage detection and generating alert messages when leakage gets detected so that we can able avoid the leakage as well as wastage of water. This project will help us in effective water conservation. In this study we suggest including cloud storage as well as live monitoring through the website for monitoring live data of water usage and conservation.

***Index Terms*: About four key words or phrases in alphabetical order, separated by commas.**

I. INTRODUCTION

Meticulous flow measurement is a fundamental advance both in the terms of economic calibarative and perspective. Beforehand a procedure known as ultrasonic flow quantification a non- encroached type of quantification is broadly used to ascertain flow, due to its potentiality to circumvent obstructions in its yield(output). Water metering is especially critical for municipalities since it frames the reason for quite a bit of their salary through the closeout of water through consumers.

Many countries currently lack proper water meter management, with many municipalities and bulk water suppliers not having the capacity to undertake and manage optimal and integrated meter calibration, replacement, reading and information management systems.

Often the divided responsibility between billing and meter man agreement (typical of the institutional arrangements within most municipalities) results in poor billing, incorrect information capture, and poor maintenance.

Further this is binded by the fact that where initiatives of conservation and water demand management are required, the data is not easily accessible to the departments responsible for this task, leading to the frequent lack of integration between domestic and bulk water metering.

Rationing water is winding up progressively essential by the world as it faces an enlarging hole between consistently decreasing water supplies because of environmental change, inefficiencies in agriculture, poor water governance, industrialization, urbanization and increased demand from population growth. It results in many environmental, political, economic, and social forces.

There are number of major predictions that III world war might happen because of water. They say: “if you can’t measure, you can’t manage”. So, what exactly happening to the customer is where the associated water bill is managed to linked to the volume consumed, rather than a flat rate or a fee based on the size of property serviced. So, the one who is not using the water most of time have to pay the same amount that of the person using the water at max. This project solves the existing problem economically and efficiently.

A. Similar Works

In [1] there was this work done with similar kind of procedure where they had used the normal water meter for the cross verification of results rest the data was fed through an WIFI module. Results were recorded and visualized graphically. Which also had shown the status of the system like when the system was up or down.

Low power technology which is wireless [2], ZigBee helped introducing smart system of measurement which is monitored in real time which in turn sends data for storage through ZigBee for provoking bills, involving a interface dependent on human.

The main aim [3] was to handle the water flow with wireless system for no. of flat’s which the data visualization is through the graph and leakages can be highlighted easily. The ability to utilize the microcontroller to its extreme advantage was briefly given in [4]. Usage of water pump situationally gave the back-end idea of using the controller.

Another method [5] using Bluetooth technology which is even a wireless thing

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internal system developed on system which is purely embedded, GSM for communication. Resulting in efficient utilization with WSN's.

Prepaid water metering system [6] without any human effort at any deep-down areas providing accurate data with proper arranged bill for the satisfaction of the user's with short security

II. METHODOLOGY

Predominantly what happens is there will be a water meter for every water source in the city and assigned a human to evaluate the meter readings attached at every home or apartments which indeed takes more man power as there are people all over places using water. These reading can be manipulated individually by the person who is checking. So, the efficiency of this type of environment is degraded. And the consumer has to pay even if there was leakage in water which he will not be knowing so there are numerous draw-backs in the conventional system like this.

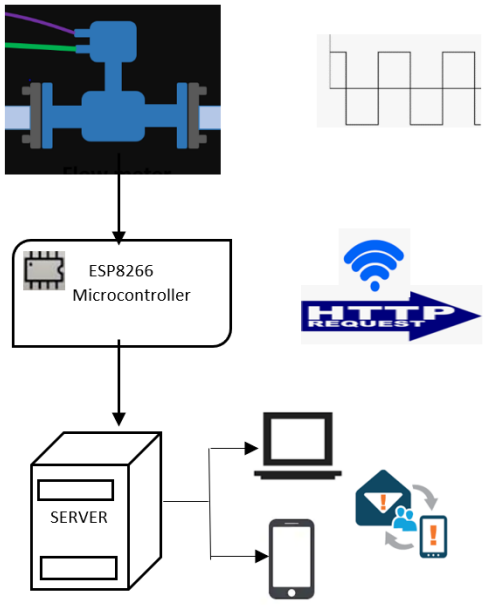

Fig. 1. Micro-controlled System

There is another big dependency which comes in only big apartments which deals with the amount of water consumed per flat. The thing which happens here is the water is brought from tankers and government water will also be part of it. The whole amount for the water is spitted equally for all the flats in the respective apartments. So, the person who uses more water and the person who uses minimum water has to pay the same amount of money.

There is a good loss for the consumer here. Without knowing how much water is consumed they have to pay the amount. If meter is added for every flat then that will take more man power additionally no information of leakage, over flow or no flow of water. Consequently, it is seen that there will be gains in automating this thing. For this reason, conventional meters can be associated to different gadgets so as to process and send the data dispensing with redundant presential work.

A. Hardware Design

In the presented work simple modular view of the system will be as shown in the Fig 2. where a water flow sensor is used which works with change in magnetic field as the water hits the turbine inside the sensor. Different size of sensor has different properties. As the little turbine moves whenever water hits it, it generates a pulse (electrical signal).

Volume of water is measure by this electronic factor. Each size of water flow sensor has different count of pulses when there is a water movement through the sensor. As in Fig 2.a this pulse values are sent to the AVR AT-mega-16 micro-controller which processes and throws back the result to ESP8266 module as AVR AT-mega-16 cannot send the data to the next web application party or the MQTT application by subscribing the same topic.

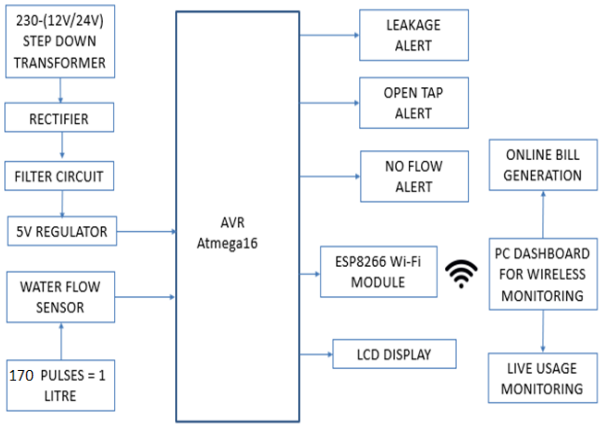

Fig. 2.Proposed Model

The main propulsion behind using the AVR Micro-Controller is that we can achieve low level operation unit wise easily and valuably. The Hardware model is as shown in Fig 3. In the software side each user has individual login to access there own data

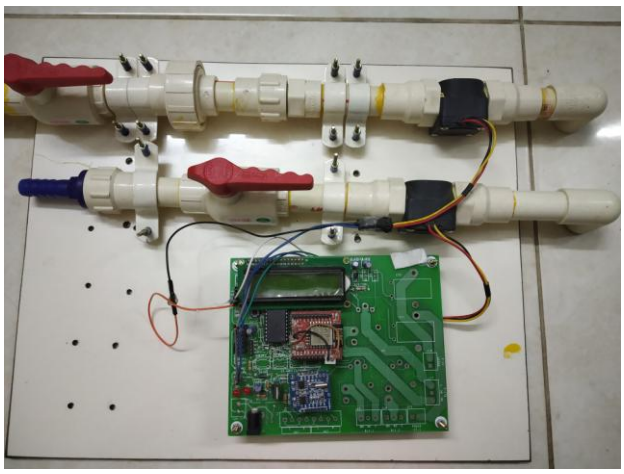

Fig. 3. Hardware Setup

B. Pulse Reading

This is the very first step of this model where the water flow is being detected by the sensor it gives the outputs. The sensor we are using here will be yf-s201, whose

measurement will be in liter-per-minute which is ¾ inch sensor gives averagely 170 pulse per liter output when analyzed with the oscilloscope. Can capture about 15 liter-per-minute if there is flow of that amount certainly there are various types and sizes of them. So, these are pulse output are fed to the microcontroller. The microcontroller can capture and process the values where at-mega 16 has interrupt pins data of this sensors is directly fed to it. In order to know the time, factor a simple RTC module is used which combinedly analyses the flow rate with the time. Now whenever there is a water flow it would send the interrupt signals to the processor then so that would calculate the liters-per-minute with interrupt signals as the there is a water flow from sensor.

C. Controller Setup

The data received from the water flow sensor is calculated as said in the pulse analysis later the live information can be seen in the LCD which will be LPM -litres per minute, LU-Live Usage and the alerts Leakage, Overflow and No Flow as in Fig 4

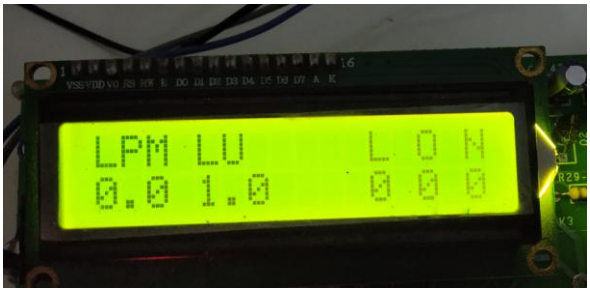

Fig. 4. LCD with LPM, LU and Alert values (in binary)

Live usage and litres-per-minute will be in terms of litres and alerts are in binary. The other part of the challenge detecting the alerts, the logical part of the concept can be configured by knowing that currently live data from the sensor is avail so by assigning a threshold value we can achieve all the three things. Salient thing was to know the working condition of the sensor the whole model fails if this thing is not known, this thing can be achieved by programming the controller in such a way that if the flow is null for certain time then there should be an alert message. Hence basic thing is No low can be attained this way.

In case of Over Flow condition, we can analyze if there is certain flow of water for uncertain interval of time then the alerts are to be sent, For Leakage if the water flow is lower than the usual then there must be an alert sent. In this way all the three conditions can be gained. As to make these data remotely get-at-able ESP8266 module comes into picture. Controller and this module communicate with UART and with the help of MQTT the data is processed. As MQTT (Message Queuing Telemetry Transport) is a subscribe publish model the data processed data of the sensor will be published and the server which will be the web-application which is Node Js to receive the set of information with a standard broker of its own which will be the subscriber in this case. The same data can be seen remotely from the mobile application of MQTT. Wi-Fi module sends the data in the forms of topics as we want to pass each information to the next part and Node-Js receives it as in the topic and in subscriber and stores in the My SQL database. As Node Js is one of the powerful JavaScript engines it supports SMS API with which SMS alerts are sent to the user. The overall work flow is as shown in Fig 5.

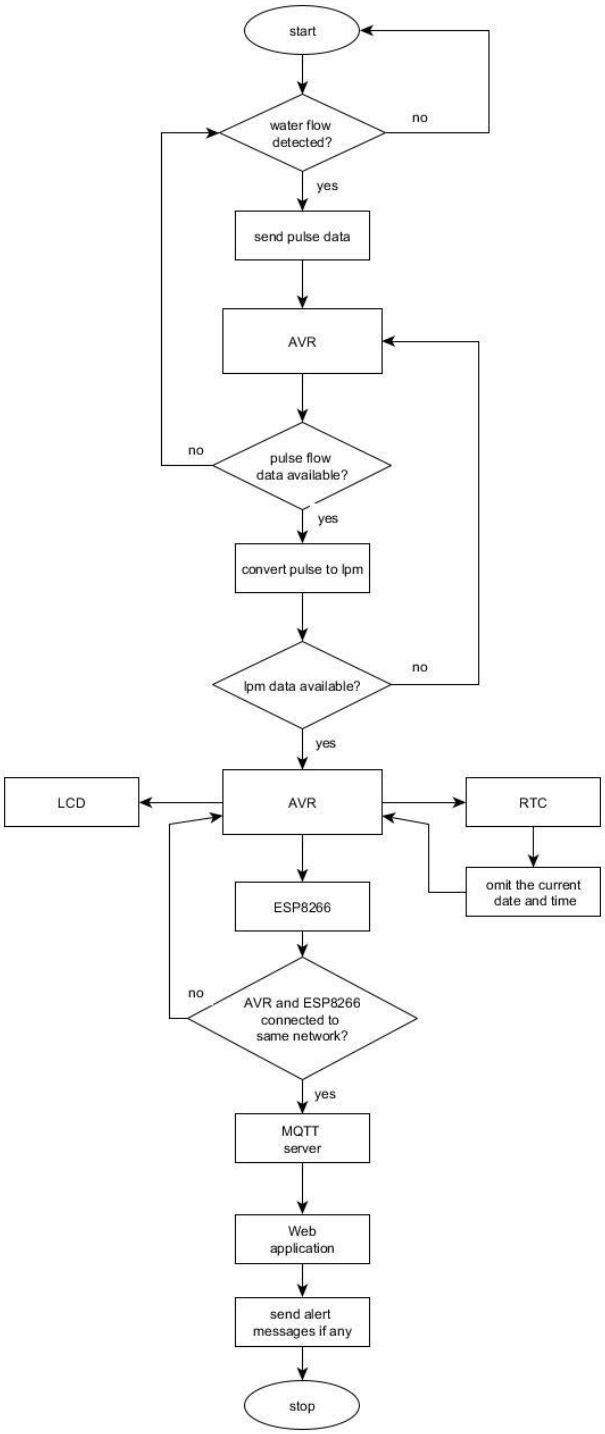

Fig. 5. Work Flow of Proposed Model

D. Web Interface

The web application developed with node Js has a login for each user who can check the details daily usage, yesterday's usage and monthly usage. There can be seen the alerts for each situation as shown in Fig 8 if everything is normal, they there will be no alerts displayed.

This will be monitored live any time the user can check as the data from the sensor is published every 5 seconds. The same can be seen in the MQTT mobile application which is freely available.

E. Multiple Sensors

We can add no of sensors as per the configuration of the micro-controller AT-mega-16 has total 32 I/O pins that many sensors can be connected to it. If it's in large scale then other series can be used for it. After adding up the sensor the hardware setup would look like in Fig 3. Consumption details are shows as per LPM current date usage and overall usage of the month in Fig 6

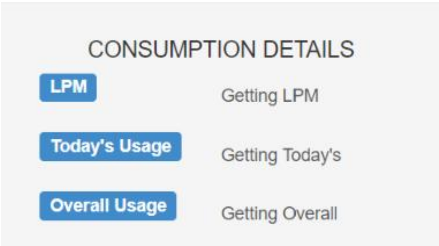

Fig. 6. Consumption Details

The overall alert system in the we application with different alerts are as shown in below in Fig 7.

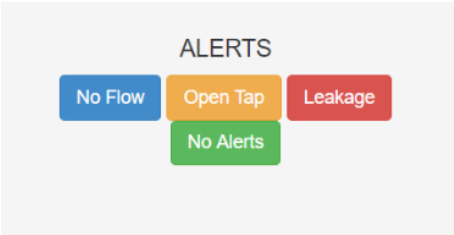

Fig. 7.Types Of Alerts

The billing details like name of the owner flat number al basic little things are also mentioned in with Yesterday's cost today's cost and we can get the month bill by clicking on Download-Invoice as shown in Fig 8. Addition to that there is also a graphical display of the monthly and daily basis. The bill can be generated with pricing by amount of litres used by the consumers.

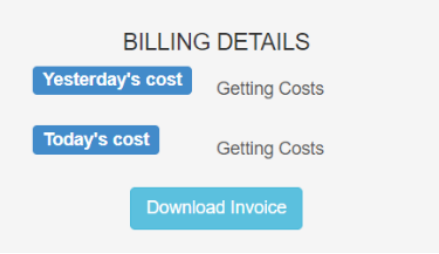

Fig. 8. Billing Details

III. RESULTS

The portion of software is coded to find the flow in liters-per-minute. In-order to evaluate the model let the threshold value for the alerts be some normal flow rate of the water which would satisfy the flow by pumping the water with some small water pump (fish tank motor or DC motor).

When there is no flow of water for 5 minutes there will be an alert SMS and it will be displayed in Fig 6.a, through webpage as well as in mobile. This can be configured in real life by setting it to one day. It is obvious that we will use water anyhow in day. If we don't then we know we aren't using but in case we are using water regularly and we get this alert then this indicates the sensor has gone faulty. No Flow functionality is achieved here.

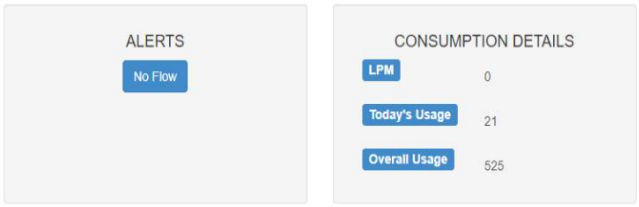

Fig. 8. No Flow Alert

In case of leakage the flow of the water reduces so for the flow if it goes below 2 LPM the alert SMS will be sent and will be visible in webpage as shown in Fig 9. In real time this can be achieved by analyzing the values which will be valuable after practical analysis.

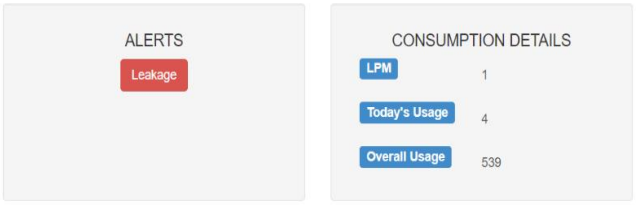

Fig. 9. Leakage Alert

When there is an overflow there the amount of water used will be more in certain amount of time. In Fig 10, For this model if the flow is more than 3 LPM then this Alert will be regulated immediately. For the real time Scenario, it can be set to for 1 ½ hour to 2 hour which people usually don't use for this much interval of time then this alert can be triggered which will be efficient enough to know.

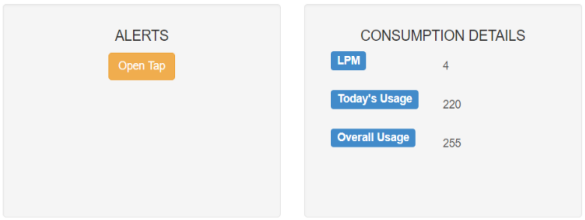

Fig. 10. Open Tap Alert

Fig 11 shows the No Alerts when there is a normal flow in the water also shows the daily graph. The water usage of the current month and the user can know what amount of water was used. Fig 12 is the monthly graph which states the monthly usage.

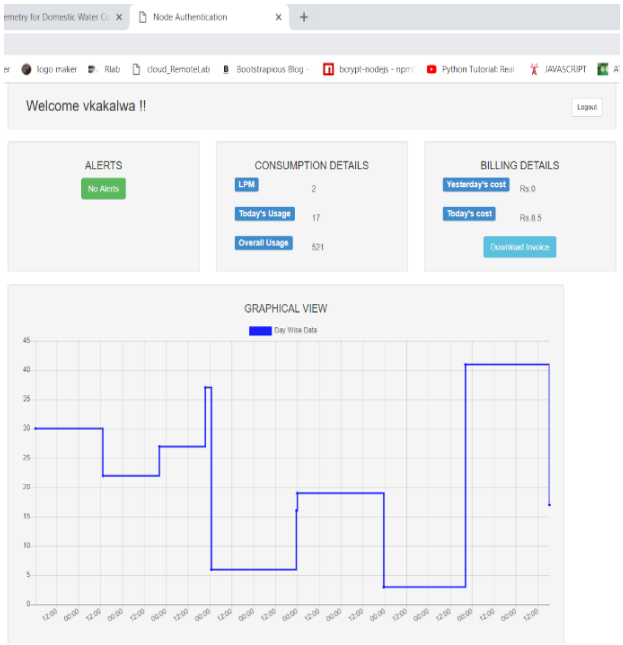

Fig. 11. Daily Graph Of Consumer

Fig. 12. Monthly Graph of Consumer

As mentioned earlier all the data can be accessed with the MQTT open source mobile application as shown in Fig 13, by subscribing the same topic which subscribed by the web application. The MQTT app refreshes the data every 5 seconds which helps for the user to know the current status of the water flow from any place

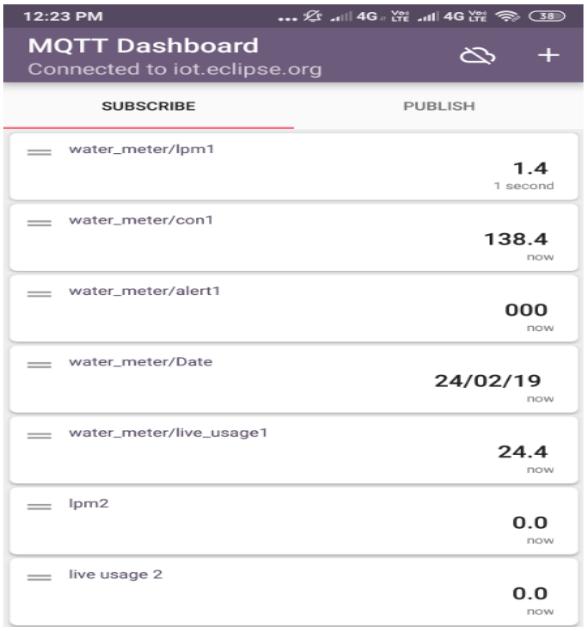

Fig. 13. MQTT Dashboard

The SMS alerts sent to the users though SMS are shown below in Fig 14.

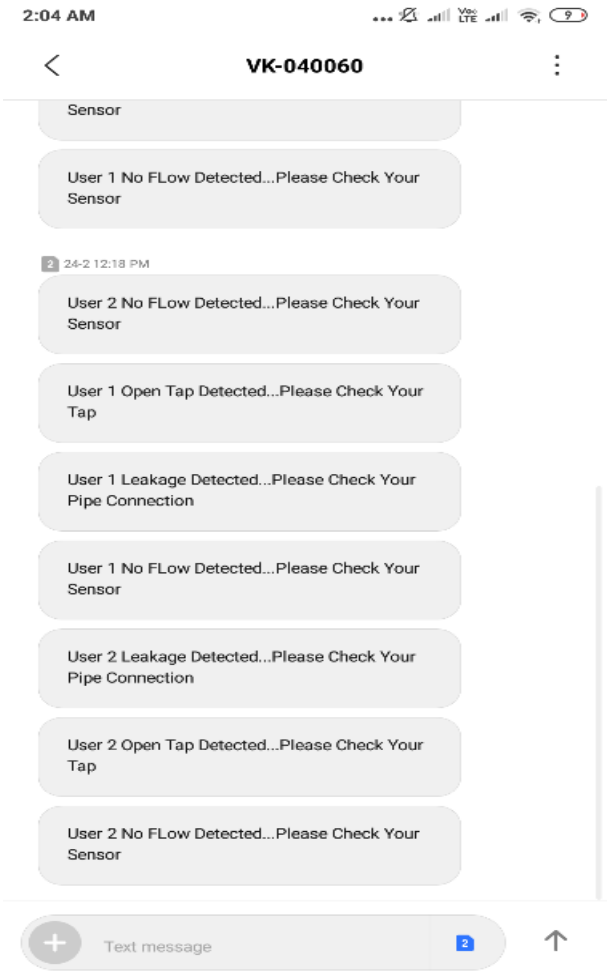

Fig. 14. SMS Alerts for the User1 and User2 from there water flow sensors.

IV. CONCLUSION

The proposed-model dealt with automating the traditional water meter system with additional features which will help user to know the status of the water flow all time with web application as well as with an open-source mobile-application. All the tests were performed and were the proposed-model deployed accuracy of 99.99% (described-in-section-III). Can be culminate that this is more efficient way to deal things for water metering then going for the traditional operation. The user can pay only whatever the amount of water the consumer used instead of paying wholly.

V. FUTURE WORK

As water is very important for the living being, we need to save water with model's alert functionality that can be achieved successfully and consumer can have look at what they have used and how much they have used. Though there might be the issue of blocking of the water sensor due to clogging by water dust can be well managed Y-Strainers. But still this might be the issue when this is not properly handled there are possibilities to get false alerts so other technologies and hardware can be integrated with this to get everything out of it solely Using radio technology for transmitting the data can Improve more better then Wi-Fi.

REFERENCES

1. Tavares, Sayonara AC, et al. "Telemetry for Domestic Water Consumption Based on IOT and Open Standards." 2018 Workshop on Metrology for Industry 4.0 and IoT. IEEE, 2018.
2. V. Sharath, S. Suhas, B. S. Jain, S. V. Kumar, and C. P. Kumar, "Smart aqua meter," in Advances in Electronics, Computers and Communications (ICAECC), 2014 International Conference on. IEEE, 2014, pp. 1–5..
3. M. F. C. da Silva and D. P. Pereira, "System for measurement and control of water consumption using wireless sensor network," in Computing System Engineering (SBESC), 2011 Brazilian Symposium on. IEEE, 2011, pp. 105–107.
4. Snehal R. Mulmane1, R.S. Khamitkar2 "Automation of Water Pump Controller for Irrigation Using ATMEGA 16" IOSR Journal of Electronics and Communication Engineering (IOSR-JECE) e-ISSN: 2278-2834, p- ISSN: 2278-8735. PP 128-134.
5. Cao, Liting, Jingwen Tian, and Dahang Zhang. "Networked remote meter-reading system based on wireless communication itechnology." i2006 IEEE International Conference ion Information Acquisition. IEEE, 2006..
6. B. E. Shlesinger Jr. and C. D. Mariner, "Magnetic reed switch," Aug. 2 1977, uS Patent 4,039,985..
7. N. Kolban, "Kolban's book on esp8266," an introductory book on ESP8266, 2015..
8. M. McRoberts, "Arduino basic," Sao˜ Paulo: Novatec, 2011..
9. R. F. Da Silva and P. R. Gonc¸alves, "Web services–uma analise´ comparativa," Revista das Faculdades Integradas Claretianas–No 5–janeiro/dezembro de, p. 8, 2012..
10. U. Raza, P. Kulkarni, and M. Sooriyabandara, "Low power wide area networks: A survey," arXiv preprint arXiv:1606.07360, 2016.

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