ISSN: 2454 - 4248
69 – 72

Leak Detection: A Review on Leak Detection in Pipe Line by using Liquid Leakage Sensor

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Abstract . This paper focuses on Leak detection in wireless sensor and network to locate the leakage in underground water pipelines. Water distribution is generally done through the underground pipes. Monitoring the underground pipeline is more difficult than monitoring it on open space. This situation will cause permanent loss if there is disturbance in pipeline such as leakage. Leakages in a pipeline can be caused by several factors such as pipe age, improper installation and natural disasters .Therefore a solution is required to detect the leak location when there is a leak. To overcome this problem, the Smart Water Leakage Detection(SWLD)in pipelines ,major water level in tank and control in pump to turn it on when water level is low .It uses Global System for Mobile technology(GSM)to send Short Message Service(SMS).The System is made up using Sensors, GSM module, Arduino and Relay. The android application is design to control the pump .The detection of the leak location will use fluid mechanics and kinematics physics based on harness water flow rate data obtained using flow liquid meter sensor and Arduino UNO as a microcontroller.
Keywords- *Arduino, GSM, SMS, Smart Water Leakage Detection (SWLD), Wireless Sensor Network (WSN)*

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I. INTRODUCTION

Leakage in the water pipeline is important issue which is affecting the customers .it is estimated that 40 to50% of drinking water is wasted through leakage in delivering countries, and less than 10% in countries where the utilities are well maintained such as Japan. We can determine the leak present in a specific part of the network by pressure measurements together with the flow measurements. Earlier, finding leaks has been challenging because even a substantial event can potentially show no manifest signs. There is various leak detection technique based on various principles. The leakage management related methods developed so far are broadly classified in three types

1. Leakage assessment method which focus on quantifying the amount of water loss
2. Leakage detection method which is concerned with the leakage hotspots.
3. Leakage control model which focus on control of current and future leakage problems. Numerous studies identified typical water loss figures.

In 1991, Lai has conducted one of the first global surveys. It estimated the water loss figures from various countries and cities. It is observed that the figures are widely varied from low 9% in Germany to high 43% in Malaysia with most countries falling into range 20-30%

II. LEAK DETECTION SURVEY

In excessive leakage area, leaks are commonly pinpointed using an acoustic device. This device detects the vibrations induced by water leaking from pressurized pipes. Suspected leaks are pinpointed by using listening on the ground surface above the pipe and the interval of about 1m. The leak sound transmitted through the pipe it travels significant distance depends on pipe size and type. Alternatively, suspected leaks can be automatically pinpointed by using modern leak noise correlates. Leak noise correlators are accurate and more efficient than Conference ID ‘UGC106’ 2 listening devices. Several non-acoustic techniques can be used to detect leaks such as tracer gas, infrared imaging and ground penetrating radar. The limitations of this technique are there effectiveness is not as well established as that of acoustic method.

III. DETECTION EQUIPMENT AND TECHNIQUES

A.Listening Devices

The listening device includes ground microphones, geophones, aqua phones and listening rods. They use piezoelectric elements to sense leak induced by vibrations or sound. Now a day, modern electronic devices have signal amplifiers and noise filter to make the leak signal stand out. The effectiveness of these devices depends on the experience of the user.

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B.Leak noise correlators

These are portable microprocessor based devices that pinpoints leak automatically based on the cross corelation methods. The location of first suspected leak can be traced using acoustic leak signals which are measured with vibration sensors or hydrophones at two pipe contact points' usually five hydrants or valves. Leak signals are transmitted from sensors to the correlators wirelessly. The leak correlators have two major purposes;

1. To detect the presence of a leak
2. To pinpoint the location of the leak for repair where the leak is detected.

IV. PROPOSESYSTEM

A. Methodology

Based on the design requirements and specifications, the system block diagrams shown in Figure 3.1 and Figure 3.2 are developed. This block diagram defines all the function to be performed by the system. A modular approach to system design was taken. The system is designed based on an Adriano mega2560 microcontroller which based on ATmega2560 microprocessor. In this paper, some of the basic concepts of circuits that are used in the system design are explained.

B.Detection Equipment and Techniques

1. Listening Devices

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3.) Tracer Gas Technique

In this technique, helium or hydrogen which is non-toxic water insoluble and lighter than air gas is injected into an isolated segment of a water pipe. The gas escapes at the leak opening and then being lighter than air it penetrates to the surface through the soil and pavement. The leak is thus located by scanning the surface of a ground which is directly above the pipe with a highly sensitive gas detector.The problem areas that can't be seen by naked eyes can be identified using thermography cameras such as detecting hidden water leaks. The infrared inspection camera can detect not only hidden water leaks and their origin but also the moisture that cannot be physically reached with moisture meters. The benefits of thermal imaging are: It detects moisture in ceiling, flat roofs, behind walls and under floors. It records exterior property heat loss and damp detection. The Non-destructive leak detection methods look at large areas quickly. It reduces energy consumption and saves on your heating bill.

4.) GPR

Ground penetrating radar can be used to locate leaks in buried water pipes either by detecting voids in the soil created by leaking water. It uses a high frequency radio signal that is transmitted into the ground reflected signals are return to the receiver and stored on a digital media. The computer measures a time taken for a pulse to travel from the target which indicates its depth and the location. The reflected signals are interpreted by the system and displayed on the units LCD panel. The accuracy of radar is based upon the subsurface material and the frequency of the GPR antenna. Different surfaces have different dielectric and conductive properties that affect a GPR waves and based on that the GPR data can be interpreted. Application which required deeper penetration in ground soil requires a lower frequency (12.5MHz to 500MHz). Depending on the subsurface material the depth range can be vary from a few inches to thousands of feet.

C.Hardware Design Model We've mentioned the hardware components as shown in Figure 2, in this paper we will go through the system hardware setup step by step in details for combining the components with each other to establish the desired tools and making the connection between the hardware parts with the software commands to get automation sensing unit and actuators. Hardware part of the system nearly was simple and easy to understand and deal with, it contains the controller which is Arduino mega category #2560, water leakage sensors, solenoid valves, ultrasonic sensor, water pump, electrical relays to control the activation of the valves and the pump depending on the input data from sensors and we use ULN 2003 to connect the output pins of the controller with the electrical relays.

D.Arduino MEGA 2560

Microcontroller this paper is using an Arduino mega2560 (Figure 6), which is based on an ATmega2560 microprocessor. An Arduino mega2560 microcontroller has been designed based on an ATmega2560 microprocessor that runs at the speed of 16MHz. As Table 1 shows, it contains 54 digital input/output pins, 15 of them could be used as Pulse Width Modulation (PWM) which is a method for getting analog results with digital means outputs. Furthermore, it contains 16 analog inputs and 4 hardware serial ports.

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Specifications	Arduino mega2560
Processor	AT mega 2560
Flash Memory	256 KB
Data Memory	8 KB
EEPROM	4 KB
Digital I/O	Pins 54
PWM outputs	15
Analog outputs	16

Table1. Specifications of Arduinomega2560 microprocessor

E.Water Sensor

Water sensor brick is designed for water detection, which can be widely used in sensing the rainfall, water level, even the liquate leakage. The brick is mainly comprised of three 6 Motaz Daadoo et al.: Smart Water Leakage Detection Using Wireless Sensor Networks (SWLD) parts: an electronic brick connector, a 1 MΩ resistor, and several lines of bare conducting wires. This sensor works by having a series of exposed traces connected to ground and interlaced between the grounded traces are the sense traces. The sensor traces have a weak pull-up resistor of 1 MΩ. The resistor will pull the sensor trace value high until a drop of water shorts the sensor trace to the grounded trace. This circuit will work with the digital I/O pins of your Arduino or you can use it with the analog pins to detect the amount of water induced contact between the grounded and sensor traces.

V. SOFTWARE DESIGN

The software is responsible for accepting data and commands, executing different commands, controlling operational terminals, and supporting data to Input/output port.

A.Arduino

Arduino software from Arduino developer is used to develop program for Arduino controller. ArduinoIDE is an integrated development environment (IDE) used in computer programming. It contains a base workspace and an extensible plug-in system for customizing the environment. ArduinoIDE is written mostly in Java, but it may also be used to develop applications in other programming languages through the use of plug-in, including: Ada, ABAP, C, C++, etc., the environment is written in C++ and based on processing and other open-source software. This software can be used with any ARDUINO board.

B.Android Application Development

This is an open source Android application which has a graphical interface. An Android application is a software application that runs on the Android platform. An Android application is designed for a smartphone or a tablet running on the Android OS. Android application is written in Java programming language and use Java core libraries. Users can extend its abilities by installing plug-in written for the eclipse platform, such as development toolkits for other programming languages, and can write and contribute their own plug-in modules. For our system the Android mobile application must allow users to control all the system by sending a message to Arduino over the network, and then commands will be issued by the microcontroller towards relays. The Android mobile application could operate seven alarm parts (six water sensors and the seventh is ultrasonic sensor) and one control part on/off pump.

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CONCLUSION

Thus we have concluded that the proposed system is tested on SWLD model. This system will grab much attention in upcoming years. Huge amount of water is wasted due to uncontrolled leakage. The main issue is that to identify the exact leakage spot in hard to reach areas. This problem is solved by the new technology of Arduino using efficient wireless sensor based on water monitoring system. Thus, the water monitoring system of home/offices will be completed monitored by wireless sensor technology.

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ISSN: 2454 - 4248
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FIGURES

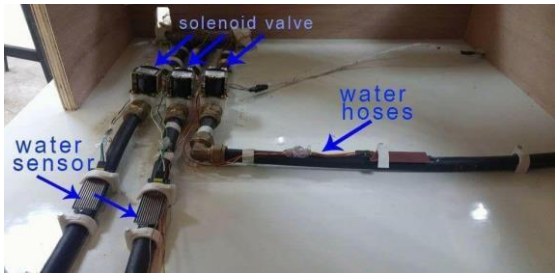

Figure 1 Water leakage sensors and their Mechanical distribution specification

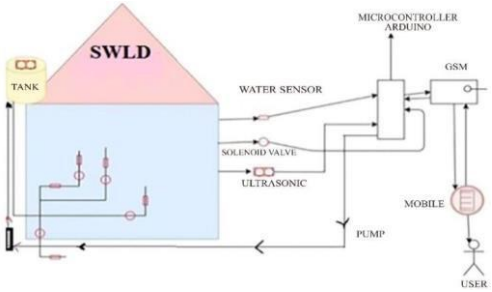

Figure 2 General purpose scheme of SWLD system