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

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DEVELOPMENT OF INTELLIGENT MONITORING SYSTEM FOR WATER LEAKAGE WITH IOT

RISHITHRAN NYANASAGARAN

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

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DECLARATION

I declare that this project report entitled “Development of Intelligent Monitoring System For Water Leakage With IoT” is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Date : 13/01/2023

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APPROVAL

I hereby declare that I have checked this project report and, in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering Technology with Honours.

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Date : 23/2/2023

Signature :

Co-Supervisor Name (if any) :

Date :

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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.

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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.

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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.

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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.

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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.

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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.

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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.

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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

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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.

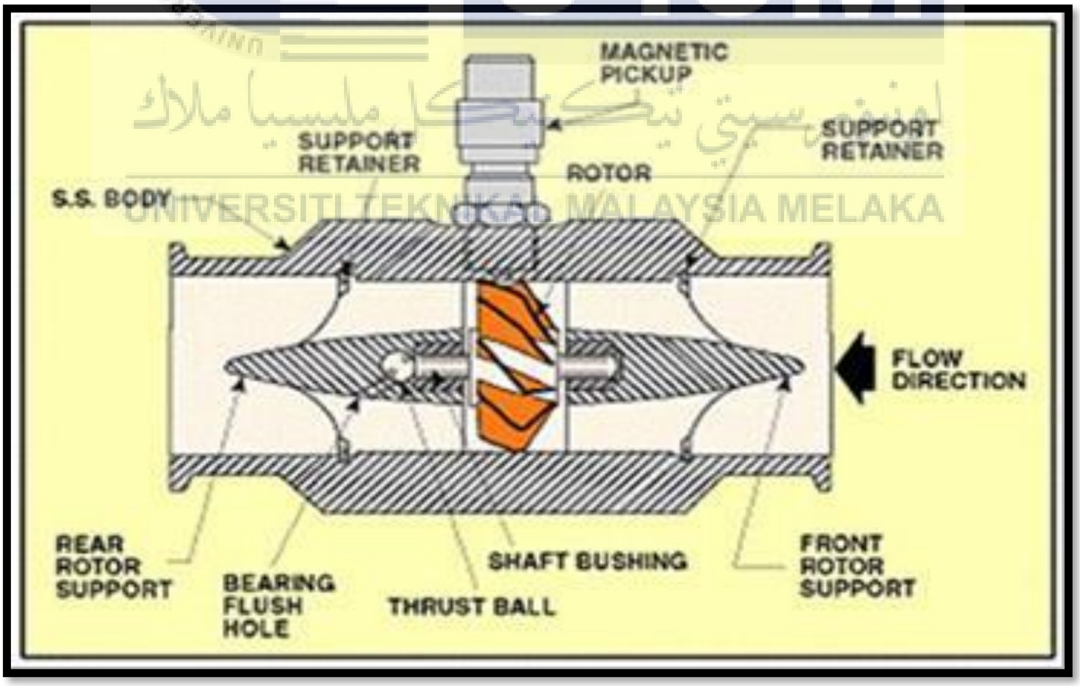

Figure 2.2: Internal structure of G1/2 water flow

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.

$$Q = V \times A$$

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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

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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.

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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.

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7. Smart Water Distribution System

This project was made by Raghavendra Havaldar& Sruthin Balachandran V.V. Ultimately, the study resulted in a revolutionary smart system for monitoring water leaks and preventing water waste. In addition, the project monitors the water usage throughout the water distribution system and records the data in a database. The values are shown in the graphical user interface and can be used to create reports. This project successfully constructed a major module, Leak Detection in Water Distribution System, in which water leaks were detected in various locations of the system by analyzing data from multiple sensor nodes broadcast over an RF carrier using the ZigBee protocol.

8. Smart Water Monitoring System

The study is looking into the correctness of water in villages and towns at all times. As a result, the internet to deliver internet of things data analytics data communication reliability, speed of operation, and data storage Throughout the phase of project development and extensive comparative analysis a study of real-time analytics technologies like Arduino. This study suggested that it be used in municipal settings, and villages to assess and deliver highquality water. Consumers' water supplies This technique can be used to Water waste should be avoided at all costs.

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9. IoT Based Automated Water Distribution System with Water Theft Control and Water Purchasing System

The study is looking into the correctness of water in villages and towns at all times. As a result, the internet to deliver internet of things data analytics data communication reliability, speed of operation, and data storage Throughout the phase of project development and extensive comparative analysis a study of real-time analytics technologies like Arduino. This study suggested that it be used in municipal settings, and villages to assess and deliver high-quality water. Consumers' water supply.

10. The Use of ICT in Household's Water Leaks Detection and Control, Opportunities and Challenges

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According to global statistics, water intended for human use is experiencing a global problem of scarcity; therefore, advanced methods are required to prevent water from being wasted. Numerous researchers have advocated for water conservation. Globally, over 844 million people lack access to clean and safe water. Generations of diverse African families and communities are imprisoned in poverty due to the lack of readily available and safe water sources. Children are dropping out of school at an alarming rate, and many parents have struggled to make ends meet. Using this circuit, the research can provide efficient methods for monitoring domestic water flows and detecting leakage.

No	Author	Year	Title	Method	Advantages	Disadvantages
1	Juma S. Tina, Beatrica B. Kateule, Godfrey W.	2022	Water Leakage Detection System Using Arduino	The Arduino board, water flow sensor, node MCU, and Arduino Integrated Development Environment (IDE) all work together to make this happen. The Arduino IDE is used to programme the water flow sensor and node MCU to measure the readings.	▪Inexpensive. ▪Can be installed at any water supplied device. ▪No need for AC outlet.	▪More investigation will be required to pinpoint the exact location of the pipe leak in order to aid water distribution authorities.

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2	Glenndon John M. Boniel, Christine C. Catarinen, Ronald Darren O. Nanong, Jose Paolo C. Noval et al.	2020	Water management system through wireless sensor network with mobile application	The system contained four sensor nodes, three of which were equipped with an Arduino Uno R3 microcontroller, an XBee S2C ZigBee module, a Hall Effect water flow sensor, a pressure transducer sensor, and a solenoid valve, and one sensor node was similarly equipped but lacked a solenoid valve.	▪Hardware was premade by Zigbee to ease the project. ▪Zigbee module supports for long range wireless transmission without problem. ▪Very efficient in handling the leakage system as its sophisticated.	▪Accuracy difficulties with specific components and their usability under certain settings. ▪Complex design and not easy to implement for big scale.
3	Manav Sandeep Mehta, Rohit Ratanjyoti Misra	2019	Leak Detection System using Arduino	Arduino Uno, SIM800L, Flow Sensor, Solenoid Valve. LCD The flow meter reading from the flow sensor at both ends of	▪After the problem has been resolved, it is feasible to remotely open the valve using the dashboard connected to the server and can be	▪There is no database in this system to track its efficiency.

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				the same pipe is checked and compared by the system.	monitored by the dashboard.	
4	Jalil, MF Abdul, Bayan Lepas, Z. Muhammad, NA Mat Leh, S. A. Hamid, and Z. M. Yusoff	2021	Water Pipeline Monitoring System (WPMS) via IoT	The flow sensor detected the input signal in pulse frequency when the water flowed into the pipeline. The NodeMCU microcontroller collected the data and calculated it as flow rate values. Then, the flow rate values were sent to the IoT UBIDOTS platform for real-time monitoring. If the flow rate dropped to a certain amount, a notification was sent to the user. Then the user could identify if the pipeline was leaking.	▪Real-time monitoring (UBIDOTS). ▪Water pump is used in this system to make the water flow uniform and systematize.	▪Notification via email which makes it difficult when there is no internet coverage.

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5	Daadoo, Motaz, and Yousef-Awwad Daraghmi.	2017	Smart Water Leakage Detection Using Wireless Sensor Networks (SWLD)	The system includes water sensors to detect leaks and an ultrasonic sensor to measure tank water level. The sensors collect data, and the system is controlled by the mega Arduino; the controller determines the risk and sends SMS to the owner using a GSM module, based on the data collected by the sensors.	▪Able to detect water leakage system and also as well measure the water level in tank. This system can be applied for piping and tanks.	▪Due to silt corrosion, the valve must be placed and exercised every six months; a 120 VAC outlet plug is required to power the system; and certain wireless systems have restricted signal range.

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6	Gopalakrishnan P, Abhishek S, Ranjith R., Venkatesh and Jai Suriya V.	2018	Smart Pipeline Water Leakage Detection System	When the water board authorities approve the water for various industrial and home uses, this mechanism goes into action. Water flow measurement sensors are installed at regular intervals in both the main pipeline and the branches. This configuration ensures that the leak may be pinpointed to a certain branch. The water flows through all of the pipelines and arrives at the intended spot. Water flow measurement sensors are installed at regular intervals in both the main pipeline and the branches. This configuration ensures that the leak may be pinpointed to a certain branch. Water enters all tubes and passes through various flow rate measurement	▪Easy to locate the leaks as the path is made as branches to identify the leak	▪Complicated to setup as its very deliciated system. ▪This product should be connected with internet all the time.

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				sensors to reach the required spot.		

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7	Raghavendra Havaldar& Sruthin Balachandran V.V	2019	Smart Water Distribution System	The suggested water distribution system is divided into two parts: the transmitter or sensor system and the receiver or server. Water flow sensors are installed inside the pipeline in the transmitter section, generating pulses as the water flows through it. The pulses are then tallied using a microprocessor and wirelessly transmitted to the receiver end through an Xbeetransceiver, which uses ZigBee technology.	▪The project also monitors water consumption in various portions of the water distribution system and enters the data into a database. The values are shown in the GUI and can be utilized to generate reports.	▪Due to silt corrosion, the valve must be placed and exercised every six months; a 120 VAC outlet plug is required to power the system; and certain wireless systems have restricted signal range.

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8	Jitendra Kumar, N. Naveen , Raja Baitha, V. Sekhar, V. Srimaheswaran.	2020	Smart Water Monitoring System	There will two water flow sensor that will connected with to two ends of pipe, both will measure flow rate of water if there will be any difference in water flow rate that will consider as leakage of water from pipe because less flow rate comparing to another flow rate.	▪PH, turbidity and temperature can be monitor at remote place. ▪Easy to investigate of water quality problem from different place using Iot. ▪It will reduce the wastage of water through leakage of pipes. ▪It will reduce chances of overflow from water tank. ▪It will distribute equal amount of in different area. This system can be placed everywhere with more efficient.	▪Price of pH Sensor, turbidity sensor and water flow sensor will increase the cost of of product. ▪This product should be connected with internet always.

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9	G.M. Tamilselvan, V. Ashishkumar, S.Jothi Prasath, S. Mohammed Yusuff	2018	IoT Based Automated Water Distribution System with Water Theft Control and Water Purchasing System	The flow metre and valve are controlled by Arduino. Water purchase should be available by utilising the Cayenne programme, which allows the requirement of water for any of the habitats to be fixed. The Arduino Ethernet Shield V1 is used to connect the Arduino board to the internet. The Wiz net W5100 provides a system (IP) stack capable of handling both TCP and UDP packets. The proposed design addresses the issues of overflow, overutilization, water acquisition, and suitable distribution.	▪Monitor water theft and water quality ▪Control and monitoring of an IOT-based automation of water supply network with theft detection. ▪Ideal for municipal use.	▪Expensive project and not recommended for home usage as it also includes anti-theft feature.

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10	Phesto Namayala Peter	2019	The Use of ICT in Household's Water Leaks Detection and Control, Opportunities and Challenges	The assessment of both the opportunities and challenges of using ICT in water leak detection and control has been completed in this paper, and the research has resulted in the design and development of a contextualized prototype that uses a microcontroller to constantly monitor water flow for post-meter leak detection and control in households. When a leak is identified, the prototype automatically closes flows, plays a buzzer, and sends GSM SMS messages to a pre-configured cellphone number.	▪IoT makes it simple to evaluate water quality issues from various locations. ▪It reduces water waste due to pipe leaking.	▪If the valve is put after the pressure switch and the well system components leak, the pump will continue to run, resulting in a flood.

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2.5 Conclusion

Based on theories and pass research there are various types of methods used to develop a water leak detector. The advantages and disadvantages of those method are listed on the comparation table above. The most suitable method to is to use a microcontroller such as Arduino or Raspberry Pi and implement IoT features such as GSM module. Apart from that, adding automatic shut of valve using Solenoid valve is effective. This project mainly focuses on developing an Automatic shut off valve in a leak detector system

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CHAPTER 3

METHODOLOGY

In this chapter, the project development will be discussed in detail. This project development consists of three main parts which are planning and design parts, hardware development and software implementation. The hardware implementation includes the output devices used in the system. The water leaking system and the Internet of Things (IOT) application system that will be utilized for sending notifications to the user will be featured here to accomplish the system's primary objectives.

3.1 Concept & Project Ideas

In general, the concept and guiding principles of this project are centered on the development of a real-time, wireless leak detection system that does not require external data calculations. Due to the availability and cost of field instrumentation, only flow meters would be used to monitor fluids. Other tools, such as density readers, would not operate well with this pipeline design, and other tools that could be connected to the boards were too expensive. The system would consist of an algorithm designed to collect data between the two locations to determine the location of the leak. The usage of wireless communication further demonstrates that the two sites are not designed to be "together" locally, but rather placed at separate points.

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3.1.1 Flow Chart

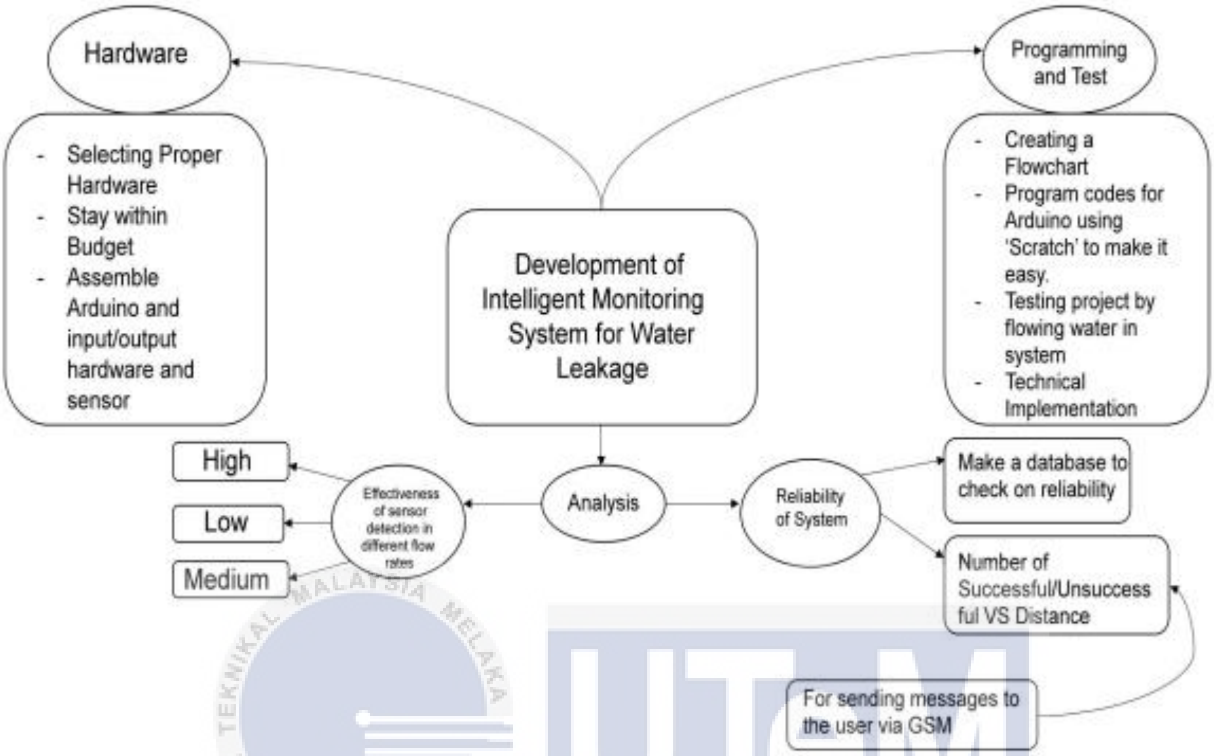

Figure 3.1: Flowchart of proposed system

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Moving to the flow chart, it is illustrated that installing the water leak detection system can be done by attaching flow rate sensors along the path of water flow. Water flow is not restricted by the sensor; instead, data on flow rate is collected. To regulate water flow in the event of a leak, actuators such as solenoid valves are required.

The proposed system employs a microprocessor that receives data from various flow rate sensors on a continuous basis, continuously monitoring the water flow. It contrasts the flow rate by calculating the differences between data from succeeding sensors and then the necessary response is taken. The microcontroller instructs the solenoid valve to close and notifies the user if the difference is greater than the threshold. This reduces the amount of water wasted. The sensor data is transferred to the cloud for data logging if the difference is less than the threshold, and the process is repeated

3.2 Hardware Design

Firstly, there will be a solenoid valve which will act as shut-off valve when leak is detected, Next is Flow Rate Sensor 1 will record the ingoing amount of water. Third is a Leak Valve to simulate leak by user. Forth is Flow Rate Sensor 2 which will calculate amount of water exiting the system. If Flow rate 1 and 2 matches, then it means there is no leakage. If Flow rate 1 and 2 doesn’t matches, then it means there is a leak in system.

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In this project, the hardware which has been used are Arduino UNO, Flow Meters, GSM, Solenoid Valve and some of the output device LCD display. The hardware design can be separated into two sub-systems. The first part is between the Arduino UNO and the sensors while the second part is between the Arduino UNO and the GSM. However, the assembly of the system will be combined in order to produce a complete working system.

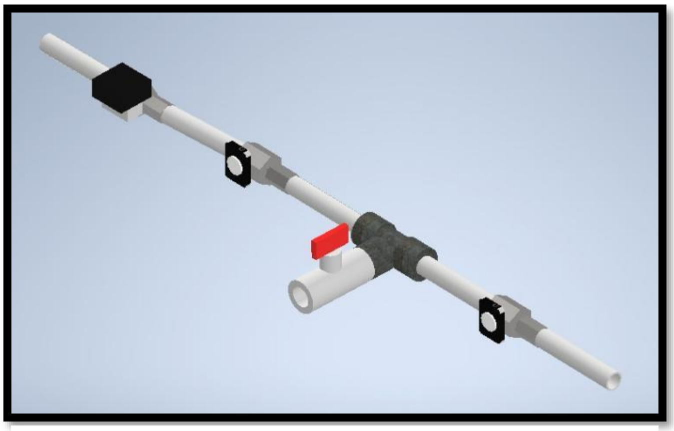

Figure 3.2: Design of prototype

3.2.1 Arduino Uno

The Arduino UNO is a type of Arduino board that is based on the Arduino ATmega328. UNO board which is also known as interactive system in embedded computer platforms family is also the first series of USB Arduino board. Besides, it is also a reference to all Arduino platforms.

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Table 3.1: Technical Specifications of Arduino UNO

Microcontroller	ATmega328p (UNO)
Input Voltage (Recommended)	7-12V
Input Voltage (Limit)	6-20V
Digital I/O Pins	14 (6 PWM Output
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current Per I/O Pins	20Ma

DC Current for 3.3V Pin	50mA
Length	68.6 mm
Width	53.4 mm
Weight	25g

3.2.2 Water Pump

The pipes utilize an aquarium water pump as the water-moving mechanism. This is particularly beneficial because the water pump has a dial for setting the desired speed. This is utilized in the experiment to monitor the water flow at varying flow rates. Aquarium Water Pump is the specific pump utilized in this experiment.

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Table 3.2: Aquarium Water Pump Schedule

Model	Hydro Salts L20
Max Flow Rate	185gph
Power	11W
Tubing	½”
Max Head	50”
Dimensions	3 ½” x 3 ¼” 2”

3.2.3 Flow Meter

The flow metre is the most important piece of equipment that makes up the pipeline. The pinwheel sensor of the sensor monitors the amount of liquid that is passing through the pipes while the sensor itself is located in the pipe line. Utilizing the Hall Effect, it is able to monitor the flow of the fluid. The yellow wire is connected to the Hall Effect pulse output, the red wire supplies 5-24VDC, and the black wire serves as the ground connection. However, the sensor is not a flow metre and hence does not measure the flow of the fluid. Nevertheless, it is suitable for the activities included in this investigation..

Table 3.3: Specifciations of flowrate sensor

Working voltage	5 to 18VDC
Max current draw	15mA @ 5V
Working flow rate	1 to 30 Liters/Minute
Working temperature range	-25 to 80°C
Working humidity range	35%-80% RH
Maximum water pressure	2.0 MPa

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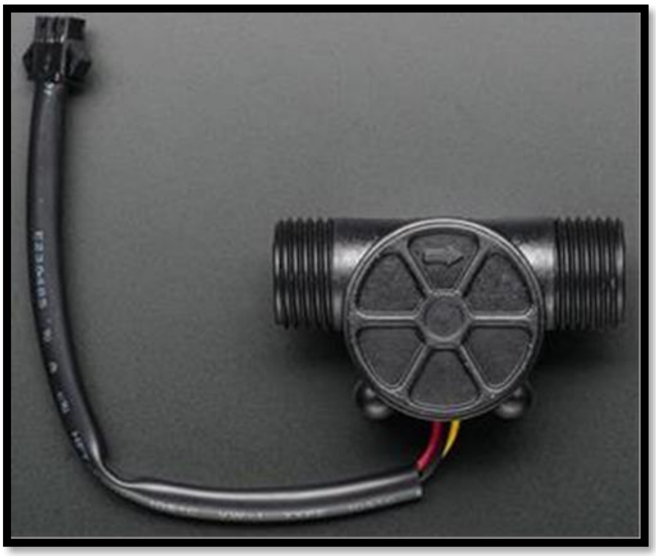

Figure 3.3: Flow meter

3.2.4 Solenoid Valve

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The solenoid valve is an electromechanical device that controls fluid flow. A ferromagnetic rod material is contained within the valve, which prohibits fluid passage. The rod is attracted to the coil when it is activated, and the region for fluid passage is cleared. In this scenario, the solenoid valve requires 12V DC.

When the valve is activated, it will function as a closed switch. A maximum flow rate of three litres per minute (3L/Min) and a maximum pressure of three pounds per square inch (3psi) are feasible. A relay circuit connects this valve to the output of the microcontroller. When a leak is detected in the pipeline sensor system, a trigger pulse from the microcontroller will activate this valve.

Figure 3.4: Solenoid Valve

3.2.5 Sim900 GSM Module

The SIM900 GSM Module operates on the 900MHz frequency band. GSM modules come in various type. The most common module, which is based on the Simcom SIM900 and the Arduino Uno, is used.

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TTL Output (for Arduino, 8051, and other microcontrollers) and RS232 Output (to interface directly with a PC) are two of the outputs that are generally included on a GSM Module, which is normally a SIM 900 GSM Modem that is coupled to a PCB (personal computer). In addition, the circuit board will have connectors for +5V or some other form of power and ground, as well as pins or other facilities for connecting a microphone and speaker. These guidelines change depending on the module being used.

Figure 3.5: GSM Module

3.2.6 I2C OLED Display

To complete this task, we will be utilizing an organic light-emitting diode (OLED) display, specifically the SSD1306 model, which is a monochrome, 0.96-inch display with 12864 pixels. The lack of a backlight in an OLED screen makes for striking contrast in low-light settings. Furthermore, the OLED display's power consumption is lower than that of other displays since its pixels only use power while they are active. The device we’re utilizing here has only four pins and talks with the Arduino using I2C communication protocol. An additional RESET pin is available on some versions. There are several more OLED screens that interact utilizing SPI communication.

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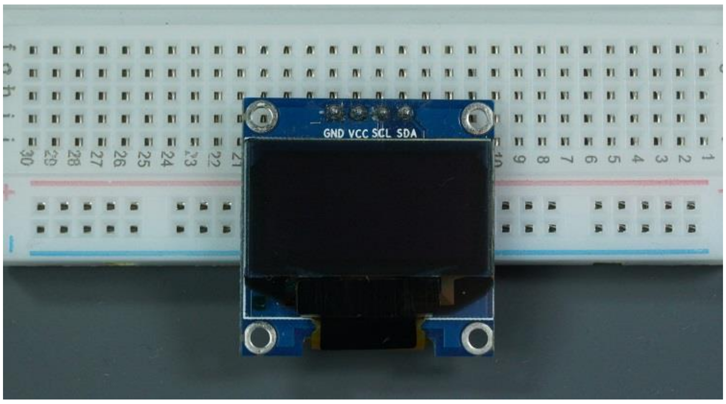

Figure 3.6: Diagram of OLED

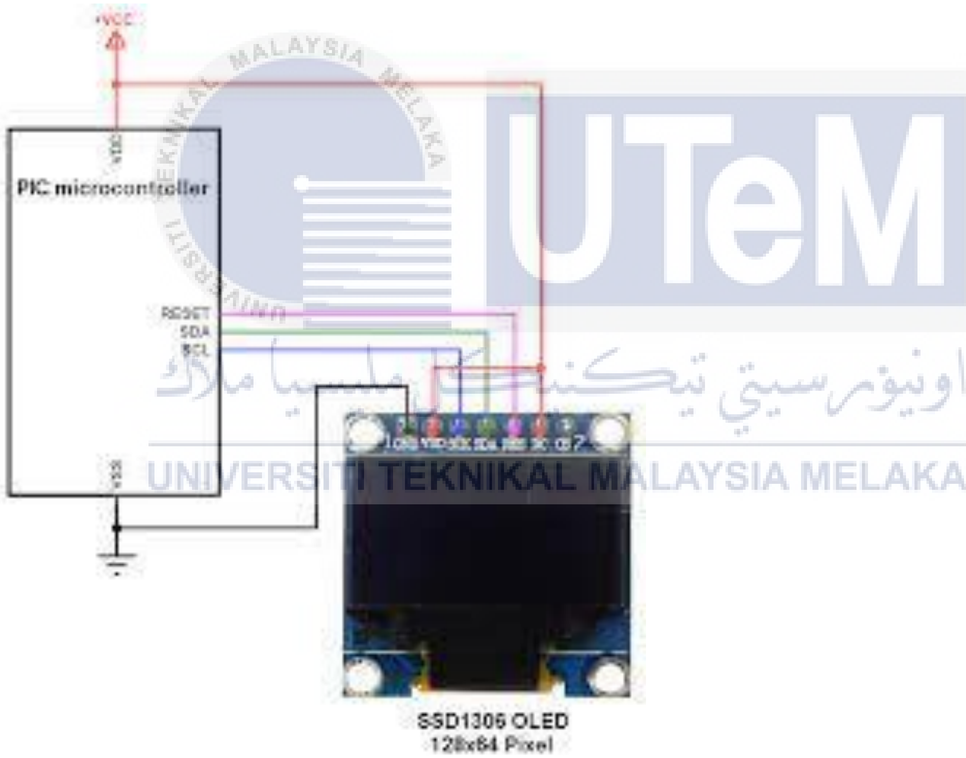

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Figure 3.7: OLED Pin Description

3.3 Software Design

The complete system is developed using Arduino UNO as microprocessor in order to achieve the objectives. Therefore, Arduino IDE is needed in order to program the Arduino. The Arduino IDE software can be easily downloaded and installed to program the Arduino. It is friendly user software as it can be installed in Window, Mac Operating system, and Linux.

3.3.1 Arduino IDE

Using the Arduino Integrated Development Environment, also known as the Arduino IDE, the Arduino may be programmed. It has a text editor for writing code, a message area, a text console, a toolbar with common buttons, and a series of menus..

The program which is programmed using Arduino IDE is called 'sketch'. The sketch is being programmed in the text editor and will be saved in extension file '.ino'. After the program is written, it can be verified using 'verify' button at the toolbar. Once the program is error free and complete, it can be transferred into the Arduino.

3.3.2 Arduino Monitor

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Arduino Monitor is a visualization tool of sensor data which is easy to use and navigated. It is suitable to display sensor data as the data is being plotted in real time while the grid is also adjustable. However, currently this software can be used in Windows only.

In order to obtain a system with good operation condition and performance, there are many things need to be considered. Therefore, this water leakage system using Arduino and IOT application is developed and implemented by using different kind of hardware and software component and devices. The selection of hardware and software is one the most crucial part in this project to make sure the desirable output can be obtained.

CHAPTER 4

RESULTS AND DISCUSION

In this project, the water leak detector using Arduino and IOT application have been developed using the hardware and software which have been explained in the previous chapter. The functionality of the water leak detection and the ability of the system to send the alert message to the users whenever the sensors had been triggered are the main priority to activate the system. Once the hardware and software installation of the system is complete, it has to be tested to make sure all the parts are assembled correctly. If there is any problem identified during the testing, the system needs to be troubleshot. It must be noted that the threshold value of each sensor is set in the programming is fixed due to level of water that is rational before the sensors are triggered. It consists of the results when there is water leak detected and the output devices activated. Besides, it also consists of the part when the notification received by the users. As if the system is working well, it is ready for analysis. Lastly, the users of this system will receive the alert message via GSM SIM 1900. These alert messages are delivered to the users as a notification so that they can take appropriate action quickly.

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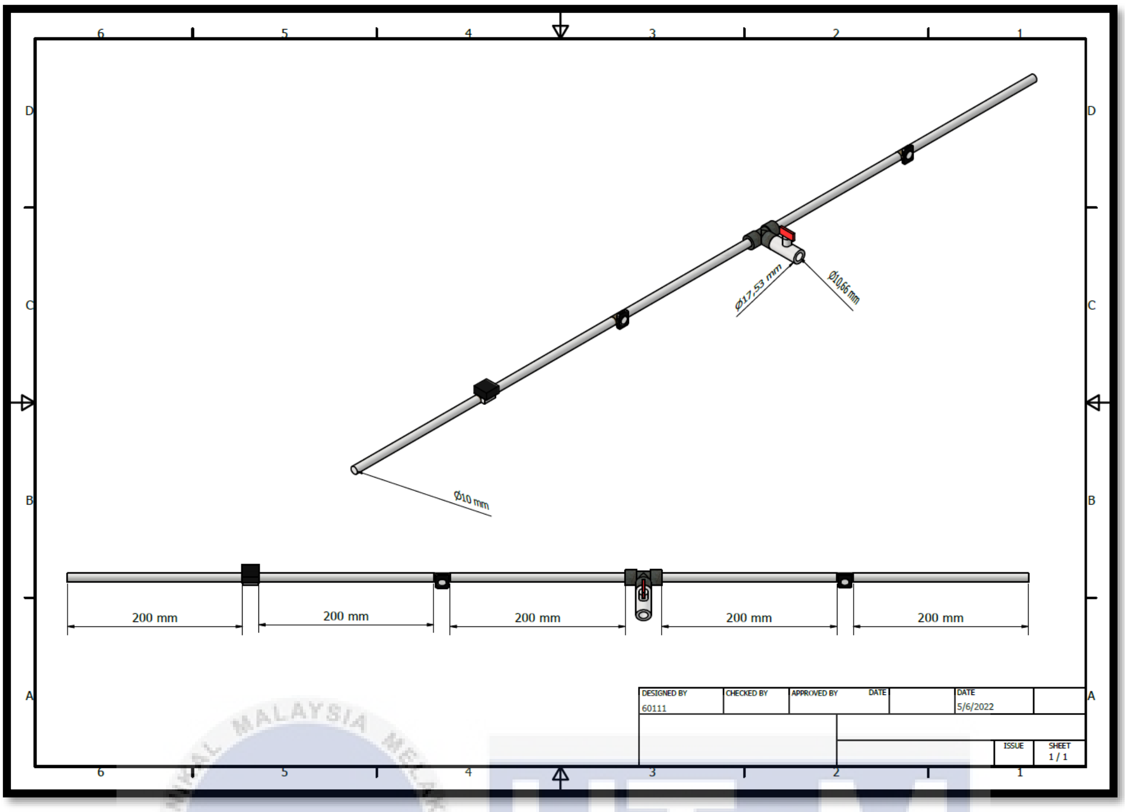

Figure 4.1: CAD Design of Prototype

4.1 Circuit Diagram

In order to develop the system, all of the hardware must be assembled according to the circuit. Every connection must be connected correctly to make sure the system can be run without any problem.

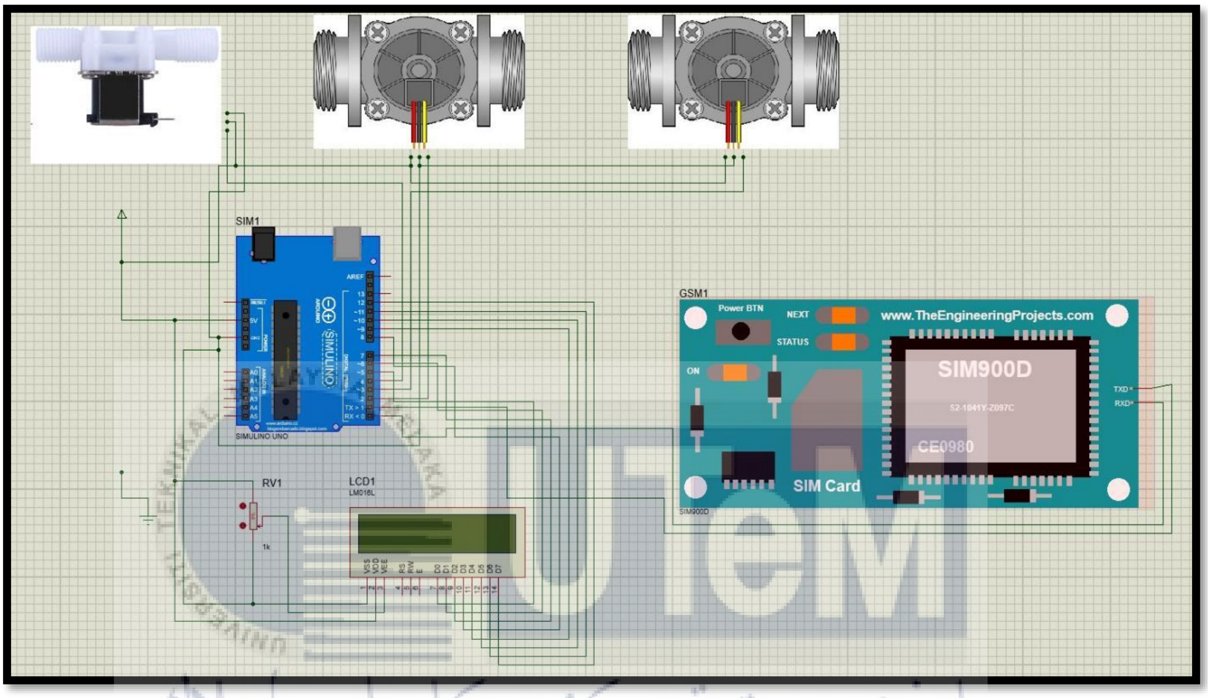

Figure 4.2: Construction of Wiring Diagram

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4.1.1 Leak Detection Algorithm

When the system is turned on, the microcontroller constantly monitors the flow rate. The leak detection method works in such a way that the microcontroller detects a leak whenever the flow rate differential between two consecutive sensors reaches a specific threshold value. To emphasize on the system's leaking scenario, alerts are issued, and messages are sent to the proper authorities when leaks are detected.

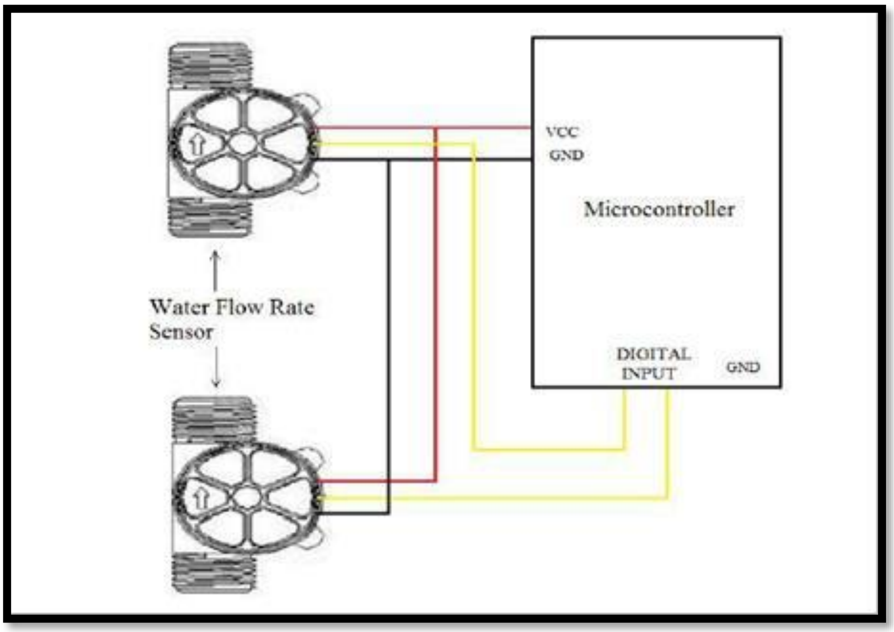

Figure 4.3: Microcontroller connected to flow sensors

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4.1.2 Integrated Water Cut-Off System

If a leak is discovered, the automated water cut-off system is highly beneficial for stopping the leakage of water at numerous spots. The Monitoring system detects water leaks and delivers a warning signal. Furthermore, the water supply is cut off using a solenoid value attached to the water pipelines.

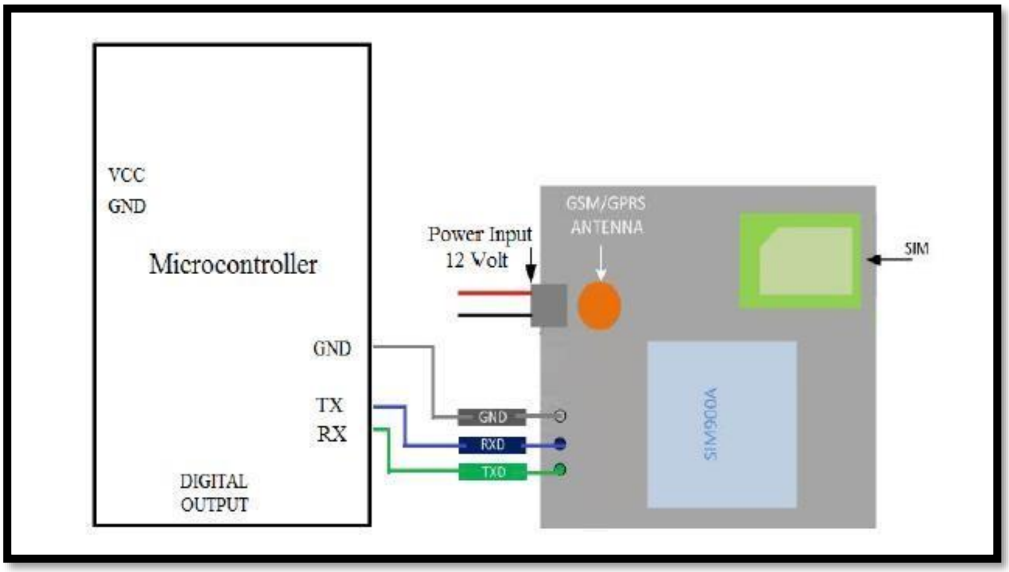

Figure 4.4: GSM/GPRS module setup

By connecting the solenoid valve in series with a transistor enables the transistor to function as a switch. The circuitry involved in setting up the solenoid valve. The Solenoid valve is a type that is generally closed. When the base signal is applied to the transistor, the solenoid value becomes usually open, permitting water flow. In the event of a water leak, however, the solenoid value should be generally closed to cut off the water supply. In this manner, the transistor's base signal is eliminated, so cutting off the flow of water and preventing waste of water at the initial stage itself.

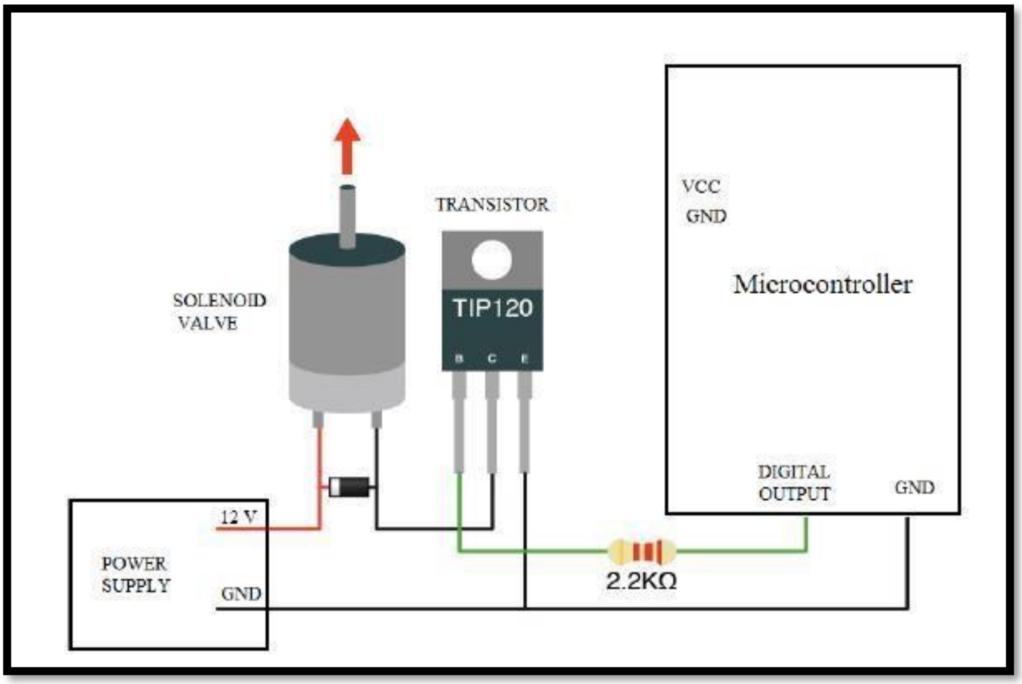

Figure 4.5: Solenoid Circuit

It shows the connection of the OLED display connected to the Arduino. To activate the OLED, pin SCK is linked to the source and pin number A5 and pin SDA connected to pin A4.

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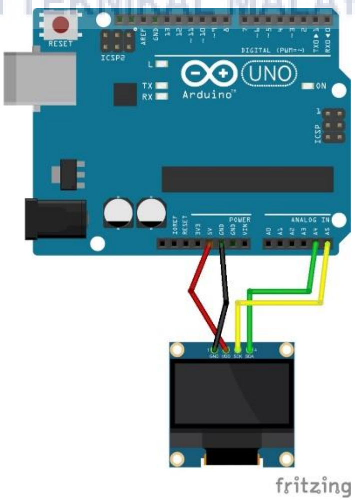

Figure 4.6: Circuit connection of LCD to Arduino

4.2 Results of the System

In this project, the water leak detector using Arduino and IOT application have been developed using the hardware and software which have been explained in the previous chapter. The functionality of the water leak detection and also the ability of the system to send the alert message to the users whenever the sensors had been triggered are the main priority to activate the system.

Once the hardware and software installation of the system is complete, it has to be tested in order to make sure all the parts are assembled correctly. If there is any problem identified during the testing, the system needs to be troubleshot. It has to be noted that the threshold value of each sensor is set in the programming is fixed due to level of water that is rational before the sensors are triggered. The results obtain from the system development are shown in all the figures below. It consists of the results when there is water leak detected in Figure 4.10 and the output devices activated. Besides, it also consists of the part when the notification received by the users. As if the system is working well, it is ready for analysis. In Figure 4.7, Figure 4.8 and Figure 4.9, it shows the initial condition of the system when there is no water leak detected by the sensors.

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Figure 4.7: Initial Condition of the system

Figure 4.8: Display no leak or no water flow

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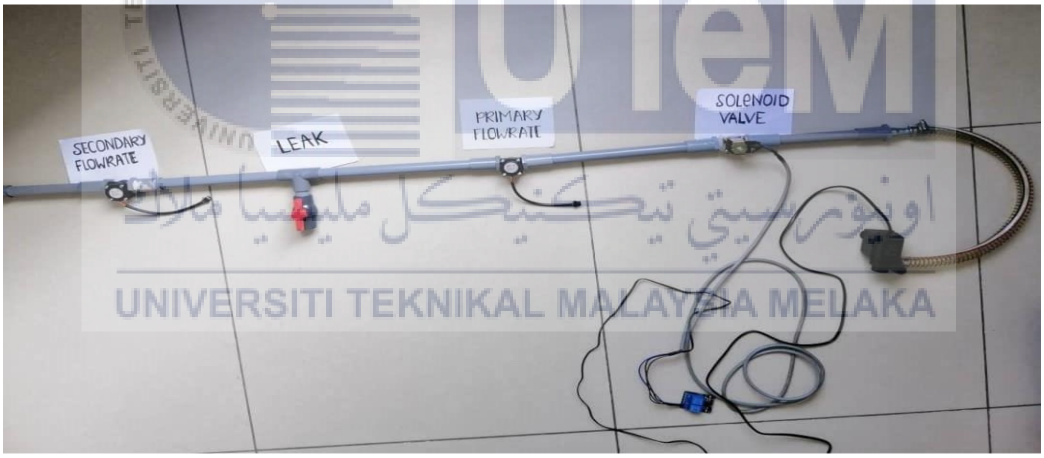
Figure 4.9: Display when there is water flow

Figure 4.10: Display when water leakage is detected

Figure 4.11: Hardware of the project



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Lastly, the users of this system will receive the alert message via GSM SIM 1900 when there is a leak detected from the leak. These alert messages were delivered to the users as a notification so that they can take appropriate action quickly.

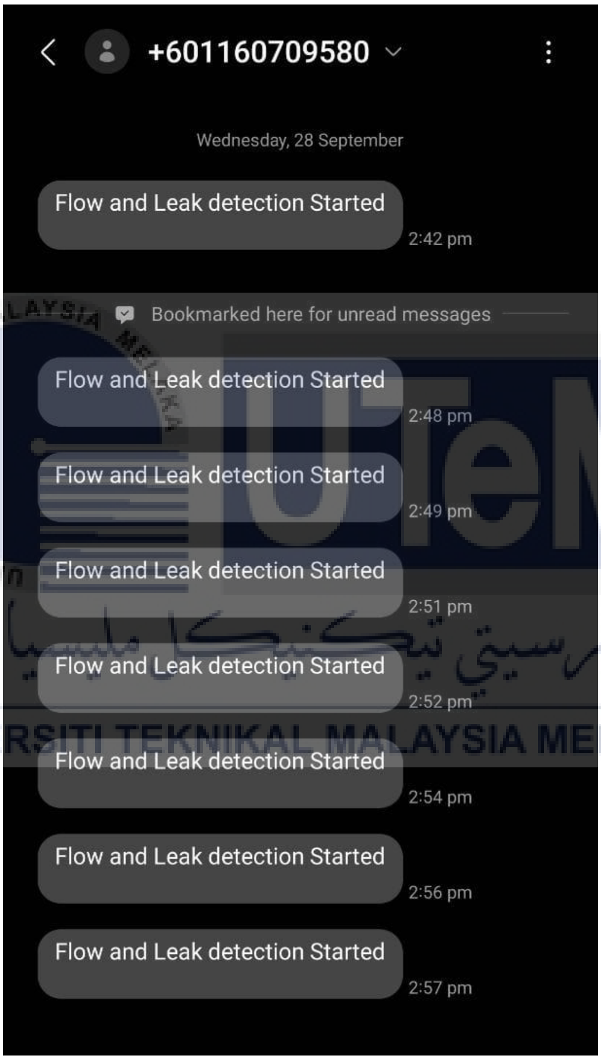

Figure 4.12: Alert message received by users

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4.3 Analysis of System Capability

The system has been analysed to test the capability in detecting the presence of water leak. In this analysis, different approaches of testing procedure have been used in order to identify the capability of the system. Hence, valid results can be obtained for future improvement.

4.3.1 Effectiveness of the Sensor Detection in Different Flow Rate of Water

The water flow of water was set at three level (High, Medium & Low) to test the efficiency of the sensors in detecting the water leak. Hence, the variables that should be considered are stated below:

- Constant variables: Placement of sensor
- Manipulated variables: Flow Rate of water
- Dependent variables: Reading of water flow

Table 4.1 : Table of measured data of water detected using different Flow

Normal Flow	Primary Pipe (L/m)	Secondary Pipe (L/m)	Leak Detected	Tolerances (L/m)
High	7.8	7.7	NO	0.5
Medium	5.0	4.9	NO	0.5
Low	1.9	1.4	NO	0.5

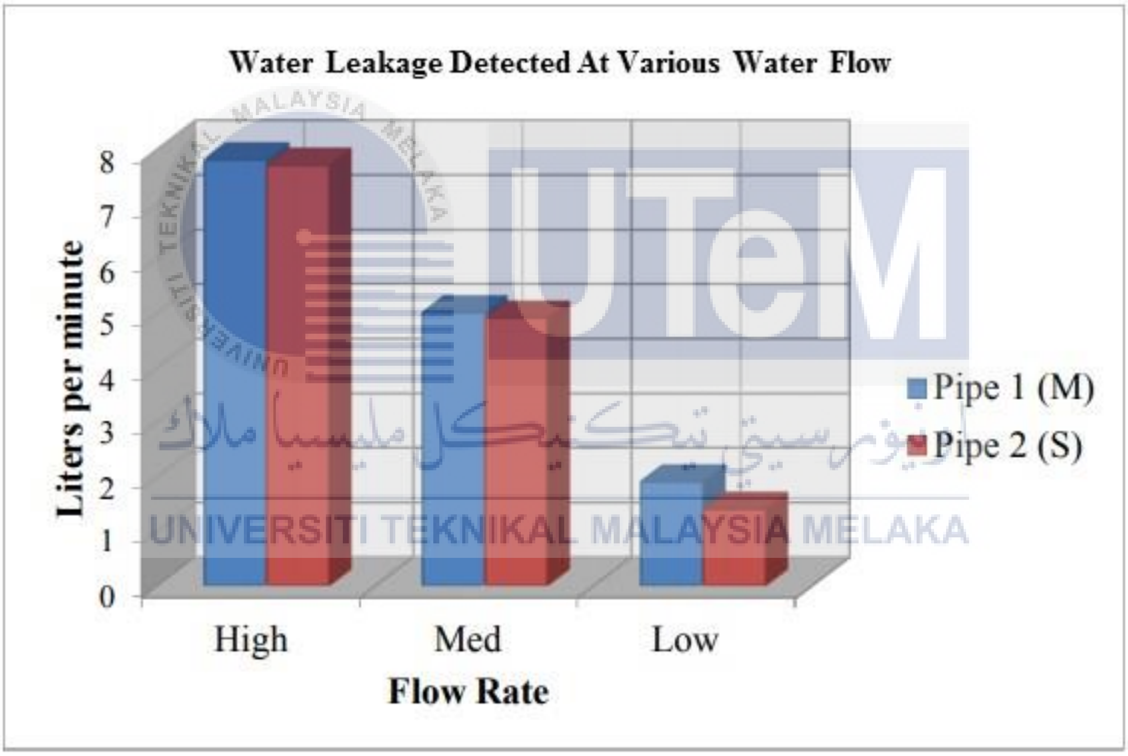

Figure 4.13: Graph representing water leakage detected at various flow rate

This gives an indication of what the normal flow rates should be when there are no leaks. The rate of water flow is measured in litres per minute. The variable in these results is the water flow rate, which was high, medium, and low; the primary pipe was tilt at three different angles to obtain each flow rate. Both the high and medium flow rate settings were observed to have similar values between the two pipes. On the other hand, the low setting, which maintained a consistent value of around 1.9 L/m at the master pipe, decreased at the exit pipe. The outflow pipe measured only 1.4 L/m. By the time the water reaches the exit pipe, there is likely less water pressure and less overall liquid flow flowing through the pipe. However, the number was still within the allowable tolerance of +/-0.5 L/m.

4.3.2 Effectiveness of the Sensor Detection at Different Amount of Leak

The second experiment is to test the system capability is by creating to types of leak; small leak & big leak. These are to identify the sensitivity of the products for better performance. The variables that should be considered are as below:

- Constant variables : Placement of sensor
- Manipulated variables : Amount of leak
- Dependent variables : Reading of water flow

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Table 4.2: Water leakage detected at 20% in various flow rate

20% Leak	Primary :Pipe (L/m)	Secondary Pipe (L/m)	Leak Detected	Tolerances (L/m)
High	8.3	7.4	YES	0.5
Medium	5.3	3.3	YES	0.5
Low	2.1	1.0	YES	0.5

Turning the valve to a position where just a small amount of water can escape creates the 20% leak valve setting. 15 to 20 degrees are deviated from the valve's default position. The pipeline continues to be operated at the three pump flow rates of high, medium, and low.

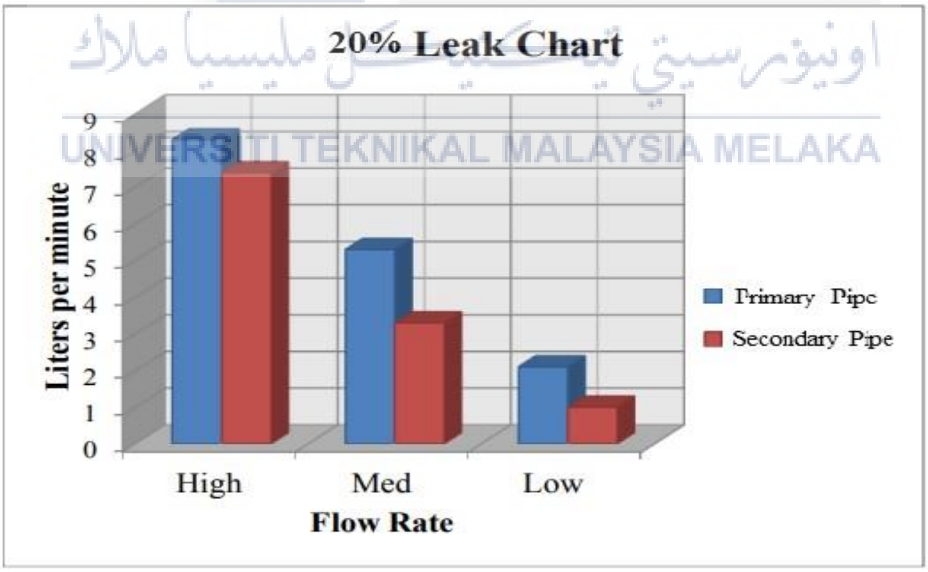

Figure 4.14: Graph representing water leakage detected at 20% in various flow rate

The 20% leak experiment examined whether the device would warn the user if a 20% pipeline leak was present. The results indicated that all three flow rates successfully demonstrated this. While the primary pipe maintained the original source flow rate, the exit pipe calculations revealed the amount of fluids lost through the leak valve. It was evident that the medium and low settings had lost over half of their initial worth. Only the high flow rate exhibited a smaller loss, which was likely because a minor leak could not significantly alter the high flow rate. In contrast to their regular control values, the master flow values for each of the three rates actually increased. This is due to the fact that the small leak functions as an exit point where pressure is attempting to escape.

The 100% leak valve setting is achieved by turning the valve parallel to its starting position, or around 90 degrees. The significant leak results from the valve being entirely open. A large amount of water is leaking from the valve, indicating that little water is flowing through to the exit pipe.

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Table 4.3: Water leakage detected at 100% in various flow rate

100% Leak	Primary Pipe (L/m)	Secondary Pipe (L/m)	Leak Detected	Tolerance (L/m)
High	10.7	5.2	YES	0.5
Medium	6.3	2.1	YES	0.5
Low	1.7	0.7	YES	0.5

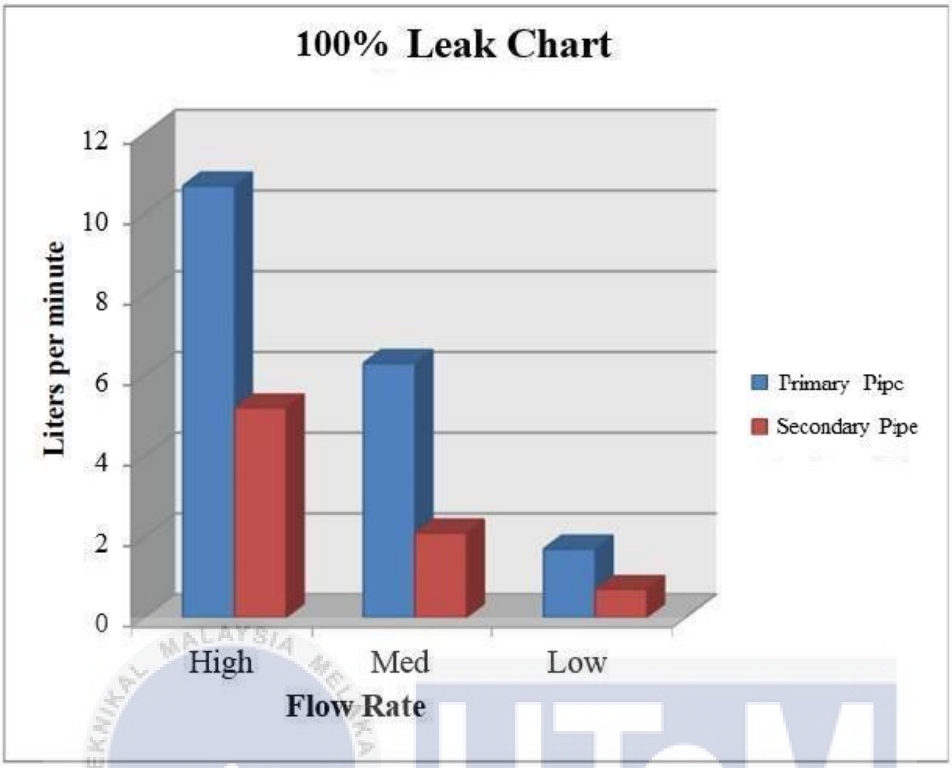

Figure 4.15: Graph representing water leakage detected at 100% in various flow rate

The effect exhibited by a 100 percent leak is striking at all three flow rates. In all flow rate trials, the flow rates at the exit pipes are halved since there is effectively an open hole in the pipeline through which water can escape. There is a "bursting dam" effect on the master pipe, which boosts initial flow rates prior to pressure equalisation. Still, the tolerance utilised in these trials is +/-0.5 L/m, which is sufficient to distinguish between any spikes in the 100% leak. The 100% leak was identified by all three pipeline results. This indicates that the leak detection system correctly identified the leak.

4.2.3 Results Comparisons

Table 4.4: Comparison Flows of Primary Pipe and Secondary Pipe

Comparison of Primary Pipe	Normal	20% Leak	Differences	100% Leak	Differences
High	7.8	8.3	0.5	10.7	2.9
Medium	5.0	5.3	0.3	6.3	1.3
Low	1.9	2.1	0.2	1.7	-0.2
Average	4.9	5.2	0.3	6.2	1.3

Comparison of Secondary Pipe	Normal (L/m)	20% Leak (L/m)	Differences	100% Leak (L/m)	Differences
High	7.7	7.4	-0.3	5.2	-2.5
Medium	4.9	3.3	-1.6	2.1	-2.8
Low	1.4	1.0	-0.4	0.7	-0.7
Average	4.7	3.9	-0.8	2.7	-2.0

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When comparing the findings in Table 4.4 for the principal pipe (primary pipe), it can be seen that both the little and large leaks resulted in an average gain. The rise in litters per minute on the principal pipe is the gain. Similarly, both the 20% leak and the 100% leak on the exit pipe result in an average loss. This behaviour contributes to the programming used to evaluate data readings from pipes. During the experiment, the small notes on spikes and skips helped to calculate the tolerance values for designing the algorithm. It is desired that the tolerance number can ignore skips and spikes while still being able to detect a permanent variation in water flow.

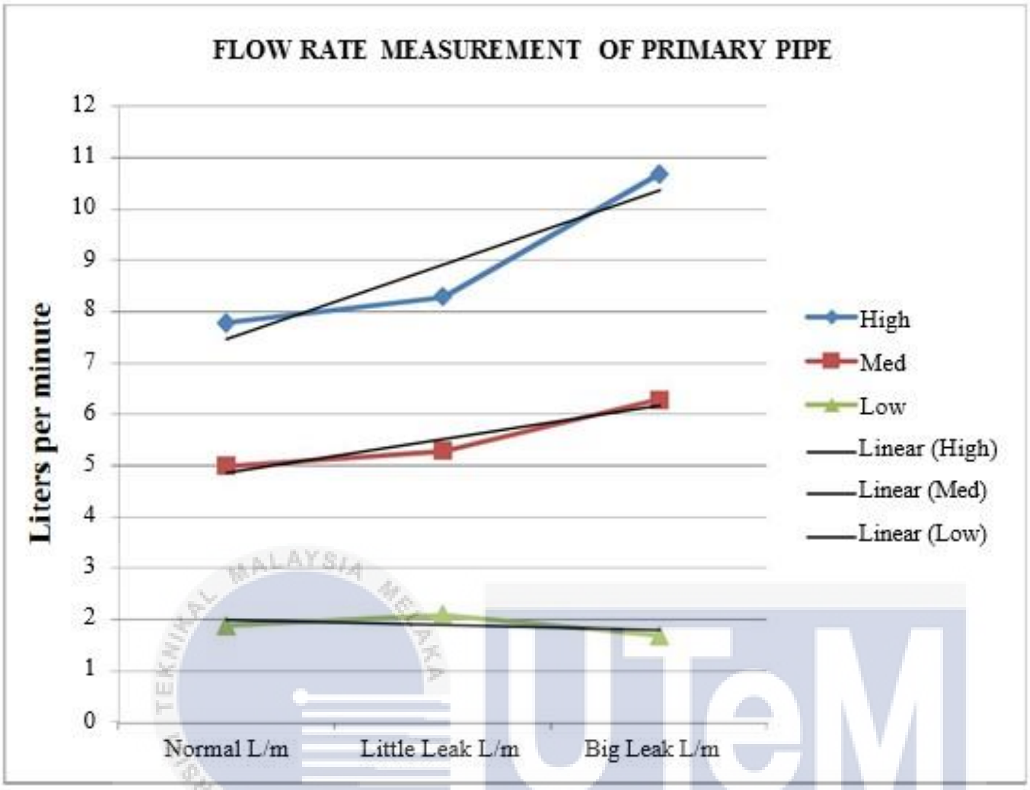

Figure 4.16: Graph showing flow rate measurement of Primary

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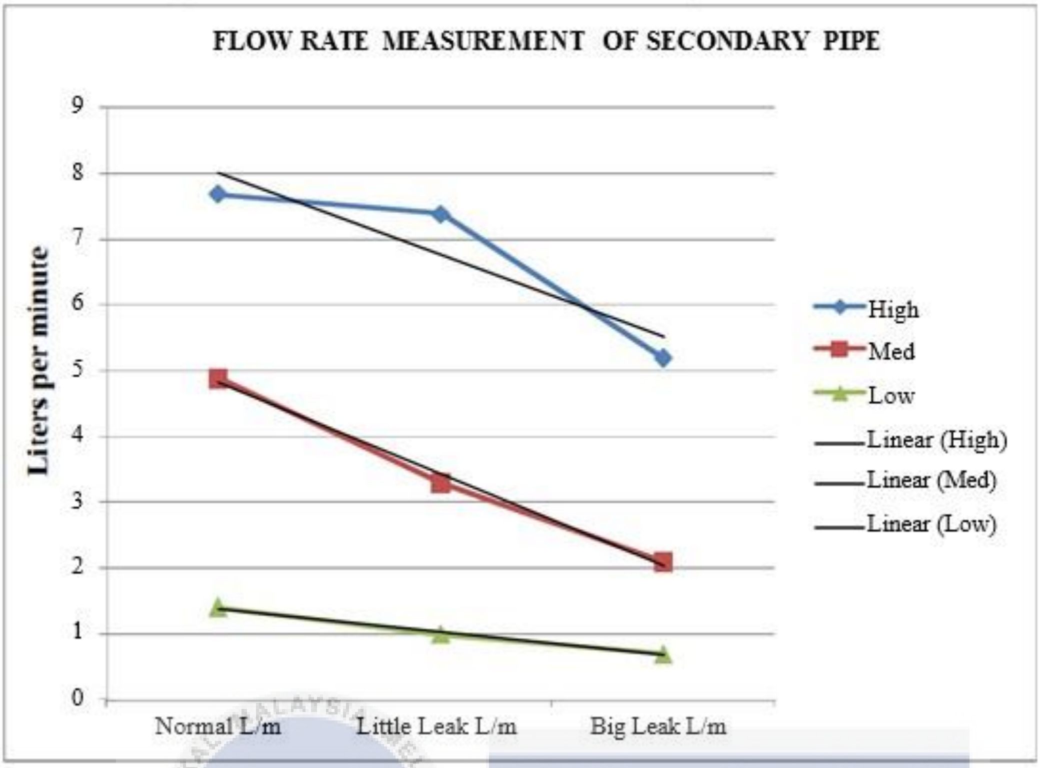

Figure 4.17: Graph showing flow rate measurement of Secondary

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In the charts and graphs, a comparison of the collected data between all water pump flow rates with a 20% leak and a 100% leak is depicted. The operator can see and identify trends in the recorded flow rates between the primary and exit pipe by reviewing and comparing the data. Increasing and decreasing flow rates are the two most notable trends seen (liters per minute).

The primary pipe reflects the increase that has occurred. The water flow rate increases as it goes from normal flow, which has no leaks present, to 20% leak, and then finally to 100% leak. This can be seen to be the case. For the purpose of illustrating this point, the comparative flow graphs each include a trend line. The one and only circumstance in which this is not the case is when the pump's water flow

setting is adjusted to a low level. This could be construed to mean that the low setting does not have much of an effect on the flow of water and that the water is simply flowing freely without restriction. It is possible for it to attract equally toward the leak valve and the second pipe while it is freely flowing. All flow rates start to increase when the water pump is adjusted to either the medium or high level, respectively.
When the water finds a way out, this effect is known as "bursting," and it may be seen when it occurs. However, once the pressure was brought back to its original level, it was seen that the flow of water decreased to a value that was constant. It is possible to see the reduction in water flow in the pipe that leads outside. The water flow rate through each of the three pipes decreased when the pump was set to any of the three different positions. The combination of the high flow water pump setting and the 20% leak revealed the least amount of drop of the three settings, which is an intriguing finding that emerged from the analysis of the data obtained.

This was construed to mean that water will naturally move in the direction of the path with the least amount of resistance. Because a large flow rate of water cannot easily escape through a breach that is just 20% of its capacity, the route of least resistance would actually be to move toward the pipe that leads outside. Nevertheless, when the huge leak is present, the path of least resistance for all three pump settings will become the exit for the big leak. This is especially apparent when comparing the data coming from the Primary Pipe to the Secondary Pipe 2. (Primary to exit pipe). The water flow rate decreases significantly, and it is roughly equivalent to being cut in half. It is essential to not forget the things that were discussed earlier. In most cases, leak detection systems are unable to pick up on the 20% of leaks that occur in high flows. This project utilises miniature pipelines that have a flow rate that is far less than that of actual pipelines. Even while the 20% leak and high flow combination was able to be recognised in this scenario, if it were to occur in a system that was actually operating, it is possible that it would not be detected. During the segment titled "Leak Characterization," this subject was discussed.

In any case, the purpose of the research was to analyse the behaviour of water in the presence of a leak using a pre-programmed algorithm on a computer and to see how water responded when a leak was there. The programme was successful in stopping all leaks, whether they were 20% or 100%. This indicates that the programme notified the user that a "Leak Detected" was found.

4.2.4 Reliability of the System to Send Text to the Users

The reliability of the system to send alert notifications was also tested. This is to analyses the capability of GSM to send the alert notification to the users. As this is one of the most crucial parts in this system, it must be fully reliable and working to make sure the system can be run smoothly. In this experiment, there are three considered variable:

- Constant variable : Location of the system
- Manipulated variable : Distance of user
- Dependent variable : Number of notifications received

It can be said that the system is reliable to send the alert notifications. This is due to the minimum number of fail notification at one place. The failure in sending notifications might be because of the network problem or the sensitivity of sensors.

Table 4.5:Table of number of success and fail alert notifications

Coverage Area	Number of Successful Notification	Number of Unsuccessful Notification	Distances
Durian Tunggal	9	1	10km
Bukit Beruang	10	0	7km
Melaka Raya	10	0	15km

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CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

This is the last chapter that concludes the findings of the research based on the analyses and discussions made in the earlier chapter. Some recommendations are also made at the end of the chapter for future works related to the study.

5.1 Conclusion

Taking everything into consideration, the Water Leak Detection device was a huge success. Using an analytical method that was computer-programmed, it was able to understand what the leaks meant. The produced device was also not like any other product now available on the market. Although there are already published and existing ways of leak detection, the device that was constructed for the purpose of this project and eventually made into an actual printed circuit board assembly was built from the ground up just for this endeavour. The device was also constructed with wireless communication in mind so that it could communicate with another device that was physically nearby. Because detection systems are typically located at various points along a pipeline, this helped us replicate the real-life model of a pipeline. When trying to communicate over a significant distance, wireless communication is the way that is most effective. The devices were able to communicate with one another and share data and calculations, which assisted in the inference that there was a water leak in the pipeline and also notified the operator of the event.

5.2 Recommendations

One of the observations that was made about the project was a future proposal for the use of a GPS. This was one of the observations that was made. If a larger-scale model of the project were to be built, a GPS system might be incorporated into it at that point in time. If a pipeline were miles long, in principle, a GPS could interpret the location of where a leak was present, so producing a system that was even more successful at localising the source of the problem. A time stamp will also be added to the data by the Global Positioning System (GPS), which is useful for analysing the data and determining whether or not a leak has occurred at any point in time. One further item to take into consideration is the variety of unique tactics that might be used in order to strike a balance. Because of financial constraints, the current experiment only made use of a single water flow metre to collect data. It is probable that the presence of many devices will help supply redundancy and further improve the inference that there is a leak. This is because redundancy and further enhancement are both benefits of having several devices. If a water flow metre can help in determining whether or not there is a leak, then many other gadgets that can also help determine whether or not there is a leak could help them. The operator is responsible for determining if the alleged leak is actually taking place or whether it is only a false positive. An insulated casing would not only make this device more marketable in the future, but it would also guarantee that any and all safety concerns will be addressed.

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APPENDIX

Appendix A Gantt Chart

H. PROJECT PLANNING																																						
List down the main activity for the project proposal. State the time frame needed for each activity.																																						
	2022																										2023											
Project Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
DEVELOPMENT OF STUDY TOOLS	BP Briefing							Mid Semester Break							Study Week		Final Semester Examination		Semester Break									Mid semester Break							Study Week	Final Semester Examination		
Topic Selection																																						
Discussion with Supervisor																																						
Machine & embedded system design																																						
Prototype Construction																																						
DATA COLLECTIONS																																						
Selection of subject to be tested																																						
Project Briefing																																						
Data collection (Phase 1)																																						
Data collection (Phase 2)																																						
DATA PROCESSING & ANALYSIS																																						
Data Entering & Pre-Post Analysis																																						
Final Report & Dissemination of Project Findings																																						
Project Presentation & Report Submission																																						

No.	ACTIVITES	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
1	PROJECT PLANNING, CHAPTER 1														
2	LITERATURE REVIEW (ARTICLES)														
3	METHODOLY, CHAPTER 3														
4	DATA GATHERING, TESTING														
5	REPORT COMPLETION & PRESENTATION														

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Appendix B Project Coding

```
#include <SoftwareSerial.h>

SoftwareSerial mySerial(2, 3); // RX, TX

//Flow sensors
#define flow1_pin A0
#define flow2_pin A1

int flow1 = 0 ;
int flow2 = 0 ;
int flow_av = 0;

//solenoid
#define valve_pin 8

/////LCD OLED 0.9' SH1106_128X64/////
#include <Arduino.h>
#include <U8g2lib.h>
#include <Wire.h>
U8G2_SSD1306_128X64_NONAME_F_SW_I2C u8g2(U8G2_R0, /* clock=*/ SCL, /*
data=*/ SDA, /* reset=*/ U8X8_PIN_NONE);


void setup() {
  // Open serial communications and wait for port to open:
  Serial.begin(9600);
  Serial.println("Flow control SIM started");

  //valve
  pinMode(valve_pin, OUTPUT);
  digitalWrite(valve_pin, LOW); //ON the valve

  // set the data rate for the SoftwareSerial port
  mySerial.begin(19200);

  mySerial.println("AT"); //Handshaking with SIM900
  delay(1000);
  mySerial.println("AT+CMGF=1"); // Configuring TEXT mode
  delay(1000);
  mySerial.println("AT+CMGS=\"+60199730442\"\r");
  delay(1000);
  mySerial.println("Flow and Leak detection Started");
  delay(500);
  mySerial.println((char)26);
```

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```
  //LCD
u8g2.begin();
u8g2.setFont(u8g2_font_ncenB08_tr);
u8g2.clearBuffer();
u8g2.drawStr(10,10,"Starting...");
u8g2.sendBuffer();

delay (3000);
u8g2.clearBuffer();
u8g2.sendBuffer();

//OLED 1
u8g2.drawStr(10,10,"Flow1: ");
u8g2.setCursor(50, 10);
u8g2.print(2.0);
u8g2.drawStr(90,10," L/min");

u8g2.drawStr(10,20,"Flow2: ");
u8g2.setCursor(50, 20);
u8g2.print(2.0);
u8g2.drawStr(90,20," L/min");
u8g2.sendBuffer();

delay (60000);

//OLED 2
u8g2.drawStr(10,10,"Flow1: ");
u8g2.setCursor(50, 10);
u8g2.print(2.0);
u8g2.drawStr(90,10," L/min");

u8g2.drawStr(10,20,"Flow2: ");
u8g2.setCursor(50, 20);
u8g2.print(2.5);
u8g2.drawStr(90,20," L/min");
u8g2.sendBuffer();

delay (1000);

u8g2.drawStr(10,30,"LEAK DETECTED");

delay (1000);

//OFF the valve
digitalWrite(valve_pin, HIGH);

//send message
```

```
mySerial.println("AT+CMGS=\"+60136238628\"\r");
delay(1000);
mySerial.println("Flow rate is different, check leaking...");
delay(1000);
mySerial.println((char)26);
//wait 10 second to check again


delay (30000);


}

void loop()
{
  //communication
  while (Serial.available())
  {
    mySerial.write(Serial.read());//Forward what Serial received to
Software Serial Port
  }
  while(mySerial.available())
  {
    Serial.write(mySerial.read());//Forward what Software Serial
received to Serial Port
  }

  // check flow
  flow1 = analogRead(flow1_pin);
  Serial.print("Flow1: "); Serial.println(flow1);
  delay(100);
  flow2 = analogRead(flow2_pin);
  Serial.print("Flow2: "); Serial.println(flow2);
  delay(100);

  //calculate average
  flow_av = (flow1 + flow2)/2 ;


  if (abs(flow1 - flow2)> flow_av*0.25)
  {
    //OFF the valve
    digitalWrite(valve_pin, HIGH);

    //send message
    mySerial.println("AT+CMGS=\"+60136238628\"\r");
    delay(1000);
    mySerial.println("Flow rate is different, check leaking...");
    delay(1000);
```

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```
    mySerial.println((char)26);
    //wait 10 second to check again
    delay(10000);
  }
  else
  {
    digitalWrite(valve_pin, LOW);
  }
//OLED
u8g2.drawStr(10,10,"Flow1: ");
u8g2.setCursor(50, 10);
u8g2.print(flow1);
u8g2.drawStr(90,10," L/min");

u8g2.drawStr(10,20,"Flow2: ");
u8g2.setCursor(50, 20);
u8g2.print(flow2);
u8g2.drawStr(90,20," L/min");
u8g2.sendBuffer();
delay(1000);
}
```

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