EasyChair Preprint

№ 7225

Smart Water Usage Predictor Using IoT

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December 17, 2021

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Abstract - Water is the necessary thing for all living organisms in the world. This work will describe the amount of water utilized in domestic application and will show the use of further weeks. The main aim is to create a smart system that monitors and predicts the usage of water in a household using IoT. A Flow Sensor is used to identify the flow of water. To achieve the same this work uses Arduino to interface the sensors.

Keywords – Water flow sensor, NodeMCU8266, AWS cloud

I. INTRODUCTION

Every living thing needs water to survive its life as it is one of the main sources of living. As the human population increases, the usage of water will also increase which leads to scarcity of water. In today's world, everyone are so busy, everyone has their own work so that no one is cared about the amount of water being used and also the amount of water being wasted.

We can see that a large quantity of water is being wasted by outflows from the tanks due to overflow in each household every day as people do not care about it. People switch on their motors and start doing their works. They will switch off the motor only when they hear the water sound due to overflow from the tank. Similarly, people open the taps in the washrooms and will forget to close the taps where water is being wasted. A large quantity of water is being wasted during the cleaning, brushing, washing etc.,

We know how difficult life is without water and what people have experienced in the past years. During water scarcity situations, we all need to use the specified amount of water so that providing others to use the same. To use the specified amount of water one needs to have a system that helps in monitoring and predicting the usage of water in a household which helps them to be aware of the amount of water being used by them or the amount of water needed further and helps them not to waste or overuse the water. So that they can make better water-conserving decisions and use water efficiently.

So, the projected system that uses a water flow sensing element, Arduino, for collecting the information and AWS cloud services for storing and analyzing the information using clustering algorithms that helps in predicting the quantity of water used and amount of water needed for additional weeks supported previous weeks data that helps in reduction of over usage of water and helps in saving the water that ends up in sustainable development.

This chapter will discuss about the existing literature works, based on various algorithms and cloud services used in water usage monitoring using IoT to derive the water usage of a household. The existing works focuses on several instances that describes the various water usage monitoring systems.

Water usage Monitoring Systems using IoT:

Ankur Ravindra Bodhe et al.[2] proposed an IoT solutions for household water usage. Here, from devices consumption data is systematized and at user side, data is installed as CSV files to Cloud to get meaning data. All entrenched communications uses the TCP IP protocol and using Wi-Fi, data reception is conducted. The installed sensor at user side is connected to an Arduino UNO and the transmission of data that is generated dynamically to Arduino through sensors. ESP8266 Wi-Fi module which is connected to an Arduino board is used for communication. By using the Wi-Fi router of user, the data is transmitted to the Database set-up. The established Cloud server stores the dynamic data in large quantities from multiple houses. In local area network, data decipherment, data inspection, generating of results and analysis phases will be handled. To the devices of respective users, the data is wired back via router by using Internet. Hence, data is communicated between end side and a wireless system.

From the Bhagya VD et al., (2018)[3] paper, they have used a Wi-Fi/LAN which is setup at the water outlets, which helps in transfer of data so that the server collects the data of the sensors. This happens in real time, therefore the data can be live tracked. Now, this data is stored in a cloud database and is displayed to users in simple and understandable format. They have also mentioned that the leakages are also displayed in their system, so it becomes an automated system which has the water usage and water leakage detection alert. From this we have considered the idea of collection and transfer of data to the cloud with the help of Wi-Fi and display of the water usage, so that it would be an automated system.

Arief Azhari Hasibuan et al., (2019)[1] paper was having a low cost system which monitors the water and which can also predict the water consumption. They use a Flow sensor and that is connected to an micro- controller, the NodeMCU 8266. Now with help of an embedded code the data is collected through the micro-controller via Flow sensor. The data that is collected is stored in cloud database, now the data is analysed and predicted with the Bayesian Method. Thus, the user uses a web application which has the resulted value. From this we have adapted the water collection and analysis part.

G Lakshmi Harika et al., (2020)[8] proposed a system in which Thingspeak Cloud platform is used along with Internet of Things (IoT). A structured dashboard provided by Android Studio is used to show the output to the consumer. The proposed work helps in understanding from which the water is being wasted or consumed maximum and helps

consumer to take better decisions that concerns the usage of water. But this system doesn't help in detection of leakages and its been conducted on two pipes.

Krishnamurthy M et al.,[15] proposed a Cost-Effective Data Node Management Scheme for Hadoop Clusters in Cloud Environment.

R. Dhanalakshmi et al., (2017) [14] proposed an intelligent monitor system for home appliances using IoT .

II. PROPOSED SYSTEM

In this model (Fig. 1) the hardware component flow sensor will be installed at the tank's pipe at user's end. Then, the continuous flow of data is collected and it would be integrated into micro controller. The micro-controller converts the sensor data into usable volume of data. Then the devices installed and is sent to the AWS Cloud, by which useful data is obtained. The data which is collected is transferred and received using the Wi-Fi network. At user end, a sensor is placed that is connected to Arduino board with an appropriate circuit. From sensor, real time data is transmitted to the Arduino and is interfaced using a module called ESP8266 Wi-Fi module and then an Arduino board is connected to this. This data is now transmitted to the AWS DynamoDB using Internet. To compute and predict the data we should create the instances in AWS there we are using AWS EC2. Once the instances are created need to create a S3 bucket in AWS S3 it will groups the data for prediction process. AWS Sage maker facilitates the data for the prediction process. Then user could see the level of further usage using AWS Amplify it will acts as an UI to see the prediction data. A huge amount of real time data from several houses is stored in acloud. The analysis and prediction of data obtained is conducted at the Cloud and the predicted output is sent to the consumer's device using a UI with help of Internet.

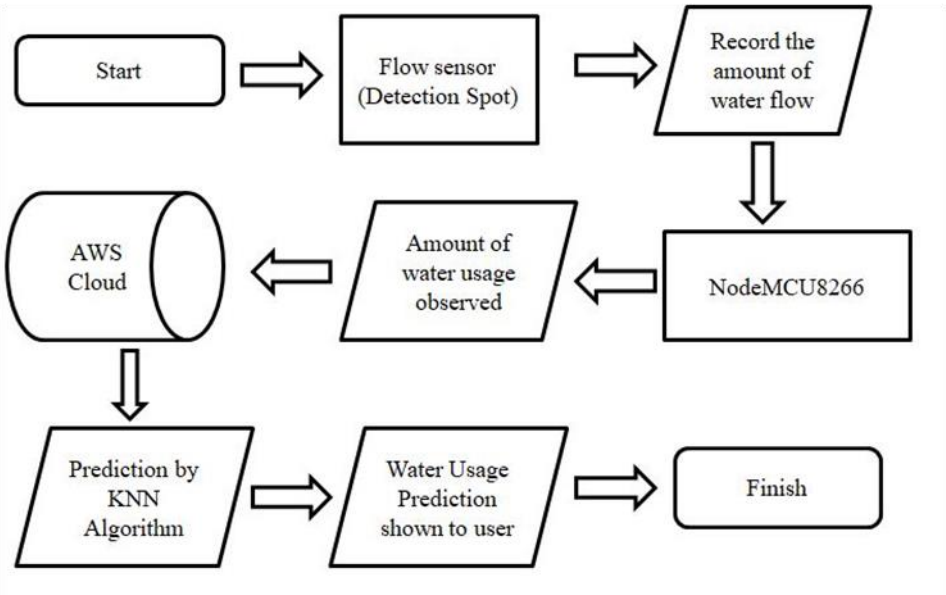

Fig 1. Flow Diagram

III. METHODOLOGY

Flow Sensor, it will measure the flow rate of liquids within pipes and tubes. Then sensor sends the pulse which will be counted by micro-controller and then water flow velocity (m/s) is calculated by converting number of pulses per unit time using a mathematical formula. Data collection is done by the NodeMCU and then it is send to the cloud.

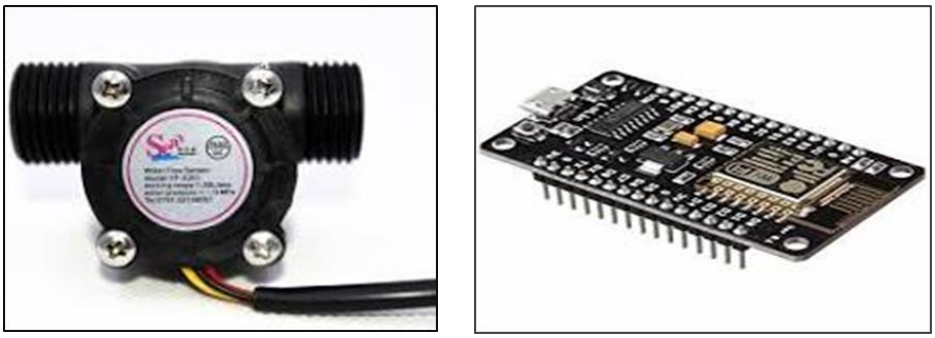

Fig 2. Flow Sensor and NodeMCU8266

Software applications of a consumer can be run and deploy in cloud environment on a advanced infrastructure which is owned by cloud provider and is managed. A database which runs on cloud computing platform and to the database access is provided as-a-service is said to be a cloud database. A website's server side is said to be a Back-end where data is stored and arranged. Proper working of website on a client-side is checked by the back-end.

IV. SYSTEM ARCHITECTURE

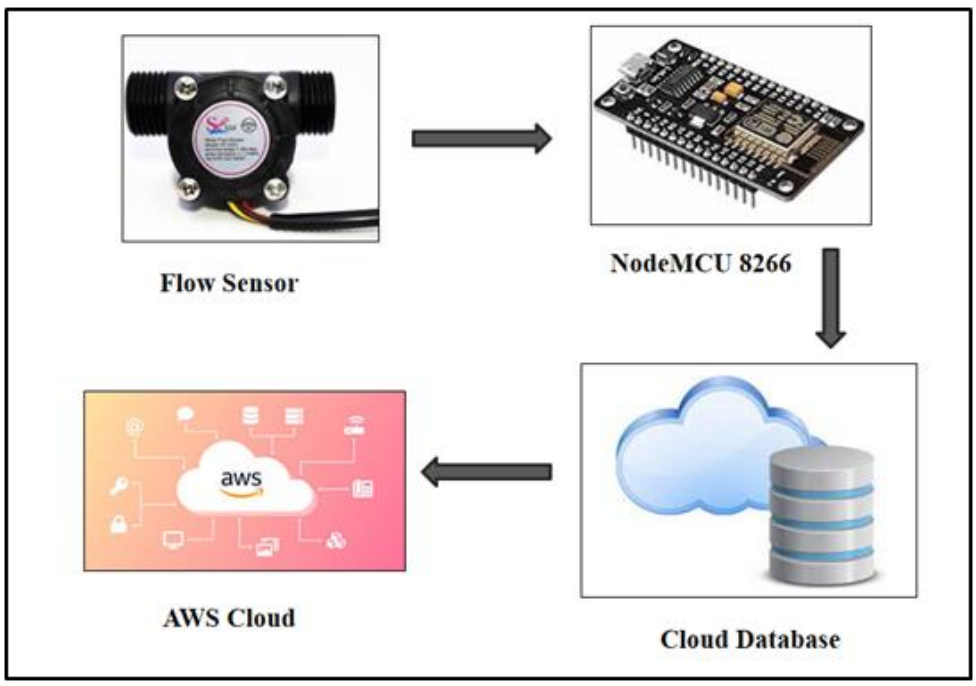

Fig. 3. Architecture of Proposed System

In the proposed system architecture (Fig. 3), a sensor is fixed and a NodeMCU board is connected to it with help of jumping wires and is connected to power supply. The data is collected and transferred with help of Wi-Fi module in NodeMCU to cloud database- ThingsSpeak . The collected data is Stored in the S3 bucket (AWS). The data is now processed at the AWS Instance. The Prediction is done at the Back End part and the desired output is visible at The AWS Instance.

V. ALGORITHM EXPLANATION

K-Nearest Neighbors algorithm is used for the problems based on classification and prediction. It is widely used for problems based on classification and regression. It is generally used for easy of interpretation and less calculation time. K- Nearest Neighbors algorithm is the simplest classification and grouping algorithm. As the algorithm is simple, it could give highly accurate results.

The KNN algorithm works in such a way that K value should be selected which determines the number of neighbors. Then K Nearest neighbors need to be determined by finding the distance among the data points using Euclidean distance formula. Nearest Neighbors are considered based on the calculated distance. Consider numerical targets of nearest neighbors and then the average is calculated, which is the predicted value for the problem.

Algorithm:

Step-1: Choose the K value.
Step-2: To K number of neighbors, calculate the distance using Euclidean formula.

$$\text{Euclidean distance} = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}.$$

Step-3: Choose the nearest neighbors based on the distance calculated.
Step-4: Now, calculate the average of the numerical target of the K nearest neighbors which is the predicted value for the problem.

Input: K & N Values.
Output: Average of Numerical value target of K.

VI. MODULE DIAGRAM

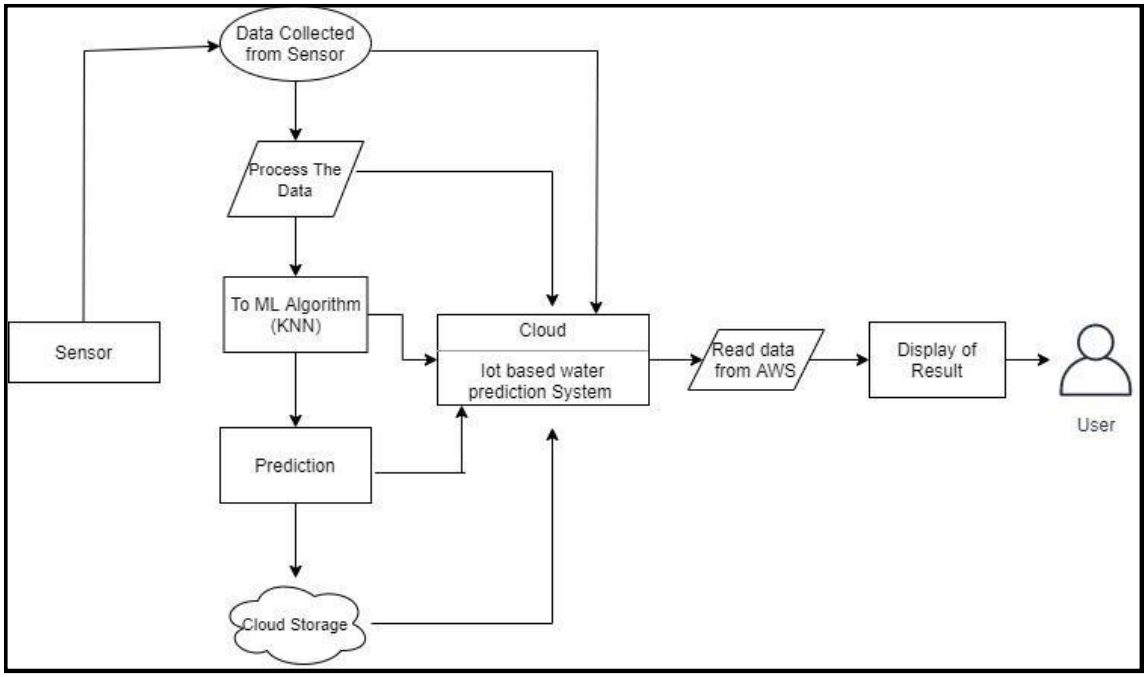

Fig.4. Module Diagram

This diagram (Fig. 4) depicts that, a water flow sensor is connect that measures the flow rate of liquids and collects the live data and it is connected to a micro- controller NodeMCU8266 and code is embedded to the micro-controller to get data through water flow sensor. Then the data is processed in such a way that the collected data is sent to AWS environment. Then data is integrated to the Amazon S3 which is a service offered by Amazon Web Services and then to SageMaker where the prediction process took place using inbuilt algorithms and then data is shown to the user as a predicted value.

VII. IMPLEMENTATION

The system has a Water flow sensor (YF-2501, Water pressure ≤1.75MBPs) which is connected to a NodeMCU ESP8266 Board. These two are connected with jump wires. The Water Flow sensor consists of three cables namely, Yellow: Connected to the D2 pin of NodeMCU, Black: Connected to the GND(Ground), Red: Connected to the VIn pin (5V). The NodeMCU is connected to the power supply. For Internet connection, the NodeMCU has a Wi-Fi module in it, which is connected to the home Wi-Fi or a Hotspot. This is setup of the system. Mandatory Internet and power supply is needed in-order to transmit the data. The setup is now fixed near the tank. The tank is considered is because, it stores the whole water for the house and is fixed at the top of the house and the flow would be convenient in the pipes and the sensor is inter-connected between the pipe so that, with help of flow of water, the usage can be measured. This would help in showing the overall usage data of a house.

Fig. 5 Experimental Setup

VIII. RESULTS & DISCUSSION

In the proposed system, Water usage for further weeks is predicted based on the usage in past. With use of K- NN algorithm, the system predicts how much of water is needed for future weeks.

Week	No of working days	Average of no of persons	Total Quantity used (liters)
1	5	3.7	1999
2	4	4.4	2140
3	4	4.1	1965
4	6	3.7	2100
5	5	4.6	2115
6	5	4	2006
7	5	3.7	1947
8	6	3.8	1897
9	6	4	1894
10	5	4	?

Table 1. Datasets for reference

K Value is chosen by taking square root of total number of datasets. Then Euclidean distances must be found for new data set with all existing datasets. So, the above (Table 1) data yields, Euclidean distances as: 0.3, 1.07, 1.004, 1.04, 0.6, 0, 0.3, 1.01, 1. Now, calculate the average of selected values which is the predicted value for the problem.

Therefore x = (1999+2006+1947)/3 = 1984
Therefore, for sixth week 1984 litres of water will be required.

IX. CONCLUSION

This paper reports that this system uses real time water usage data from the Flow sensor at a small level of household and the Analytics and prediction of water is shown in anweb page with a better UI, so that, it helps the end user in understanding, how much of water is consumed and how much of water can be used in future and helps to take decision concerning of water usage. Considering this system is developed at a household level, this can be developed at a community level or it can even be developed in housing projects while constructing by having sensors installed in every household. The drawback this system has is that it doesn't detect any kind of leakages, but in near future, this can be improved with help of right technology and better mechanisms. In future, this system can be expanded to provide a smart solution for leakage detection and water usage prediction using advanced algorithms. The system will be fully atomized using different services like AWS IoT and AWS Machine Learning. So, finding out predictive values will be more effective rather than manually updating the values in Jupyter Notebook. Efficiency will be done better than now. Front end will be done so, so that the user could see the only predicted values.

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