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STUDY OF ML ALGORITHM IN SMART DRINKING WATER MANAGEMENTSYSTEM FOR PREDICTING WATER LEAKAGE IN PIPE

Rojina Shakya and Gajendra Sharma
Department of Computer Science & Engineering Kathmandu University, Dhulikhel, Kavre

Abstract: Water is the elixir of life which is a transparent, tasteless, odorless, nearly colorless chemical and inseparable element of every living creatures. Being the second richest country in the water resources, it is actually the matter of melancholy that Nepalese are facing the problem of scarcity of water in the highest degree. Thus, the water should be managed in a felicitous way by adopting the smart technology where the implementation of IoT must be followed by ML so that the prior detection of possible damages in the water pipes can be determined. In this paper, we propose a smart water management model where the integration of internet of things is done with the ML Algorithms for identifying the possibility of break down in water pipes by analyzing all the data sets obtained from the information of pipe.

Keywords: Smart Water Management, Internet of things, Machine Learning

Introduction

According to (IWRA, 2018), Smart Water Management (SWM) is a system which uses information and Communication Technology (ICT) and real-time data and responses as an elemental part of the solution for water management challenges. The use of smart technology in water management gives the information about water quality, water quantity, leaks, pressure, flow and much more. By using various infrastructure such as sensors, smart meters, monitors, GIS and satellite mapping and other data sharing tools to water management, real-time solutions can be implemented which helps to reduce current water leakage problems.

Olga Martyusheva, 2014 discussedvarious existing water infrastructure monitoring methods till now. Those methods are: Automated Meter Reading (AMR), Advanced MeteringInfrastructure (AMI), Supervisory Control and Data Acquisition (SCADA) which are all his own idea.

The development of smart grids is one of the remarkable previous attempts that have been done for the smart water management system.Smart water grid consists of a two-way real time network with field sensors, measurement and control devices that remotely and continuously monitor and diagnose problems in the water system. Smart water meters can monitor some key parameters such as flow,

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pressure, temperature, quality, consumption, and energy usage.

Similarly, the use of smart pipes and sensor networks, implementation of the cloud computing in this field as mentioned in the Smart Water Management in Cities, (2012) are also the additional previous attempts that have been done for the smart water management system.Smart pipes incorporate multifunctional sensors that can sense strain,temperature and pressure anomalies as well as measure water flow and qualityduring service to provide operators with continuous monitoring and inspectionfeatures, while assuring safer water supply distribution. And the Cloud computing uses an external computing power ability which is outside the boundary of a user's own infrastructure to run programs or applications. Cloud environments typically enable the following functionalities: monitor and manage computing without human involvement, broad network access to allow computing services to be delivered, access over several networks and heterogeneous devices, technologic ability to scale up or down computational resources swiftly and as needed, ability to share across multiple applications, as well as to track applications/tenants for billing purposes.

(Michele Romano and Zoran Kapelan, 2014) in their paper present a novel methodology to perform adaptive Water Demand Forecasting (WDF) for upto 24 hrs ahead with the aim to support near real-time operational management of smart Water DistributionSystems (WDSs) which is one of the remarkable steps attempted by using ANN (Artificial Neural Network).

While drilling down to the current status of the water management system in Nepal, we are not introduced to any of those technologies except SCADA. SCADA has just been introduced in few cities. Supervisory Control and Data Acquisition (SCADA) is a computer-controlled system that helps to monitor and control processes. SCADA systems acquire information from remote devices such as pumps, valves, transmitters, and others. The Host software system can communicate and control these devices remotely. SCADA Host platform are equipped with displays, alarms, and can store received information (Schneider Electric, 2012). SCADA systems are commonly used in industrial processes such as manufacturing, transportation, energy management, building automation, and other fields where real time operational data can be used to make decisions.

The water leakage is one of the main reasons behind the scantiness of drinking water which further result in the bursting if the timely detection is lacked. So, this problem should be mitigated as soon as possible for the efficient drinking water supply. One of the primary solutions is to minimize the time prior to and of awareness and location. This proactive step can be the best solution for controlling the leakage by being alerted to future faults that might occur. As a solution, as there is SCADA system already introduced in Nepal, this System can be advanced and improved by implementing ML (Machine Learning) and IoT (Internet of things) for getting prior information related to possibility of the water pipe damages. The various features like: Distance from the origin, pipe age, height of water pipe from ground level, number of breaks nearby, installation year, heavy flow and soft flow of water, hard water

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and soft water, number of breaks nearby, type of soil, etc. should be fed into the system. The proposed methodology shows the implementation of the system in the specificplace where the feature extraction is done from all the related water supply data. Here, the best classifier modelamong the SVM, Decision Tree and Random Forest is chosen for knowing the result about the chances of any break down to be occurred. So, the decision tree is chosen as it contains many conditional control statements and the data split as per certain parameter.

Methodology

This section covers the steps performed in order to conduct the research. The process is a series as listed below:

Step 1: Gap analysis and defining objectives
Step 2: Data collection and preprocessing
Step 3: Model preparation
Step 4: Evaluation and analysis of results

Step 1: Gap analysis and defining objectives

The present status of Nepal in the water management system is low.

The SCADA system also has just been introduced in some of the places of Nepal like:makwanpur,karyamukraas said by the immediate past president of SOPHEN (Society of public Health Engineers Nepal)in one day workshop on Smart Water Management on date 21st feb,2019). Even being the richest in the water resources but due to the lack of proper utilization and technologies we are facing the scarcity of drinking water. The leakage of water during the distribution from source to the destination is also one of the main reasons behind the scarcity of drinking water. Recently, there has been growing interest in the smart water management system and are concerned about how to solve the water leakage problem. Thus, we propose a smart water management system which is used for the prior water leakage.

Step 2: Data collection and preprocessing

First of all, we select the place khopasi which lies in thepanauti municipality for the sample data collection as this is one of the places highly affected by the water leakage problem. Then, the required information related to the specific water pipes are collected. For the data collection, we contacted the water management personnel of this place, Mr. UttamUlak.The various information related to the pipecollected are:

I. Distance from the origin
II. What type of water flows?
III. Age of Pipe
IV. Height from the origin
V. What is the material of pipe?
VI. How many connections are there nearby?
VII. What is the speed of water flow?
VIII. What is the installation year?
IX. What type of road is it?
X. What type of soil?
XI. What is the traffic status of the road?

The table I shows the various data related to the information of water pipe of khopasi. Each roman number in the table represents the question as mentioned above.

Table I: Table showing all the information related to water pipe

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S.N.	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
1	1km	Hard	50yrs	100m	plastic	3	100m/sec	2045	Gravel	Alluvial	Busy
2	1km	Hard	50yrs	80m	plastic	1	880m/sec	2045	Gravel	Alluvial	Busy
3	3km	Hard	50yrs	40m	plastic	1	750m/sec	2045	Bituminous	Sandy Gravel	Free
4	5km	Hard	80yrs	20m	plastic	1	100m/sec	2045	Gravel	Sandy Gravel	Free

Once, these data are collected, then it is stored and fed into the system and the features are extracted from the data. The features which have been extracted are used to manage and group them into the specific type about the condition of the water pipe.

Step 3: Model preparation

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After then, the prediction is done by the help of decision tree algorithm. As mentioned above, first of all the data related to pipe is collected and are fed into the system. The features are extracted from the data which is fed into the system and by the help of decision tree algorithm, the water leakage prediction is done. The proposed system for predicting the water pipe break down is shown in fig I

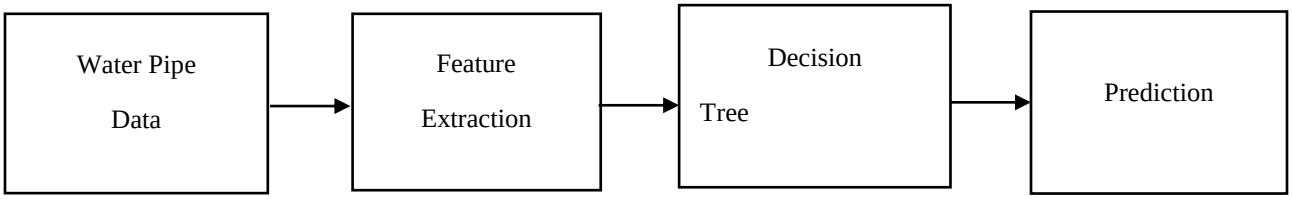

Fig I: The proposed system for Break down prediction

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Step 4: Evaluation and analysis of results

The evaluation and analysis of result is still need to be carried out completely. Here, the prediction is done but the evaluation and analysis will take some time as this is the matter of uncertainty.

From the above data I, it is predicted that there is higher chance of having breakdown soon in the coming days. As the road is of gravel type with heavy traffic having alluvial soil and numerous of connections nearby. But the remaining data II, III and IV are somewhat in the safe zone in comparision to the data I.

Discussion

Thus, the proposed smart water management system contains machine learning algorithms to identify the pattern by inserting all the data from past and present scenario. After then, finding the most similar scenarios alreadymanaged in the past and apply a multi-criteria analysis to evaluate similar operational scenarios and predict the possibility of breakdown.

Conclusion

The concept of Smart water management system is being taken seriously as it has become the necessity in todays time. This research by studying the machine learning algorithm in the field of water leakage detection will surely be the great help for the water management system in the near future as even the single drop of water is the blessing during the time of scarceness. As the saying, prevention is better than cure, the early prediction of the damage help to get rid of the problems that we might encounter in future.

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