

WATER PIPELINE LEAKAGE DETECTION USING VIBRATION METHOD

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ABSTRACT

Water leakage is a common problem that often results in water waste, damages, and hazards to public health. Existing leak detection tools and methods typically rely only one sensor to detect and pinpoint leaks, therefore the leakage is not identified until the water has risen above the surface. This project addresses this shortcoming by developing a prototype system that is fed with multi-sensor fusion data from flow rate and pressure sensors and accelerometers. This project proposed a new method in detecting water pipeline leakage with vibration method using accelerometers in which it is low cost and can detect leakage correctly. The connections between both accelerometers and the laptop are through serial/wired communications. Results show that the prototype model can detect the leakage in the water pipeline system. However it has a distance range in which it can detect the leakage. This is the disadvantage of using this method which can be overcome in future research. Future development will focus on testing the prototype system with various parameters such as pipe diameter and materials in the real environment using wireless networks to transfer data between sensors and prototype model system.

ABSTRAK

Kebocoran paip adalah masalah yang sering dihadapi oleh masyarakat hari ini. Ini boleh mengakibatkan pembaziran air, kerosakan dan boleh menyumbang kepada masalah kesihatan masyarakat sekeliling. Terdapat banyak teknik dan alat mengesan kebocoran saluran paip air masa kini. Dalam tesis ini akan menerangkan dengan lebih lanjut teknik-teknik yang digunakan untuk mengesan kebocoran. Tujuan utama tesis ini adalah untuk mencuba, mengeksperimen dan mengkaji satu teknik baru iaitu teknik getaran untuk mengesan kebocoran saluran paip air. Alat utama yang akan digunakan untuk teknik ini adalah meter pecutan di mana teknik ini boleh mengesan kebocoran dengan kos yang rendah. Meter pecutan ini akan disambungkan ke komputer riba dengan sambungan secara berwayar atau bersiri. Keputusan daripada eksperimen projek ini menunjukkan bahawa teknik ini berupaya mengesan kebocoran saluran paip air tetapi mempunyai jarak yang terhad. Ini merupakan kelemahan bagi teknik ini tetapi boleh di atasi dengan kajian yang lebih mendalam di masa hadapan. Untuk kajian atau perkembangan masa hadapan, eskperimen demi eksperimen boleh dilakukan dari segi saiz paip, saiz lubang bocor, jenis paip dan eksperimen di saluran paip yang sebenarnya boleh dilakukan. Cara penyambungan and penghantaran data juga boleh diubah kepada tanpa wayar.

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CHAPTER 1

INTRODUCTION

1.1 Motivation

This research thesis is prepared as a requirement to complete Project 2 MSc Computer System Engineering. This work is beneficial in detecting leakage in the water pipeline network which is under Dr. Rudzidatul and Dr. Azurati's grant.

1.2 Project Background

This project is about a vibration method for detecting water pipe leakage. Pipeline leak detection in underground distribution water networks is a challenging research topic. The current techniques have some limitations in detecting leaks particularly with plastic pipes. The amount of treated water loss in Malaysia is estimated RM1.74 billion in the year of 2010. Apart from water service, the oil and gas industries are also suffering from severe leak problems [1]. Hence, developing new ideas for leak detection and localization are important to our country, Malaysia. This project involves the design and construction of a simple, but effective leak detection system based on sensing the high vibration in the vicinity of the leak. The project will be deployed at a lab experiment water pipeline setup and accelerometer sensors will be used to detect the leakage of the water pipelines.

1.3 Introduction

The clean water is important for the human being in the world and most country government will be give the best water service for their citizen in the country. The cost for water treatment process to produce the clean water for the people is very expensive. A leakage is an accidental release of liquid. Pipeline leakage results from bad design or from any damaging cause, due to sudden changes of pressure, cracks, defects in pipes or lack of maintenance. The problem of leakage becomes serious when it is concerned with the important supply of fresh water to the residential or industrial areas. In popular cases, the damaging effects associated with the occurrence of leaks may present serious problems and therefore, leaks must be quickly detected, located and repaired. High possibility of environmental health tragedies due to delay in detection of water pipeline leaks have encouraged to improve the development of methods for pipeline leakage detection. The water absence along with the significantly higher cost for water distribution and treatment, have generated a high interest in leakage problems. Water distribution in Malaysia is a large network of pipelines construction. The problem of water leakage from these pipelines will cause clean water contamination, low clean water supply and energy loss. In 2010, it is estimated at 1.87 billion cubic meters volume of water loss from these pipelines.

1.4 Problem Statement

Fast detection of water leakages in water supply system has always been a challenge in the water industry as most water pipelines are placed underground, which are generally hidden to human naked eyes until water starts to flow out from roads and creates puddles. For the past few decades, various equipment had been improvised in order to assist the related body to detect and locate leakages in water distribution system. These equipment are developed based on several scientific theories such as acoustic method, thermal image detection and flow or pressure sensors. However, all these

equipment and methods such as thermal image using satellite and acoustic method are very costly. In addition, flow and pressure sensor can provide simple monitoring leakage it has very high percentage of false alarm. The project proposed a new method in detecting water pipeline leakage with vibration method using accelerometers in which it is low cost and can detect leakage correctly (correctly means the source of leakage can be detected within specific range).

1.5 Research Aim

The aim of this project is to design and build a prototype of the Water Pipeline Leakage Detection System. It is also to experiment the distance range to detect leakage in the water pipeline.

1.6 Project Questions

RQ1: What technique is use in the water pipeline leakage detection system?

RQ2: Is it suitable to apply the vibration method for water pipeline leakage detection?

RQ3: What is the distance range of detection for the proposed system?

1.7 Research Objectives

The project objective is to design and construct a sensor that is able to detect leaks in pipes. The sensor is based on the idea of pressure drop producing a vibration force in the vicinity of the leak. Upon the detection of the leak, the sensor generates an alarm which can be sent to the master alarm system for a pipe network. More precisely, our project objectives are to:

1. To design a water pipeline leakage system in wired sensor network
2. To develop a prototype of water pipeline leakage detection system using vibration technique.
3. To evaluate the distance range for water leakage detection.

1.8 Research Scope and Limitation

The scope and limitations for this research are consists of:

1. Build a prototype of wired pipeline leakage detection system
2. Limited pipe length about 2-10meters.
3. Analyze vibration data offline.
4. Water pipeline material used is PVC (Polyvinyl chloride) pipe.

1.9 Summary

This first chapter focus on the research background which can affect water pipeline distribution to residential and industrial area if leakage cannot be detected quickly. The leakage is unavoidable in water distribution systems as many pipelines were laid a long time ago with some of them existing for so long and are could be in poor condition. This chapter also have included all this project objectives that must be achieved with some factors of limitations due to limited time and budget. Many water companies utilize different methods to determine and locate the leaks. This project will focus on applying new method of detecting leakage using vibration technique with the aid of accelerometers. A review of leak detection techniques is presented in the Chapter 2. Then chapter 3 presents the project methodology, chapter 4 explain the project design of the whole system including the experimental setup. After that, this thesis proceeds with chapter 5 which include the analysis and the evaluation of the proposed method. Chapter 6 concludes with the project findings and the future works to expand the research.

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