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Pipeline Leakage Detection System using Machine Learning

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ABSTRACT

Pipeline leakage is the major reason for wastage of water in India. Delivery of water is done from the dams and other water resources towards the user end like factories, households and other locations. There are frequent news of pipeline leakage and wastage of millions of liters of water at any point of times and at anyplace. There is still no provision to identify the location of leakage and fix the problem to avoid wastage of water. The solution could be the real time pipeline leakage detection system which can constantly observe the status of water pipeline to see whether water is flowing through it continuously or not. This system will use sensors to detect the leakage between pipeline and Internet of Things will be used for data transmission towards central server. Server will alert authority about leakage so that wastage of water can be reduced. In results we can get upto40-50% of accuracy based on different threshold values. It can be concluded that this system will immensely helpful to use in real world to reduce wastage of water as well as proper management of all water resources with usage of minimum hardware and cost efficient system.

Keywords: authority, hardware, leakage, server

1. INTRODUCTION

In many areas of India people are still struggling to get sufficient water according to their need. One of the reason of poor management is leakage in pipelines. Therefore, there is need to have a proper water management technique which can prevent such wastage of water.

In order to do this a monitoring system can be designed by using flow sensors, Arduino Uno board, GSM Module, solenoid valve etc. System has a interconnection of different pipelines which keeps track on flow of water through the different pipelines. When leak is detected system shows leakage on the dashboard and generates signal to stop water flow. An alerts are sent to the central server as well as next node on the network for efficient operation. At the same time system will inform the server that leakage is detected at particular location. Location of leakage will be available at server. Now, authority will take care of further process of fixing the leakage issue and again start the working of system.

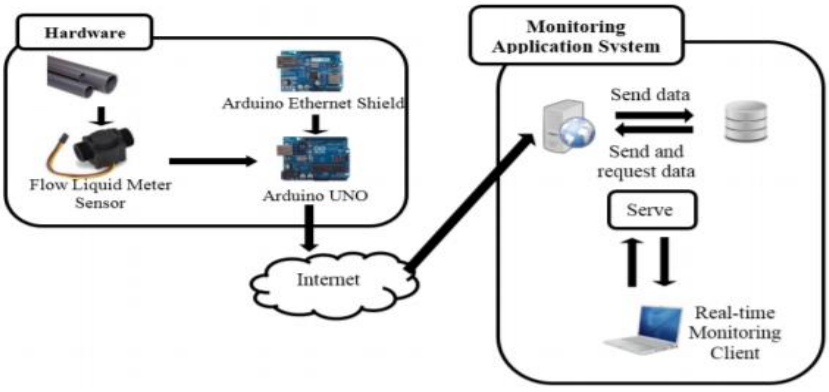

Figure 1. General System Architecture

Figure 1 shows the general system architecture which indicates that the server and hardware components are connected through internet.Arduino Uno board is connected with flow sensors and GSM module. This assembly is connected with server through the internet. Figure 2 shows block diagram of the system which shows that flow sensors are mounted on the both sides of pipes to take readings.The readings taken from flow sensors are then fed to the Arduino Uno board for

comparison. According to that signal is sent to the server about leakage is there or not. Programming of Arduino Uno board can be done in Embedded C language and programming at server side can be done in python language.

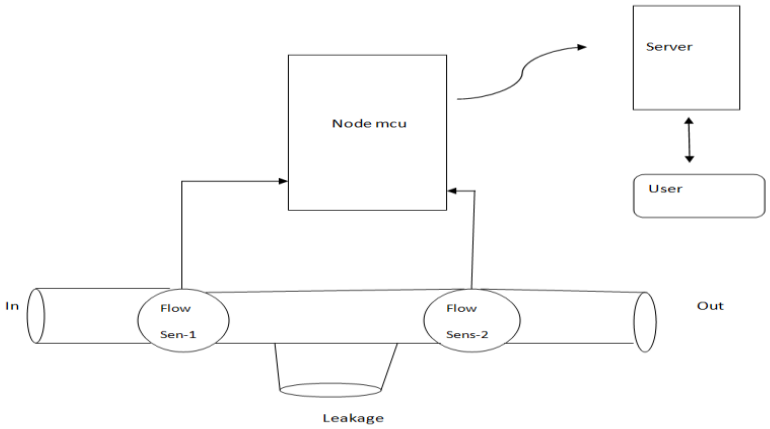

Figure 2. Block diagram of Pipeline leakage detection system

2. LITERATURE SURVEY

This section provides a brief overview of the existing survey works in Pipeline leakage detection system using WSN, magnetic induction method, fiber optics method, acoustic system sensor hoses, flow monitoring method, transient based method etc.

K. Rehman, Faiza Nawaz [1] focused on identification in pipeline structure which is most of the time primary reason for damage of pipes and leakage in it. In petroleum industry this damage costs human lives and destruction of nature and property. Used technologies are Wireless Sensor Network (WSN), magnetic induction based WSN. Results states that Wireless Sensor Network (WSN) provides cost efficient technique to keep track on liquid flow and requires less power for its operation. Magnetic induction based monitoring can be used inside and outside of pipes but implementation is difficult.

Lawrence Boaz, S. Kaijage, Ramadhani S. Sinde[2] involved in the field of delay in detecting leaks. They also mentioned its effects such as damage of structure and property, lives of people and valuable materials in accidental burnings in case of leak in gas pipelines. They also included causes and bad effects on environment due to leakage of pollutant gases. Paper discusses that how badly all these things affects an environment. This paper involves usage various techniques such as fiber optic cable system, acoustic system sensor hoses, video monitoring, magnetic induction method etc to compare performance with each other. Paper gives results of detecting the leakage in pipeline as well as location where the leak has occurred. Comparison between different techniquesand their performance has also included in it. From results it's clear that external leak detection methods are time consuming and methods which uses pressure measurement can detect large leaks at fast rate.

K. B. Adedeji, Y. Hamam, B. T. Abe, and A. M. Abu-Mahfouz [3] discussed finding out the leaks and estimating algorithm for decrement of loss in water flowing through the pipeline. They focused on multiple techniques to detect leakage in pipeline from inside as well as from outside of the pipe. Externally based methods were Acoustic Emission, Fiber optics sensing method, Gas injection method, Magnetic injection method etc. Internally based methods were Balancing method, Flow monitoring method, Transient based method, Signal processing method etc. Results says that internally based methods have good accuracy, low cost but response time and false alarming rate is big issue.

Summary : It can be concluded that leakage detection can be done using various methods and each method has its own merits and demerits. More efficient, accurate, cheap and rapid technology is needed. IoT can fulfill all these requirements which we will be discussing in this paper. Moreover this paper involves technique to shut off the water flow in case of leakage and sending signal to the server about location of leakage. This will give new higher edge to the leak detection system.

3. AIM AND OBJECTIVES

Problem Statement : To come up with solution to detect leakage in pipeline and exact location of leakage with proper shut off technique in case of leakage.

Aim :

- To study the Pipeline leakage detection system.

Objectives:

- To keep track on the flow of water and keep recording data about how much water is passing between two ends of pipe. Also stopping the flow of waterin case of leakage.
- To send the location of leakage to concerned authorities and keep record of water flow and leakage.

4. METHODOLOGY

The system consists of Arduino, flow sensors, solenoid valve, GSM Module, dashboard etc. Dashboard shows the real time scenario of the pipeline connection throughout the network. Therefore, it is easy for authority to monitor the pipeline network on dashboard. Readings are taken from the flow meters which are installed on the both ends of the pipes. These readings are then fed to the Arduino which compares these both values. If the readings from both these flow sensors issame then its concluded that there is no leakage in between the pipeline and hence same amount of water is passing through both flow sensors. Therefore, flow of water will be continued and dashboard shows normal flow of water through the pipeline. If in case the reading of these two flow sensors is different then it can be concluded that there is a leakage in between pipeline. Solenoid valve will be activated to shut off the water flow immediately and message of leakage detection will be sent to the central server. Authority can see the location where the leakage occurred on the dashboard. Solenoid valve can be opened once the leakage problem is fixed.

A] Components used :

- **Arduino Uno :** It is a micro controller board having inbuilt 8-bit ATmega328P microcontroller. It is for interfacing with flow sensors, GSM module and solenoid valve.

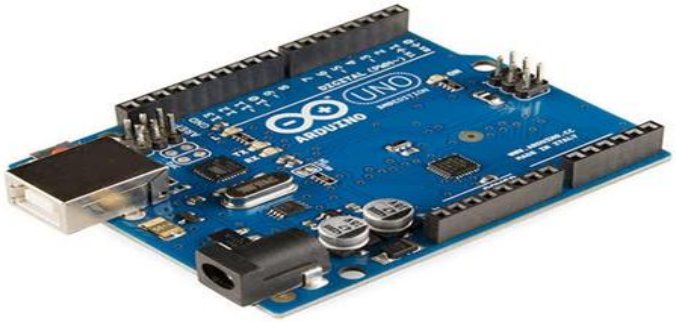

Figure 3. Arduino UNO Board

- **Flow sensor :** The Flow Sensor is a sensor which can be used to measure flow of liquid or gas through it. This sensor uses Hall effect and it has inbuilt rotor, Hall effect sensor and connection between it.

Figure 4. Flow sensor

- **GSM Module :** The GSM module communicates with the microcontroller.GSM is a mobile communication modem which stands for Global System for Mobile communication.

Figure 5. GSM Module

B] Software used :

- **Internet of Things (IoT) :** IoT stands for Internet of Things. It is nothing but the interconnection of components, devices, sensors etc which are embedded with electronics, software, and network connectivity which enables these objects to connect and exchange data. In this system IoT allows sensors to get connected & controlled remotely across existing network.

- **Python :** Python is popular as well as powerful programming language. In this system we will be using python 3.6 version. In machine learning Support Vector Machine (SVM) algorithm is used which is supervised learning model.

C] Flowchart :

Figure 6 shows flowchart in which step by step actions are mentioned.

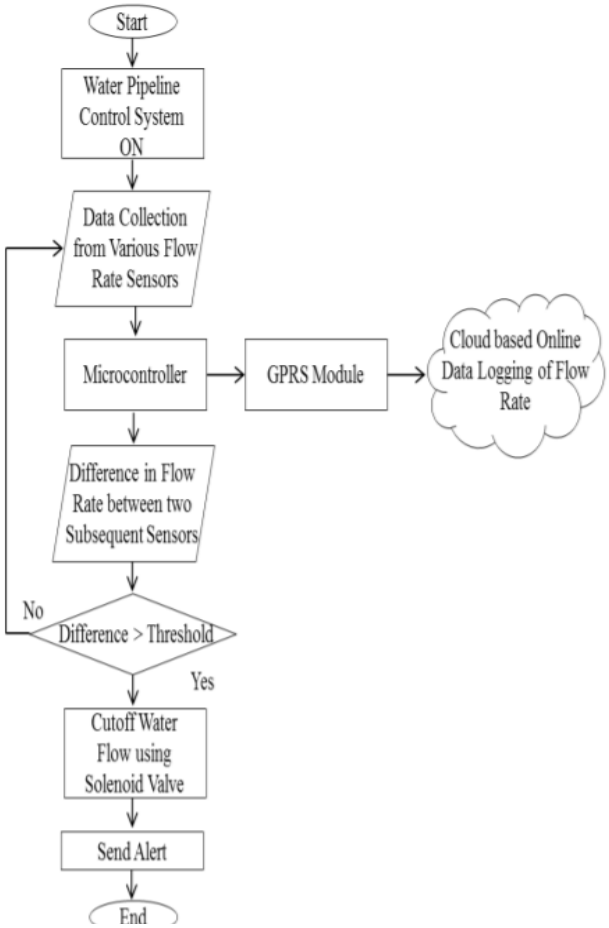

Figure 6. Flowchart

D] Algorithm :

Step 1 : Start

Step 2 : Water Pipeline Control System is on

Step 3 : Data collection from various flow rate Sensors

Step 4 : Microcontroller check difference in flow rate between two subsequent sensors

Step 5 : If difference > threshold yes cutoff water flow using solenoid valve else again Microcontroller check difference in flow rate between two subsequent sensors.

Step 6 : Send Alert

Step 7 : Stop

5. RESULTS

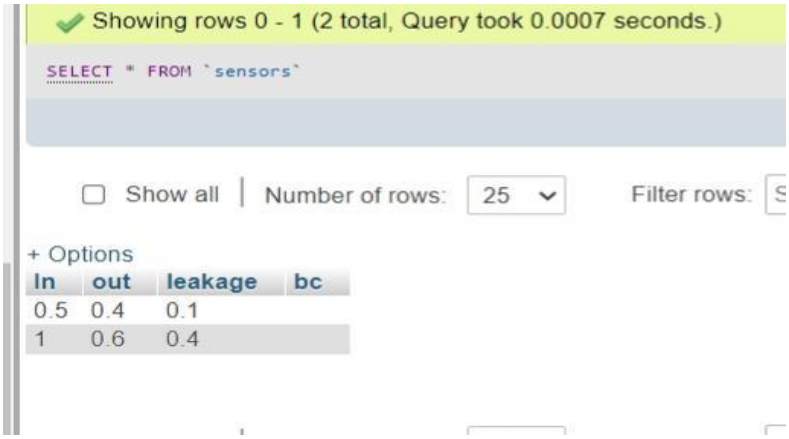

Figure 7. Dashboard

Figure 7 shows results displayed on output window. 1st case shows that inlet sensor recorded 0.5 litres amount of water passed through it and outlet sensor recorded 0.4 litres amount of water passed through it. Means there is leakage of 0.1 litre of water in the pipeline. Similarly 2nd case shows 0.4 litres of leakage in the pipeline.

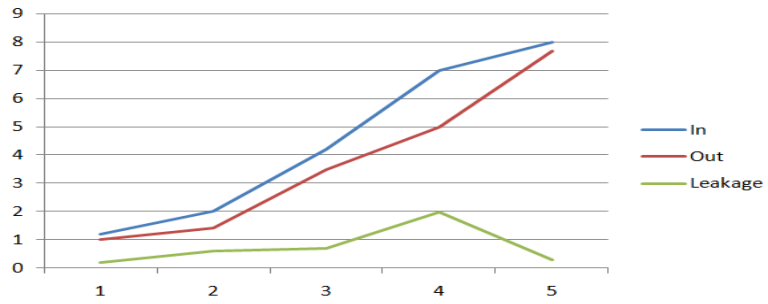

Figure 8. Graph of Inlet, Outlet and leakage

Figure 8 shows graphical representation of the flow recorded at Inlet and outlet sensor to show the recorded leakage.Result shows that system can detect the leakage in pipeline when the difference between inlet and outlet flow sensor is greater than threshold value.

CONCLUSION

Flow of water can be stopped by the system when the leakage is detected between pipeline. Location of leakage can be detected too which saves time so that leakage problem can be fixed at the earliest and transportation of water could be initiated again. GSM network, dashboard and other sensors helps to keep track on water flow through pipeline which shows real time water flow through the pipelines.

Accuracy and false leakage detection depends upon the value of threshold. The system shows 40-50 % accuracy for lower threshold value and 50-60 % for higher threshold value. False leakage detection is less for higher threshold value. That's why threshold value plays important role. Solenoid valve works properly as per it's triggering events and blocks the water flow as soon as leak is detected. System can be implemented in low cost and can give higher throughput.

FUTURE SCOPE

This system will be useful in water management. All the readings taken by the flow sensor data will be stored as data which will tell how much amount of water is passing through specific pipeline. Depending upon this data estimation can be made that specific region of city has specific amount of water requirement. So, each region will be provided water supply according to its need resulting less wastage of water. Those region which requires large amount of water such as villages can get their need fulfilled.

This system can be used for building of smart City where every node of city can be considered under the network of such system. This will result in prevention of water wastage at great extent

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