Design and Development of Smart Portable System for Underground Pipeline Leakage Monitoring Based on IoT

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Abstract. Water is arguably the world's most important resource. Enormous water is lost around the world due to leakages of water pipelines. Wisely wasting water should be stopped in order to exploit this advantage. This article suggests a safer approach in which the pipeline controls pressure, and the leaking of the pipeline is observed. Observatory package with Raspberry Pi and a water quality sensor pair are connected throughout the pipeline. Continuously uploads the sensor data to the cloud server. If the pressure is below the specified threshold and the processor sends the warning message to the workers concerned amid persistent stress, the water quality disrupts. In order to post to the server, we need Internet access. However, warning messages can also be sent via SMS services that operate with the GPRS in the absence of the internet. This article further clarifies tentative steps to minimize leakage. The flow of water through the valves located at the link between the pipelines is supplied and controlled. The control valve location is controlled to mitigate water loss due to the leakage generators so that water flow is decreased into the same pipeline resulting in lower water loss.

Keywords: leakage detection, IoT, pressure sensors, Cloud computing, quality sensor.

1. Introduction
Oil and gas were still a central component and a critical factor in the country's growth, which focused on tracking the oil and gas pipeline [1]. Future water shortages were, however, still ignored. Much water pollution is because no significant measures have been taken to avoid water depletion worldwide. Few nations, such as China, Germany, the United Kingdom and the USA have been using various strategies and channels to avoid water leakage [2]. Based on the pipeline network’s completeness, acceptable control approaches would be preferred for the environmental conditions across the pipeline and sources of particular errors related to weather conditions [3]. In Mumbai, on either side of the pipeline, there are approximately 2,000 slum settlements, 90% illegal. The municipal corporation in Brihanmumbai annually suffers from water diversion and illicit links damages for Rs 400 crore. In Mumbai, too, some accidents happened when the pipeline dropped because of poor old pipeline conditions. Thane Municipal
Corporation named manual supervision of the pipeline network due to large water leakage levels and tampering in the BMC pipeline [4-5]. However, the lack of water continues due to eventual manual errors which eventually lead to a shortage of water supply and thus frequent water cuts with low-pressure water supply. The proposal recommends quick and cost-effective pipeline surveillance. It not only tracks but advises the workers concerned about the estimated location of the leakage via SMS. The requisite and preliminary measure is needed when water pressure falls below the desired value [6]. This article also proposes locating the break in the pipeline with a compact device, consisting of a transmitter and receptor for acoustic or radio waves. The beep sound will be pumped as the gap's precise location on the pipeline is detected [7-8].

2. Literature Review

Many various pipeline control methods and platforms have been identified. Leakage is typically observed primarily by acoustic sensors using these equipment, sensors and sensing components (such as piezoelectric materials) using either a microphone or a geophone [9]. In this article, gateways are also used for further processing of the sound obtained from acoustic sensors. FFT is one of the encoding methods for sound or water noise [10]. It analyses the contrast between normal and irregular sound when there has been a leakage. Some methods are based on microprocessor ARM M4, while PIC is used to capture the acoustic sensor's output. However, only small diameter pipelines of 2-3 bar pressure are ideal for acoustic applications. Many other approaches, other than acoustic sensors, have been addressed. There are also tracer gas techniques and thermography. The leakage can be defined based on Time Domain Reflectometry (TDR), which requires high precision calculation, high flexibility and robustness, relatively low costs for deployment and the probability of continuous automatic remote measuring in real-time [11-12].

Some analysis is based on TDR but uses electromagnetic signal application and reflection. The reflective coefficient is measured in proportion to the pipeline flow gap. The transmission line, i.e. metallic cable, is positioned on a path allowing electromagnetic pulse to travel through the ground and from the pipe surface reflected [13]. Some methods have used this tool to detect the leak and the volume of wastewater and uses GPR, but waves are captured and digitized, and B-Scan subsequently creates the pictures. A 3-step method has been developed to analyze these B scan images. Suggests for crack photos a predictive screen. It explains the actions of a crack detector dependent on image analysis in detail. Visual checks or CCTV videotape are used to take pictures and discuss double-island structure sensor theoretical study. Detailed analysis is made of the location for resistance values and width of resistors. The piezoresistive micro-pressure system's strain diaphragm uses a FEM process, and software analysis, static and dynamic analysis and computer simulation are done. The Explorer is a 4-wheeled camera with piping robotics that uses smartball[14]. Both water flow in the pipe senses a crack that leads to leakage with Wireless Networked Sensors. ZigBee technology provides efficient connectivity. PIG (Pipeline Inspection Gauge) method based on vision is used for the creation of pictures. The vibration sensor and widespread intercorrelation technique are used for this technique. The system uses an adjusted prefilter with regularisation factor (ML) and a better method to predict the time gap for all pipeline types [15].

3. Proposed System

Below Figure 1 shows the block diagram of the system.

This project proposes an easy way to track the pipeline, identify leaks and cracks as seen in fig. 1. The pipeline pressure will be felt continually by the pressure sensor. A processor which compares the sensor performance with the expected water pressure is provided with sensed data.
In order to retain the required pressure in the pipeline, the analogy has to be performed continuously. This live data is constantly updated on the cloud network (sensor output). As a result, manual control can be stopped in very remote locations. ThingSpeak is a cloud network supported by MATLAB applications, capturing data on private channels such as sensors. It can exchange information via the IoT platform on public channels. The fascinating thing about Cloud is that it can even examine the data obtained without Matlablicencing. If the sensor and the water’s consistency, i.e. the sensor output is not according to the desired value, the controller takes action. GSM900A, attached to the raspberry pi, also transmits a warning message (SMS) to workers situated far from the water pipe. In SMS, the leakage is registered as the closest processor can send the SMS. Each GSM900A has a different raspberry pi3B model interfaced.

SMS are sent through a GPRS network to show the sensor output and the raspberry kit's IP address indicating the estimated leak location. The precise location of the leakage can be calculated to establish a moderate spacing between two observatory kits. Two lines are prominently used for water supply. Feeder and distributive line. Feeder line. A water supply valve is mounted at each cross-section of the pipeline system. The water flow from the feeder pipeline is manually balanced using a plunger to various dispersed pipelines. Once leakage has been detected, the water flow should be decreased in order to prevent further pollution. Dive can be rotated in this direction as one of the initial steps so that water pressure can be minimized progressively. Without manual interference, the nearest raspberry pi could rotate this plunger. Any excess water can be avoided before additional solutions are consistently implemented. Leakage will be detected and alerted by the nearest RPi to personnel via SMS. However, it is rolling down manually, without digging the portable and convenient kit, to determine the exact position of leaking (between two observatory kits). This collection will be the sensor that predicts precisely where the break in the pipeline was located.

4. Working
The suggested block diagram implies the automated detection of leakage, which is defined as a consequence of decreased water pressure and an increase in water impurity. The entire pipeline consists of the observatory kit, as shown in figure 1. The sensor flow alias pressures count the number of pulses per minute equal to water flow in litres per minute. These bursts include RPi counting and corresponding cloud readings. It also occurs that even in leaks and significant water depletion the pressures of the pipeline do not drop. Clean, purified water is mixed with impure water due to a minor crack on a pipeline, especially where the pipeline is surrounded by sewers or polluted water puddles, which holds...
the pipeline pressure as before. The turbidity count of the water in the Cloud will shed light on this water quality sensor benefit, which explicitly shows the pipeline's failure pollutes the water if the turbidity has risen.

In contrast, pressure sensor production stays unchanged. The GSM900A and the raspberry kit processors send an alarm in both cases via SMS. To prevent any water leakage, RPi will take tentative measures while the valve is shut down, which decreases the flow of water into the respective pipelines. Approximate leakage position and time can be identified in SMS sent to personnel. Since each RPi has its IP address, Cloud already knows how to find the RPi package with its IP address on its pipeline. The time or sum of leakage sensor data is loaded into the cloud server to analyze the location trend. This paper uses Mathwork's ThingSpeak operation. To minimize a leakage plunger liable of delivering water through the respective pipe so the water flow can be cut through the piping where the leakage has occurred.

The trend can be studied in future to take continuing steps against locations that sometimes occur leakage. Raspberry Pi receives input from a cloud network which displays the sensor depth graphically or pictorially. The Stepper motor, which is attached to the closest plunger, rotates with a large leakage RPi. The RPi can spin the stepper motor to decrease the dipper and lowers the supply of wastewater flowing into the same conduit. Cloud to RPi feedback is indirect. This paper would not recommend cloud analysis. However, if the valve position is set to the next level, the water pressure decreases but stabilizes steadily. The valve's position reduces supply flow. Therefore pressure sensors update this persistent low cloud pressure that means that the valve location is changed and other important measures have to be taken to mitigate the leak. The water source can only begin with the original pressure after the corrective solution is applied by manually changing the valve.

Furthermore, water supply is given to colonies in water scarcity for a fixed number of hours. The majority of the time, no water can flow into each pipeline. The processor can be configured according to this timetable. To determine the precise location of the crack mobile device that rolls over the concrete. The smartphone kit can detect the crack between the two points estimated by underground pressure sensors with the RPi Acoustic or electromagnetic sensors.

5. Results and Discussion

Not only is the water pressure sensor measuring the pressure constantly, but even the data are uploaded every 15 seconds on the CLOUD server. CLOUD can display the readings as a graph that provides a quicker idea of the condition. It is also able, in order to recognize most recurring leakage trends, to conduct data analyses. The leakage direction, which is useful in determining short or long term solutions, can be established from the sensor position. The prototype can only display two sensors, but virtually across the pipeline, more than one sensor can be placed along with RPi. Below Fig.2 shows the graph of the pipeline monitoring system.

The leak's direction will be calculated more precisely if the number of observatory points over the pipeline is expanded. The figure displays measurements taken by time mapped pressure sensor. Sensor output is changed by RPi kit on the cloud server every 15 seconds, which offers the concerned workers tremendous versatility, and can track readings from a distant area. The pictorial display makes the decrease in pressure easier to note. Pressure sensor data is currently only shown. If we expand the number of sensors in the pipeline, the numbers of graphs will rise. The relation to this cloud graphs also allows examining some of the trends for a certain position repeatedly leaks. If these areas are considered to have a permanent solution, further leakage can be prevented.
6. Conclusion
The GSM900A kit is used to alert the faculties in question. In ThingSpeak, live data, i.e., the performance of both sensors is modified. To minimize the loss of water due to the leakage, RPi will take the tentative action in advance. More than one package is installed around the pipeline, including Raspberry Pi, pressure sensor and consistency sensor to track each kit. One portable kit shall be built to calculate the leakage’s precise position between two observatory kits such that a ground crack or leakage can be determined without digging.

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