Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF INTELLIGENT MONITORING SYSTEM FOR WATER LEAKAGE WITH IOT

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Bachelor of Electronics Engineering Technology with Honours

2022

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A project report submitted
in partial fulfillment of the requirements for the degree of Bachelor of Electronics Engineering Technology with Honours

Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI TEKNOLOGI KEJUTERAAN ELEKTRIK DAN ELEKTRONIK

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : Development Of Intelligent Monitoring System for Water Leakage with IoT

Sesi Pengajian : 2022/2023

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DEDICATION

I dedicate my dissertation work to my family and many friends. A special feeling of gratitude to my loving parents, Nyanasagaran and Amutha whose words of encouragement and push for tenacity ring in my ears. My sister, Sivagammi have never left my side and is very special.
I also dedicate this dissertation to my many friends and family who have supported me throughout the process. I will always appreciate all they have done.

I dedicate this work and give special thanks to my supervisor Ts. Puan Saleha, who acted as an official mentor in the final year of this project and provided invaluable guidance. I would like to express my sincere gratitude to the Universiti Teknikal Malaysia Melaka for letting me fulfill my dream of being a student here.

ABSTRACT

The main aim of this project is to develop an intelligent monitoring system for water leakage detection in the water distribution system. Leakage constitutes a major loss of drinking water when supplied through pipeline systems. Introducing automated leakage detection systems would save huge amount of water globally. Water leak detection by means of simple embedded system aids water conservation in a cost-effective way. It focuses mainly on two parts: The first part is a real-time water leakage detection system using flow meter. The second is the controlling part; it uses Arduino to control the solenoid valve and alarm based on Global System for Mobile technology (GSM) to send Short Message Service (SMS) to the owner. The system is made up of basic components: flow rate sensors, GSM module, Arduino, relays to control the device. The result of using the proposed system is improving the efficiency of operation, reducing delay time and cost of maintenance pipelines after leakage detection.

ABSTRAK

Tujuan utama projek ini adalah untuk membangunkan sistem pemantauan pintar untuk pengesanan kebocoran air dalam sistem pengagihan air. Kebocoran merupakan masalah utama air minuman apabila dibekalkan melalui sistem saluran paip. Melalui sistem pengesanan kebocoran automatik akan menjimatkan banyak air secara global. Pengesanan kebocoran air melalui sistem tertanam mudah membantu pemuliharaan air dengan cara yang kos efektif. Ia memberi tumpuan terutamanya kepada dua bahagian: Bahagian pertama adalah sistem pengesanan kebocoran air semasa menggunakan sensor meter aliran. Yang kedua adalah bahagian yang mengawal; ia menggunakan Arduino untuk mengawal injap solenoid dan penggera berdasarkan teknologi Global System for Mobile (GSM) untuk menghantar Perkhidmatan Pesanan Ringkas (SMS) kepada pemiliknya. Sistem ini terdiri daripada komponen asas: sensor aliran aliran, modul GSM, Arduino, geganti untuk mengawal peranti. Hasil penggunaan sistem yang dicadangkan ini meningkatkan kecekapan operasi, mengurangkan masa kelewatan dan kos penyelenggaraan paip selepas pengesanan kebocoran.

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CHAPTER 1

INTRODUCTION

This chapter provides reader the overview of the project. It consists of the background of the study, project objective, problem statement and the scope. It gives the understanding on the idea and motivations that led to this research.

1.1 Synopsis

The most dependable means of water transportation is pipeline networks. Pipelines, as a means of long-distance transportation, have high demands on safety, efficiency, and reduced losses during transportation; to meet them, pipeline maintenance will be enhanced, allowing pipelines to last indefinitely without breaks. Spills typically occur because of erosion damage, particularly at development joints low points where dampness gathers or regions with pipe faults. The Water Leak and Detector system is one of several systems designed to improve the wellbeing of individuals and their belongings by detecting their proximity. However, different strategies and algorithms are utilized to improve system efficiency and reliability. In this project, the water leak detection and monitoring system was improved by incorporating Global System for Mobile Technology (GSM) to alarm users via notifications rather than just using the standard alarm system. As a result, the homeowner will be warned at any moment if there is a water leak in their home. The system is supposed to be dependable and convenient in assisting customers in monitoring their home or residential area from a short or long distance.

1.2 Problem Statement

Water is a necessary natural resource for living. Water covers the majority of the earth's surface. Yet generally only a small portion of water can be consumed directly by living organisms. To emphasize, man-made pipeline connections aid in the transportation of such resources. When drinking water is delivered through pipeline systems, leakage represents a significant loss. Introducing automatic leak detection devices would save enormous amounts of water worldwide. In developed nations, water leaks are detected using acoustic sensors, which exploit vibrations or sound created by pressurized pipes. In underdeveloped nations, large leaks are identified only upon the appearance on the surface, resulting to substantial water loss. For the property holder (high rise building), a pipe burst, or break can be a bad dream including brief lodging, contractual workers, destruction, basic support, compulsory construction standard redesigns, and the loss of imperative belonging, photographs, and treasures. Also, the issue can reoccur over and over. Most people would be concerned about the health risks of mould development caused by water damage. However, there are additional possible concerns to be aware of that a water leak might cause. This type of damage is more structural in nature, and it may be just as costly, if not more so, than the medical problems that mould can cause. The most visible and immediate impacts of water damage are cosmetic - staining, discoloration, and streaks along the walls. Moreover, the common water leak and detection system is lack in ability to alert the users who are away from their house. It is only can detect the presence of water leak and alert the users in limited space area. On that reason, this project is being proposed.

1.3 Objective

The objectives of this project:

1. To develop a real-time water leak detection system utilizing a flow meter and a water shutdown system.
2. To design a response system via GSM to inform about leakage event.
3. To test and analyze the flow meters as the tool to measure fluids parameters.

1.4 Scope of Study

1. Water leakage detector using Arduino and IOT application is developed using Arduino UNO microcontroller.
2. The main input to Arduino is the Flow Rate Sensor.
3. The flow rate sensor is used to collect the data of flow rate.
4. Computational algorithms written in C-language for Arduino programming.
5. In the case of a leakage, actuators such as solenoid valves are utilized to regulate the water flow.
6. GSM SIM900 module is used to produce emergency message to the property owner.
7. The prototype will be made in a small scale within less than 1.5m of straight pipe.

CHAPTER 2

LITERATURE REVIEW

This chapter will cover a literature review of the research study and theory pertaining to the implementation of the water leakage and leak response for this project. It includes the study related to the project's problem statement, the type of detector, the potential for water leakage in the home, the technology used to send the alert notification, the types of microcontrollers used on the development board, and all projects and works associated with the project.

2.1 Water Leakage

In a developed country like Malaysia, water spillage in a created nation like Malaysia loss of water in residential area because of spillage is around 30 to 41% of the aggregate stream in the distribution. This endangers all the essential natural resources, invested funds, including the public health. Malaysia had a water system proficiency of ~36 percent in 1993 1994 and anticipated that effectiveness would need to increment to 60 percent by 2050 to acquire an equalization. To illustrate, distributed system elements, including transmission pipes, distribution pipes, service connection pipes, couplings, valves, and fire hydrants are susceptible to leakage.

Leaks are caused by corrosion, material defects, improper installation, excessive water pressure, water hammer, ground movement due to drought or cold, and excessive loads and vibration from road activities. Leaks are typically located utilizing acoustic equipment in regions identified as having high leaking. These instruments identify the sound or vibration produced by pressurized water pipes leaking. Leak sounds travel great distances via the pipe (varies on the size and type of the pipe) as well as through the soil in the vicinity of the leak. Initial leak detection procedures include listening at all accessible distribution system contact points, including fire hydrants and valves. Then, suspected leaks are discovered by listening at extremely close intervals just above the pipe on the ground surface (about 1 m). As an alternative, current leak noise correlators, which have risen in popularity in recent years, can be used to automatically identify suspected leaks. In most cases, leak noise correlators outperform listening devices in terms of efficiency and accuracy. Leaks could potentially be detected using non-acoustic techniques too. For instance, tracer gas, infrared imaging, and ground-penetrating radar can also be employed to detect leaks.

2.2 Type of Detectors

There are several types of detectors that can be used as the water leakage detection system like tracer gas detector, ground penetrating radars and listening device. These detectors are helping in minimize the injuries and loss of properties in water leak incidents.

2.2.1 Tracer Gas Technique

Looking into the tracer gas technique, it involves injecting a non-toxic, water-insoluble, lighter-than-air gas, such as helium or hydrogen, into an isolated piece of a water pipe. It is commonly known that the gas is lighter than air, it escapes through a leak and subsequently permeates to the surface through the soil and pavement. An extremely sensitive gas detector is used to monitor the ground surface right above the pipe for leaks. The part is typically placed in a chamber and sealed off. Before the real test, a hard vacuum must be pulled on that volume. Investment in equipment often begins at or exceeds $100,000.

2.2.2 Listening Devices

In reference to listening devices, it involves aqua phones, geophones, listening rods and ground microphones. These devices use sensitive mechanisms like piezoelectric devices to detect leak-induced sound or vibration. Commonly, modern electrical devices use signal amplifiers and noise filters to make the leak signal visible. The functioning of listening devices is typically straightforward; however, its use is determined by the user's experience.

Figure 2.1: Acoustic Leak Listening Device

2.2.3 Ground Penetrating Radar

Radar can be used to locate leaks in buried water pipelines either by locating gaps in the soil that are caused by leaking water circulating near the pipe or by locating pipe segments that appear to be deeper than they actually are as a result of an increase in the dielectric constant of the soil that is adjacent to the leaking water and being saturated with water. When ground-penetrating radar waves come into contact with dielectric anomalies, such as a vacuum or a conduit, they experience a partial reflection back to the ground surface. The radar time-trace that was obtained by scanning the ground provides insight into the dimensions and contours of the target object. The amount of time that elapses between the sending and receiving of radar waves is used to calculate the depth of the reflecting object.

2.3 Selection of Sensor

In impoverished countries, existing water delivery systems with high-range acoustic and pressure monitoring sensors are extremely expensive to adopt. A few irrigation leak detection systems using heating coils to discover flow rate differences have the drawback of distinguishing quick changes in the system because of their uniform reaction to changes in temperature. Flow sensors are used in several other systems to measure flow rate. This single setting has no effect on preventing system leakage.

Flow sensors are increasingly becoming crucial components of efficient irrigation systems. These sensors detect and quantify the flow of water through pipes. They act largely as a sensory organ for the brain of the irrigation controller, supplying it with information that it may use to make decisions on the operation of the system. The flow meter simply works using the flow sensor's output. In this system, the flow is calculated using a rotor encircled by a magnet and the Hall Effect sensor. This is referred to as a G1/2 water flow sensor. The rotor's blades rotate when water runs through it. As the turbine rotates, a magnetic field is generated, resulting in an AC pulse, which is then converted to a digital output by a Hall Effect sensor situated close to the turbine. The software programming can count the number of pulses created per mL. As a result, pulses produce an output frequency proportional to the meter's volumetric flow rate/total flow rate. Flow rate measurement with a revolving rotor also provides high precision, excellent repeatability, a simple structure, and low-pressure loss.

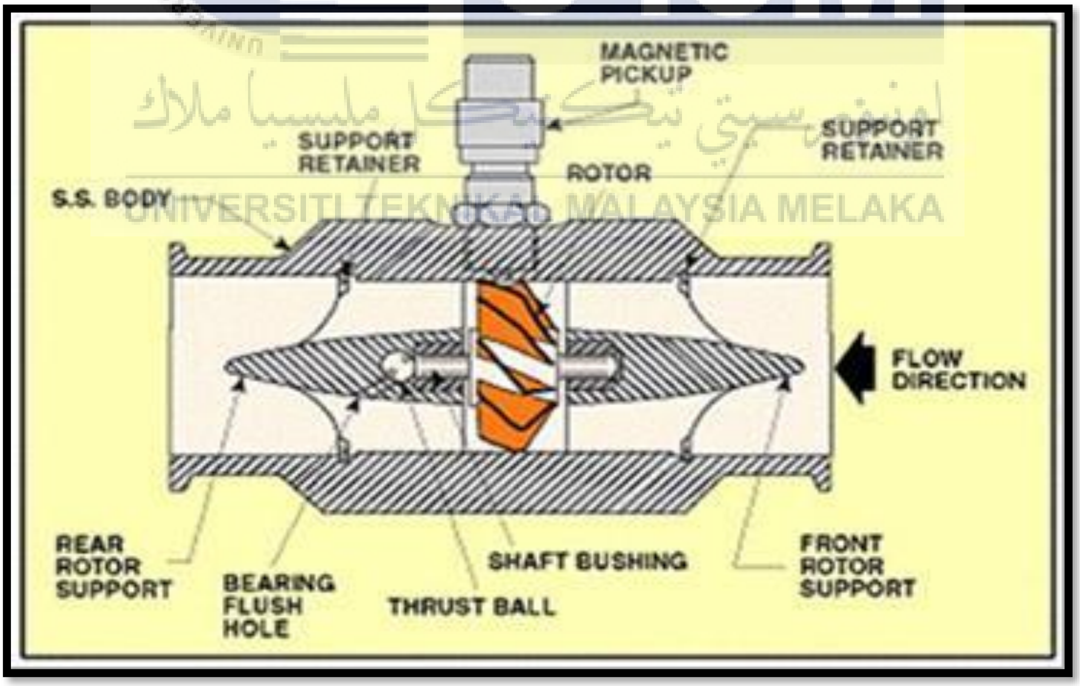

Figure 2.2: Internal structure of G1/2 water flow

The primary benefit of combining a water flow sensor with a Hall Effect sensor is that it is highly resistant to contamination such as dust, dirt, and oil, has no moving parts, is highly repeatable, operates with stationary input, works at high speeds exceeding 100 kHz, works at high speeds exceeding 100 kHz, operates with stationary input, has no moving parts, and operates with stationary input. Additionally, it is small and makes it easy to process subsequent signals due to digital output.

In such instances, the foundation relationship for determining the liquid's flow rate is shown in equation.

$$Q = V \times A$$

Figure 2.3: Equation of volumetric flow rate

To illustrate on the equation as above, Q is the flow rate/total flow of water through the pipe; V is the average flow velocity; and A is the cross-sectional area of the pipe. There are a few factors that affect water flow, including viscosity, density, and pipe friction.

2.4 Related Journals

1. Water Leakage Detection System Using Arduino

Juma S. Tina, Beatrice B. Kateule, and Godfrey W. Luwemba created this project. The objective of this project was to create an IoT-based water leak detecting system. Two sensors were inserted at either end of the pipe as part of the prototype method. According to the study, water travelling from the source to the destination can be assessed for distribution-related leaks. To help water distribution authorities effectively manage this rare resource, much more effort will be required to determine the specific position of the leaking pipe. A higher emphasis on distance calculation could provide intriguing results, necessitating more study of IoT monitoring systems.

2. Water management system through wireless sensor network with mobile application

Glenndon John M. Boniel, Christine C. Catarinen, and Ronald Darren O. Nanong designed this project. Using the integration and implementation of several sensors, microcontrollers, and a microprocessor, a water management system capable of applying some of the NWRB's water conservation measures was built. The viability of employing the system for water management was enhanced by the positive findings received and data from user acceptability testing. However, accuracy difficulties with various components, as well as their usability under specific settings, must be investigated and addressed. Despite the fact that new restrictions were revealed during the development phase, all of the study's objectives were satisfied.

3. Leak Detection System using Arduino

Manav Sandeep Mehta and Rohit Ratanjyoti Misra created this project. The technique makes use of IoT to detect leaks in real time. The system is scalable as well as cost-effective. The dashboard can monitor all of the implemented systems because they are all connected to the server. Leaks may be swiftly and safely stopped with this technology, which reduces water waste dramatically.

4. Water Pipeline Monitoring System (WPMS) via IoT

This project was made by M F Abdul Jalil, Z Muhammad*, N A Mat Leh, S A Hamid, Z M Yusof. Based on changes in flow rates, the Water Pipeline Monitoring System (WPMS) successfully detects water pipeline leakage. The WPMS also uses the Internet of Things to track pipeline activity in real time (IoT). The project's goal has been accomplished effectively. The pressure of water used to propel the water into the sensor might also alter the flow rate readings.

5. Smart Water Leakage Detection Using Wireless Sensor Networks (SWLD)

This project was made by Motaz Daadoo , Yousef-Awwad Daraghmi. T. The key problem that this system attempts to solve is the use of an effective wireless sensor for water monitoring system. There are two ways to monitor the water: Water pipeline leak detection and level monitoring The wireless sensor technology will be used in the study concept for homes/offices. You can keep track of your progress using the monitoring system. We can easily prevent water waste, and the water will be saved for future generations. In our system, we rely heavily on Control, and features are handled in a technical manner. Home plumbing can be monitored in a variety of efficient and effective methods.

6. Smart Pipeline Water Leakage Detection System

Gopalakrishnan P., Abhishek S., Ranjith R., Venkatesh, and Jai Suriya V. created this project. By remotely activating solenoid valves, the intelligent water leakage detecting system can assist with water distribution. Data may be collected and analyzed at any stage in the process thanks to the use of cloud logging technologies. As a result, the system is both affordable and simple to operate. Rather than pinpointing a leak's precise location, the system can detect it between any sensor nodes. The sensors require significant wiring for power and data transport. As a result, the area under monitoring shrinks. Batteries or a solar panel may be used to power the sensors and actuators. Transceivers can be used to collect sensor data and send actuator orders wirelessly. This sensor network-based technology may increase system costs, but it provides the following benefits: monitoring a broad area with minimal human effort and requiring fewer sensors.