ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijircce.com

Vol. 7, Issue 2, February 2019

Water Leakage Detection and Pricing Analytics Using IOT

Rashmi Rajalakshmi.M[1], Niveditha.G[2], Shobia Inbathersini.I[3], Thenmozhi.R[4]

UG Students, Department of Information Technology, Valliammai Engineering College, SRM Nagar, Kattankulathur, Tamilnadu, India[1,2,3],

Assistant Professor, Department of Information Technology, Valliammai Engineering College, SRM Nagar, Kattankulathur, Tamilnadu, India[4]

ABSTRACT: Asset monitoring, specifically infrastructure monitoring such as water distribution pipelines, is becoming increasingly critical for utility owners who face new challenges due to an aging network. In this project, a water monitoring system which monitors and provides us the in-flow of water and out flow of water from a particular pipe is proposed. Thus monitoring the water gallons from inlet and outlet, the system can predict the leakage of water. The particular leakage location in the pipeline can also be detected using sensors, but this system focuses on identifying the leakage presence in the pipeline using flow sensors. Also the exact leakage location can be detected using water leakage sensor. Also the project work is extended by obtaining the real time data and perform data analytics. Clustering the data, classification and prediction of water usage for a particular region can be achieved by data analytics using R programming. In R programming, clustering and classification based on the water consumption of the users is performed. K-means algorithm and naive bayesalgorithm are used for clustering and classification respectively.

KEYWORDS: Leakage detection sensors, R programming, K means clustering, Naivesbayes classification, data analytics**.**

I. INTRODUCTION

Water, the need of life, is likely to pose the greatest challenge on account of an increased demand with population rise and economic development, and shrinking supplies due to over-exploitation. Though water is an abundant and renewable source of energy which covers two thirds of the planet, but only a very small of water in available for human use. In India, due to developmental growth , the demand for water is increasing both in urban and rural areas. This may increase tensions and disputes over sharing and command of water resources. The emerging scarcity of water has also raised a host of issues related to sustainability of the present form of economic development, sustained water supply, equity and social justice, water financing, pricing, governance and management . A household telemetry system provides a more detailed and reliable water consumption data. For this reason it is being increasingly used by water supply companies as a management tool. Telemetry systems have several advantages and due to technological innovations the deploying cost is decreasing. However, the large number of data produced by daily measurements becomes a big challenge. This creates opportunities for the development of models and algorithms using that information to give a detailed analysis of consumption and enabling an efficient water management. In order to contribute with efficient tools for the water consumption monitoring and control, the main goal of this research project from the Department of Civil Engineering (University of Coimbra) is to develop a method for losses/ leakage detection and water consumption characterization through the detailed study of the signals pattern generated by water meters.

II. OBJECTIVE

- The objective of this system is to develop an automated system to detect water leakage in underground using sensors & Internet of Things (IoT).
- To perform an analytics to predict water consumption for different family sizes.

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- Develop a water monitoring system which monitors and provides us the in-flow of water and out flow of water from a particular pipe.
- Identify the leakage presence in the pipeline using flow sensors.
- To detect the leakage in the pipelines by observing the flow rate of water regularly, which saves water as excess water would not be delivered unwantedly.

III. RELATED WORKS

[1] Luis Castaiier, Vicente Jimenez, Manuel Dom'nguez, FrancescMasana and Angel Rodriguez(2009),"Design and fabrication of a low cost water flow meter", IEEE International Conference on Solid-State Sensors and Actuators, Vol. 5. Lot of research work has been carried out for evolving different water flow measurement techniques. This paper describes design and fabrication of a low cost water flow meter which can measure up to 9 litre/minute, avoiding direct contact of flow with silicon sensors in. Techniques of measuring water flow rates with the help of neural networks had also been proposed. A novel low-cost system consisting of a hot-wire water flow meter of capacity up to 9 liter/minute is presented. The flow does not come into direct contact with the silicon sensors. Thermal contact is ensured by pins in a lead frame. This system is less sensitive to the geometry and relative position of the sensor and the pipe, and simpler to pack, than previous solutions. This paper gives details of the design, fabrication and performance of the system and the basic ideas in a qualitative way.

[2] Santhosh KV and BK Roy, "An Intelligent Flow Measurement Technique using Ultrasonic Flow Meter with Optimized Neural Network," International Journal of Control and Automation, Vol. 5, pp. 185- 196/2015. Design of an intelligent flow measurement technique using ultrasonic flow meter is reported in this paper. The main objective is to extend the linearity range of measurement to 100% of the input range, to make the measurement system adaptive to variations in pipe diameter, liquid density, and liquid temperature, and to achieve the objectives by an optimal Artificial Neural Network ((ANN). An optimal ANN is considered by comparing various schemes and algorithms based on minimization of Mean Square Error (MSE) and Regression close to one. The output of ultrasonic flow meter is frequency. It is converted to voltage by using a frequency to voltage converter. An optimal ANN block is added in cascade to frequency to voltage converter. This arrangement helps to line arise the overall system for 100% of full scale and makes it adaptive to variations in pipe diameter, liquid density, and liquid temperature. Since the proposed intelligent flow measurement technique produces output which is adaptive to variations in pipe diameter, liquid density, and liquid temperature, the present technique avoids the requirement of repeated calibration every time there is change in liquid, and/or pipe diameter, and/or liquid temperature. Simulation results show that proposed measurement technique achieves the objectives quite satisfactorily.

[3] Zhang Wenzhao, Liu Zhizhuang, Xu Xiao, Liu Ailing, Chen Aiwu,(2010), "A Liquid DP Flow Sensor on Straight Pipe," International Conference on Industrial Mechatronics and Automation, Vol.1.Zhang Wenzhaoet. al had developed a liquid differential pressure flow sensor for Straight Pipe. In this system a pressure difference between the upstream branch primary and secondary element. The primary element causes a change in kinetic energy, which creates the differential pressure in the pipe. The unit must be properly matched to the pipe size, flow conditions, and the liquid's properties.And, the measurement accuracy of the element must be good over a reasonable range. The secondary element measures the differential pressure and provides the signal or read-out that is converted to the actual flow value.

[4] Young-Woo Lee, SeongbaeEun, Seung-Hyueb Oh,(2008) "Wireless Digital Water Meter with Low Power Consumption for Automatic Meter Reading," International Conference on Convergence and Hybrid Information Technology IEEE, pp. 639-645. DOI 10.1109/ICHIT.19 /2008.172. Young-Woo Lee et. Al had developed a wireless Digital Water Meter with Low Power Consumption for Automatic Meter Reading in which they used magnetic hole sensors to calculate the amount of water consumption and they had used ZigBee wireless protocol to transfer amount of water consumption to the gateway. Zigbee is a low-cost, low-power, wireless mesh network standard targeted at battery-powered devices in wireless control and monitoring applications. Zigbee protocols are intended for embedded applications requiring low power consumption and tolerating low data rates. Since this a low power system, it is employed here for the purpose of transferring amount of water consumption to the gateway.

[5] MongkornKlingajay, and TawatchaiJitson, Real-time Laser Monitoring based on Pipe Detective Operation, International Scholarly and Scientific Research & Innovation 2(6) 2008.The pipe inspection operation is the difficult

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detective performance. Almost applications mainly relies on a manual recognition of defective areas that have carried out detection by an engineer. Therefore, an automation process task becomes a necessary in order to avoid the cost incurred in such a manual process. An automated monitoring method to obtain a complete picture of the sewer condition is proposed in this work. The focus of the research is the automated identification and classification of discontinuities in the internal surface of the pipe. The methodology consists of several processing stages including image segmentation into the potential defect regions and geometrical characteristic features. Automatic recognition and classification of pipe defects are carried out by means of using an artificial neural network technique (ANN) based on Radial Basic Function (RBF). Experiments in a realistic environment have been conducted and results are presented.

IV. ARCHITECTURE DIAGRAM

The proposed system monitors and compares the water gallons from inlet and outlet of a pipeline system. If there is a difference in the data we can predict that pipeline leakage is there. Also the project work is extended by obtaining the real time data and performing a data analytics. In this project, the water leakage sensor is used to detect the exact leakage location.

Clustering the data, classification and prediction of water usage for a particular region can be achieved by data analytics using R programming. In R programming, clustering and classification based on the water consumption of the users is performed.. Also with the water gallons been consumed, the user can pay for the water consumed every month online. In existing system there is no monitoring system which shows the user about the water consumed.

Every year it is becoming increasingly more important to conserve water and energy. It is, therefore, incredibly important for water to be used efficiently. Any breaks in large pipeline systems that go unnoticed for extended periods of time could potentially waste devastating amounts of fresh water, as well as time, labor, and money. It is clear that detecting and locating breaks in these systems quickly and efficiently is desired, if at all possible, and the motivation for our project is realized.

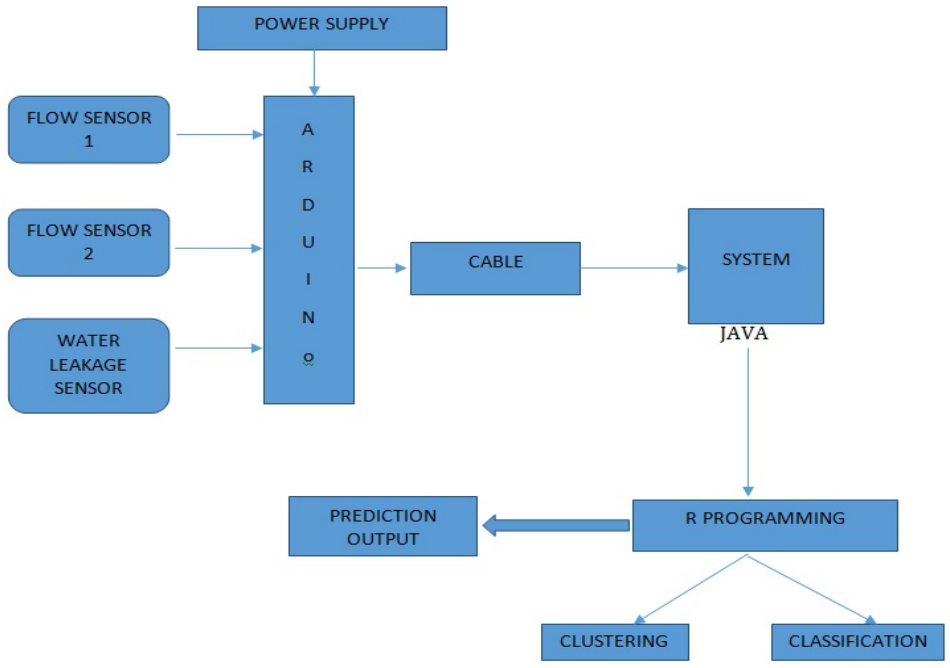

Fig -1: Architecture Diagram of Water leakage system

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V. METHEDOLOGY

DATA ANALYTICS:

R is a programming language and software environment for statistical analysis, graphics representation and reporting. A huge multidimensional data have been collected from various fields like marketing, bio-medical and geo-spatial fields. Mining knowledge from these big data field is highly demanding.However,it far exceeds the human ability to analyse these huge datas.Unsupervised machine learning or clustering is one of the important data mining method for discovering knowledge in multi-dimensional data.

K-MEANS CLUSTERING

K Means Clustering is an unsupervised learning algorithm that tries to cluster data based on their similarity. Unsupervised learning means that there is no outcome to be predicted, and the algorithm just tries to find patterns in the data.

The formula for this distance between a point ***X*** (***X1, X2,*** etc.) and a point ***Y*** (***Y1, Y2,*** etc.) is:

$$d= \sqrt{\sum_{i=1}^{n} (x_i - y_i)^2}$$

In k means clustering, we have the specify the number of clusters we want the data to be grouped into. The algorithm randomly assigns each observation to a cluster, and finds the centroid of each cluster. Then, the algorithm iterates through two steps:

- Reassign data points to the cluster whose centroid is closest.
- Calculate new centroid of each cluster.

These two steps are repeated till the within cluster variation cannot be reduced any further. The within cluster variation is calculated as the sum of the Euclidean distance between the data points and their respective cluster centroids.

RANDOM FORESTS

Random Forests is an ensemble learning method also thought of as a form of nearest neighbor predictor for classification and regression that construct a number of decision trees at training time and outputting the class that is the mode of the classes output by individual trees. Random Forests is a combination of tree predictors where each tree depends on the values of a random vector sampled independently with the same distribution for all trees in the forest. The basic principle is that a group of “weak learners” can come together to form a “strong learner”. Random Forests are a wonderful tool for making predictions considering they do not over fit because of the law of large numbers. Introducing the right kind of randomness makes them accurate classifiers and repressors.

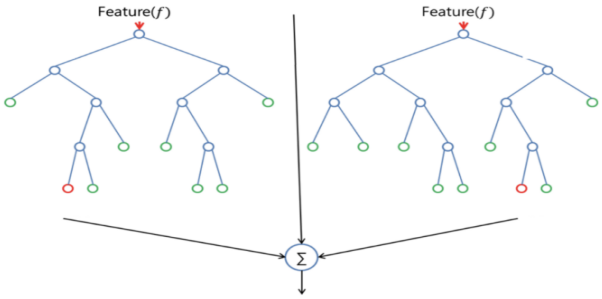

Figure No:2 Random Forest Representation.

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