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A Survey on Leaks and Faults Detection & Diagonsis in Water Supply System

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Abstract

The various approaches on leakage detection & diagnosis in water supply System are discussed and also propose a novel approach for analysis and solving the problems. The methods adapted here are develop schema for datasets, collecting data from thousands of hall sensors based on second billing, organization of these big data sets. After the proper analysis of data set, conclude with the best approaches. To enhance the techniques for leak detection and diagnosis, look into innovative methods that could make the leak exposure surveys more effective.

Keywords:

Leaks Detection;
Faults Diagonsis;
Water Supply;
Optimal;
Survey approache.

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1. Introduction

Water is one of the most important substances on earth. All plants and animals must have water to survive. If there was no water there would be no life on earth. Most of the civilizations are formed by the availability of water sources like Sindhu and Harappa nation. In our Indian tradition and culture art forms like Oggu Katha, Thamburra Katha and janapadha folk stories of Telangana state, and these activities started with the keerthana of the god Ganga Devi (head of the water) by the folk artist. On the other hand, the human body consisting of 75 percent of water, it is evidently clear that water is one of the prime elements responsible for life on earth. Water circulates through the land just as it goes through the human body, transporting, dissolving, replenishing nutrients and organic matter while carrying away waste material. Further, in the human body, it regulates the activities of fluids, cells, lymph, tissues blood and glandular secretions. An average adult body had 42 liters of water and they feel dehydration with just a small loss of 2.7 liters.

Water management policies of Indian government: Indian national Water Policy is formulated by the Ministry of Water Resources of the government to planning and expansion of water

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resources and their optimum utilization. The first Indian National Water Policy was adopted in September 1987 and it was reviewed and rationalized in 2002 and later in 2012. India accounts for 15% of the world residents and about 4% of the world's water resources. The major provisions under the Indian national water policy are: Envisages establishing a standardized national information system with a network of data banks and data sets, Resource planning and recycling for providing maximum availability, Guidelines for the safety of storage water dams and other water-related structures. The main importance of National Water Policy 2012 is to treat water as economic good which the national ministry claims to promote its conservation and competent use. This stipulation proposed for the privatization of water-delivery services is being criticized from various quarters. The major features are that to ensure access to a minimum quantity of potable water for essential health and sanitation to all citizens, available within easy reach of the household, setting up of water regulatory authority, to give statutory powers to water users associations to maintain the distribution system. The critics are the paradigm shift in approach from the service provider of water to facilitator of service.

Water distribution networks (WDN) supply people and factories with water. During operation, such systems are exposed to uncontrolled leakages of differing intensity and location. There are many causes of such leakages such as the natural process of wear, corrosion of the inner and outer surface of pipes, mechanical damage of pipes caused by excessive loads, assembling errors, seasonal temperature changes, movements of a subsoil, aging infrastructure and material defects of pipes. The most severe result of leakages is an economical loss. Water loss depends on the technical standards of the pipeline and can approach 3-7% of total water consumption in case of developed countries until 50% of consumption in the developing countries. [1] On the other hand, there exists direct danger to people as a result of water pollution by contaminations that penetrate into the pipeline while it operates by reduced working pressure. [2] Therefore, there is a constant need to develop methodologies for detecting and localizing leakages occurring in the water supply networks.

Undetected leaks in water distribution networks are a significant problem both economically and environmentally. For instance, Across Australia, 12% of water is estimated to be lost through leaks and the annual cost to water utilities worldwide is US$14 billion.[3] A sensor net that measures water flow in the pipes can be used to predict the position and size of leaks. Recent advances in sensor knowledge and lesser costs mean that large-scale sensor networks may rapidly be a trade and industry choice for solving the leak recognition problem.

The World Bank estimates that the worldwide water-loss volume amounts to 48.6 billion m3/year, with a monetary loss of approximately 14.6 billion US dollars per year.[4] Most of such losses are due to leakage in the water distribution systems; therefore, for an effective water management, the individuation of leaks & faults are extremely important for the optimization and rationalization of water resources. However, the techniques and methodologies adopted for it, despite being universally accepted, are extremely time-consuming and require highly-experienced personnel and unreliable & ineffective when the measurements are not performed in specific operating conditions of the pipe (e.g., high water pressure).

2. Survey Details

The summarization of this paper is that the Novel method uses smart water meter data to formulate daily water demand profiles. Individual end-use demand profiles used to build various water consumption patterns. They derived demand profiles and peaking factors lower than those used by the water utility. In this paper they taken the parameters like humidity, temperature, pressure, sound detection and flow rate detection around leakage areas are detected using sensors and Arduino microcontroller. The sensed data is acquired and posted via ZigBee and processed over GUI webpage.[5]

They explained about Water leak detection systems, A specialist service applicable to sensitive areas and important buildings. They provide early warning of leaks and thus help to prevent damage to equipment and buildings.[6]

RF internodes communication among the smart meters is proposed and sensor interfacing is implemented in this system. The advantage of this system is that a smart meter node in the network generates the power required for its operation within the node. [7] The Conclusion of this paper is that the real-time continuous monitoring of water supply could identify water leakage, water theft in the entire water supply distribution network. They have developed (Aqua sense) Smart Water meter as an Internet net of Things (IoT) solution using LPWAN technologies. They monitor the water quantity and flow rate using a hall sensor, built with RF communication system. The smart meter is supported by a self-generating power unit developed using the pipe water flow. Their system architecture enables continuous centralized streaming of sensor data, processing and visualization by the web application. In the next phase, they would extend to increase the number of nodes in the sensor network from 10 to 100000. Their intention to invent on-node event detection and localization algorithms for pipe bursts and leaks, in-pipe water quality measurements system.

The deployment of multi-parameter sensors to monitor water distribution pipeline networks operational activities. They are not only responding to the change of operational pattern to produce data, they also embed with computing and communication capabilities.[8] It allows vast amount of data to be collected, analyzed, and acted upon in the shortest periods of time. These systems are able to store, process locally and transfer data they produce to the water utility company's main database. it explore the latent future uses of operational water distribution pipeline database in view of the current limited use by highlighting the immediate opportunities like monitor and identify anomalies and optimize water utility.

They conclude that the Water distribution operational data has always been the benchmark for effective decisions making process. The development and implementation of geographic information system (GIS) technology, supervisory control and data acquisition (SCADA), and smart AMR by water utility industries, with widespread deployment of multi-parameter sensors to monitor operational activities allows tremendous amount of data to be collected, analyzed, and acted upon in the shortest periods of time allows water utility companies to save water, time, money and energy. The basic implication of this study is to transfer knowledge among water utility professionals, by prominence the potential future pioneering applications of municipal water supply database for decision support or other data related IOT innovations that improve important outcomes across diverse practice settings of water supply system asset organization or any other operational or planning activities.

It presents a sensor network intend method that generates human-readable rules for leak detection and diagnosis. Additionally, for a given network and range of operating scenarios, it discovers the best locations for flow sensors. The method is demonstrated to make acceptably accurate predictions under real-world conditions of uncertain measurements. It also allows trade-offs to be made between minimizing the costs of installing and maintaining sensors and maximizing prediction accuracy. For example, in some cases, sufficiently accurate predictions can be made using sensors on only half the pipes.

It deals with a tactic of detecting, localizing leakages and diagnosis in water distribution networks. They used two approaches are the hydraulic model of the network and approximate models and fuzzy classifiers. [9]

They presented the characterization of an aural wireless sensor for leakage detection in underground pipes is presented. The sensor is based on an acoustic sensing element, called a hydrophone, which senses the noise inside the pipe. The sensor sends the sensed signals wirelessly to a gateway which is located on the ground. The gateway, in turn, relays these signals to a backend server for further processing. For concept-proofing, a novel experimental test-bed has been designed and realized in a water supply facility in Turin, Italy. In this paper, this test-bed is used to characterize the capability of the hydrophone of water leakage detection under high water pressure and under various leakage locations and volumes.[10] On this basis, in this paper, a time domain reflectometry (TDR)-based system for the non-invasive detection of leaks in underground metal pipes is presented. Not only does the adoption of the developed system leads to accurately pinpoint the leak, but it also allow to dramatically reducing the required inspection times. The proposed system is validated through an experimental campaign that consisted in carrying out a leak-detection survey through the traditional methods and through the proposed method like a strategy for enhancing the accuracy in pinpointing the leak is addressed.

3. Results and Analysis

In this phase, we will explain how to push sensor data over the network to your database, and display it on the webpage. We can connect Arduino to our network either Wi-Fi or through a network (UTP) cable by using Arduino "shields". We need Arduino, Ethernet shield, hall sensor, jumper wires, network cable and water pipe test bed etc. In online website hosting, Google web hosting provides our needs with the support of PHP XAMP and MySQL database. The steps are Connect Arduino to your local network, Prepare the database, Create files that will capture data sent from Arduino and write it to the database, if the whole thing worked fine you can find records in your database.

PHP code snippet for strong sensor values in the database.

```
<?php
  // Prepare variables for database connection
  $dbusername = "arduino";
  $dbpassword = "arduinotest";
  $server = "localhost" or "www.scce.ac.in";
  // Connect to your database
  $dbconnect = mysql_pconnect($server, $dbusername, $dbpassword);
  $dbselect = mysql_select_db("test",$dbconnect);
  // Prepare the SQL statement
  $sql = "INSERT INTO test.sensor (value) VALUES ('".$_GET["value"]."')";
  // Execute SQL statement
  mysql_query($sql);
?>
```

Arduino code snippet for strong sensor values in database.

```
// Initialize the Ethernet server library
EthernetClient client;
void setup() {
 // Serial.begin starts the serial connection between computer and Arduino
 Serial.begin(9600);
```

```
    // start the Ethernet connection
   Ethernet.begin(mac, ip);
 }
 void loop() {
 // Fill the sensorReading with the information from sensor Connect to the server
   if (client.connect(server, 80)) {
     client.print("GET /write_data.php?"); // This
 //read data from sensor and store in database
     client.println(" HTTP/1.1"); // Part of the GET request
     client.println("Host: scce.ac.in");
     client.println("Connection: close");
     client.stop();    // Closing connection to server
   }

   else {
       Serial.println("--> connection failed\n");
   }
      delay(1000);   //1 second wait
 } //loop close
```

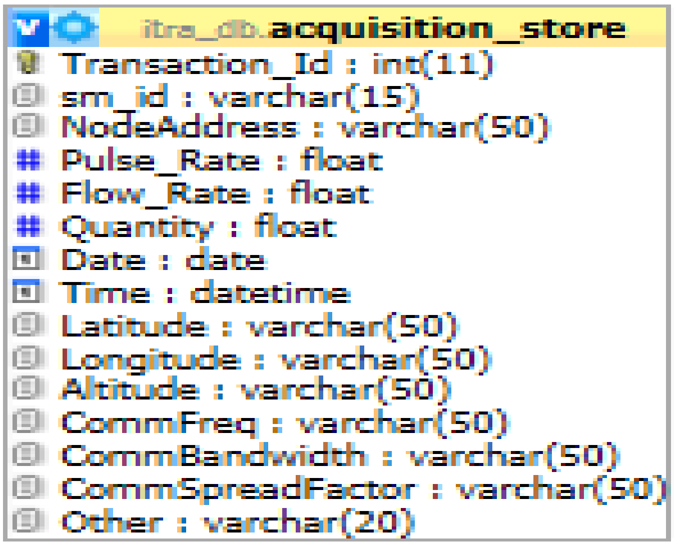

Figure 1: Schema of acuisition store data set

The transaction id is the first attribute of the dataset, used to uniquely determine the record, every time it is incremented by 1 if a new record is inserted. Sm_id is the filed for smart meter identity. Node address is the ipv4 address of smart meter. Pulse rate and flow rates are the fields to know the water quantity moving form that pipeline. Data and time fields are used for the timestamp. Latitude and longitude fields are used for identifying smart meter location and the filed altitude to find out the height of that machine. The fields common frequency, common bandwidth, common spread factor are used to know load on the network. The common fields for a particular node are longitude, latitude and altitude, the varying fields like pulse rate, flow rate, quantity and other.

Assume for huge network of smart meter nodes are delyed in real time system,then the system can generate big data, Storing & analyzing of this big data is complicated issue. Some of the common database technologies are used to interpret it. Mission-critical transactions are a center part of almost all environments; It allows you to connect to a wide variety of Relational Database Management Systems (RDBMS) packages such as MySQL, PostgresSQL, SQLite, Microsoft SQL Server, Oracle, IBM DB2, Teradata, Azure SQL Database and Azure SQL Server. And also it connects to a wide range of analytic databases, allowing users to easily answer questions against large or complex data sets. Some of these include: HPE Vertica, Greenplum, Amazon Redshift, SAP HANA, Teradata, Netezza. Progressively businesses require data stores that can quickly ingest high volume data and accommodate flexible data structures. It helps you connect to common NoSQL databases, such as: Cassandra, MongoDB, Apache HBase, CouchDB. It empowers users to consume, merge and analyze diverse data at scale with Hadoop – all without writing a line of code, works with a wide variety of Hadoop distributions and components, including: Cloudera, Hortonworks, MapR, Amazon EMR, Microsoft Azure HDInsight, Hive, Impala and Apache Spark.

4. Conclusion & Future Enhancement

As I mentioned in the introduction, by the running of application on 30 seconds with 10 nodes (smart meters), it will generate 300 records; approximately the memory requirement of this is 34.4kb. Assume the 100000 smart meter nodes are used in real time system. Then the system can generate one lack records per second, Storing & analyzing of these many records are a very tedious job. Using modern big data techniques hive and hadoop are useful to sovle this big data issues and applying stream mining techniques on this data set, we can predict fault detection and diagnois in under ground water pipe line system.

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