PUBLIC WATER SUPPLY GRID MONITORING IN UNDERGROUND PIPELINES LEAKAGE DETECTION USING IOT

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ABSTARCT

Underground pipeline leakage in public water supply grids poses a significant challenge, resulting in the loss of substantial water resources, infrastructure damage, and costly repairs. This project presents an Internet of Things (IoT)-based solution for monitoring and detecting leakage in underground pipelines, aiming to enhance water supply management and reduce water wastage. The system integrates ESP32, a low-cost microcontroller with Wi-Fi capabilities, alongside multiple sensors to monitor water quality, detect leakage, and manage water levels. The system employs a turbidity sensor to assess water quality, ensuring that water remains uncontaminated throughout the grid. A flow sensor monitors the water flow rate, detecting anomalies such as a sudden decrease in flow that may indicate leakage. The ultrasonic sensor measures water levels in critical areas, helping in the detection of any significant water loss. Additionally, a rain sensor and moisture sensor monitor environmental factors such as ground moisture, which helps in identifying external causes of water leakage or flooding. In case of leakage or water quality issues, the system automatically activates a water pump to reroute or stop the water supply, mitigating further loss. The real-time data is transmitted via the ESP32 to the Blynk IoT platform, providing remote monitoring and alerting capabilities. This system allows operators to receive immediate notifications and take corrective action swiftly. The proposed IoT solution offers significant advantages such as real-time monitoring, automated response mechanisms, and efficient use of water resources. The system is ideal for urban water management, helping municipalities and water authorities detect and fix pipeline issues promptly, reducing operational costs and minimizing water wastage. This can also enhance the sustainability of water supply systems in water-scarce regions.

I.INTRODUCTION

Sufficient clean water is a necessary element for every organism and needs, especially to human and animals to provide sustainable economic activities and daily lives activities. Malaysia is enriched with water resources with the demand of water increasing either from residential, agricultural, industrial, or medical. The rise in population and urbanization as well as improved living standards is imposing additional pressure on the water resources in the country. As a result, the per capital availability of water is decreasing, where evidence has shown that national coverage of water supply has increased from 80% of the total population in 1990 to 95% in 2000 stated by Akademi Sains Malaysia, National Hydraulics Research Institute of Malaysia, Ministry of Science, Technology, and Innovation. Thus, providing a good water monitoring system is required, especially in the residential household. Additionally, the report also stated that the frequency of water supply disruptions in the Klang Valley has been like a "monthly event" to more than one million consumers in the area. The frequent river pollution is like a nightmare to the affected residents who have been seeking for more concrete action to be taken as 90 percent of the country's source of raw water is river water or surface water. With the river basin exposed and frequency of water supply disruptions, many have suggested for the government to use high technology to overcome these problems. Yet, a large portion of water is lost during lost during transportation and distribution, commonly known as nonrevenue water (NRW) which required labour-intensive detection surveys which are usually expensive and not be able to give a continuous monitoring system. NRW is attributed to a various of sources, including metering errors, accounting errors, water theft and pipeline leakage. Undetected water problems also pose a health risk to occupant, which can lead to the growth of hazardous mold and fungus that can spread quickly to the surrounding areas. These causes lead the property damage, faulty of equipment's and expensive clean-up costs if the undetected water leak problems are not resolved or improved. Undetected water leakage will cause a low pressure of water and the flow of water will be small among the residential. The undetected water leaks problems in residential can lead to large water lost and damage to building structure. The cost of repairing these damages can increase into thousands of ringgits if the water leaks are not detected as soon as possible. Several works have been proposed for detecting water leakage in the pipeline, focusing on detecting leakage using microcontrollers, [1]–[3], wireless sensor networks [4], [5], SVM classification [6] others on fluid mechanics and kinematic physics based on water flow rate obtained from liquid meter sensor [7]. Meanwhile, [8] proposed an approach to household leakage detection by using of sound signal recordings. Their work records the sound signals produced by water fixtures and appliances, then used recordings to detect any abnormalities situation which be indicate the leak. To addition, [9], [10] detected the leak by acoustic sensors based on Internet of Things (IoT). Although there are many studies, research in water leakage remains limited in applying the approach using the Internet of Things (IoT) and to expand this technology in measuring the quality of household water to be drinkable.

II.LITERATURE SURVEY

Water is without a doubt the most precious resource in the world. Tremendous amount of water is wasted all over the world due to leakage in water pipelines. In order to utilize this resource wisely wastage of water should be avoided. This paper proposes better method to monitor the pressure of water flowing through the pipeline and detects leakages over the pipeline. Observatory kit which includes Raspberry Pi and pair of pressure sensor and water quality sensor is mounted all over the pipeline. Processor uploads the output of sensors on cloud server continuously. If it finds pressure below the predefined level; also despite the constant pressure if quality of water detoriate, then processor sends the alert message to concerned staff. We need internet connectivity in order to upload on cloud. But even in the absence of internet, alert message can be sent through SMS service which works on GPRS. This paper also sheds a light on taking preliminary measures on leakage reduction. Water flow is been supplied and controlled through valves which are situated at the junction of pipelines. In order to reduce water loss due to leakage processor controls the position of control valve so that water flow through the same pipeline will be reduced resulting in less loss of water. Many different techniques and platforms have been discovered for pipeline monitoring. In general leakage detection is mostly done by acoustic sensor (using either microphone or geophone). [3], [5], [14] uses these devices, resort to sensing mechanisms or sensing elements (like piezoelectric materials). This paper has also used gateways to send the sound received by acoustic sensor to backend server for further processing. FFT is one of the technique used to process the sound or noise of water. It analyses the difference between normal sound and abnormal sound condition if leakage has occurred. [5] uses microprocessor ARM M4 to collect the acoustic sensor output whereas [3] uses PIC microcontroller for the same purpose. But acoustic is only applicable for small diameter pipeline with pressure 2-3 bars. There are many other methods discussed in [6], [13] like detection using tracer gas technique, thermography etc. other than acoustic sensors. Leakage can be detected based on Time domain Reflectometry (TDR) where high measurement accuracy, high versatility, and robustness, relatively low implementation costs, and thanks to the possibility of carrying out continuous, automated, remotely-controllable, real-time measurements are demanded. [7] is also based on TDR but it uses application and reflection of electromagnetic signal. Reflection coefficient is calculated which is proportional to flow difference through pipeline. Transmission line i.e. metallic wire is laid on the road which allows electromagnetic signal to pass through the soil and reflects back from pipe surface. [1] have used this method not only to detect the location of leakage but also quantity of water wastage. [8] uses Ground Penetrating Radar (GPR), but here reflected waves are recorded, digitized and then B-scan images are formed. 3 step method is developed to analyze these B scan images. [2] suggests a statistical filter for the images of cracks. It describes in depth study of behavior of crack detector based on image processing. Images are taken by visual inspection or by CCTV videotape. [4] discusses theoretical analysis about double islandbeam structure sensor. The position for sitting resistances values and width of resistances are analyzed in detail. It utilizes finiteelement method (FEM) and simulation software analysis, static and dynamics analysis and computer simulation are carried out for strain diaphragm of piezoresistive micro-pressure sensor. [9] uses Smartball and [10] uses Explorer, 4 wheeled camera carrying in pipe robots. Both flow with the water in pipe, [11] detects the crack which finally results in leakage using Wireless Networked Sensors. Reliable communication takes place by ZigBee technology. Vision based system PIG (Pipeline Inspection

III.SYSTEM ARCHITECTURE

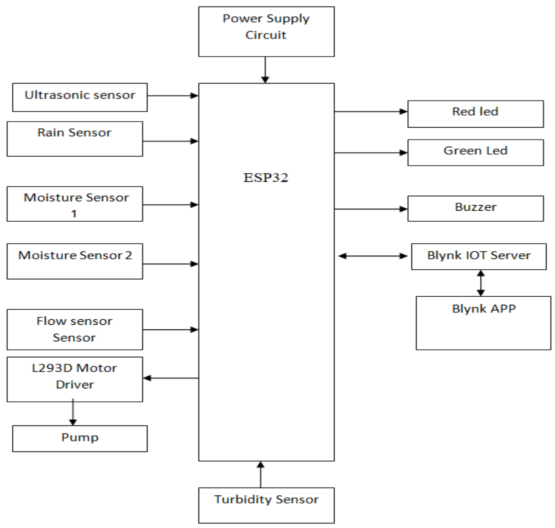

Figure 3.1 System Architecture

IV.OUTPUT SCREENSHOTS

This project is well prepared and acting accordingly (including all the hardware and software) as per the initial specifications and requirements of our project. Because of the creative nature and design the idea of applying this project is very new, the opportunities for this project are immense.

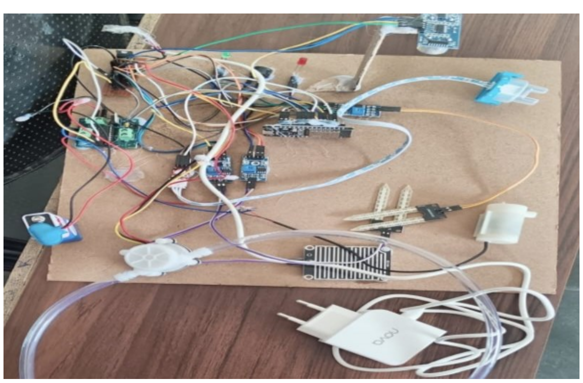

Fig no: 4.1 Practical Representation of Experiment

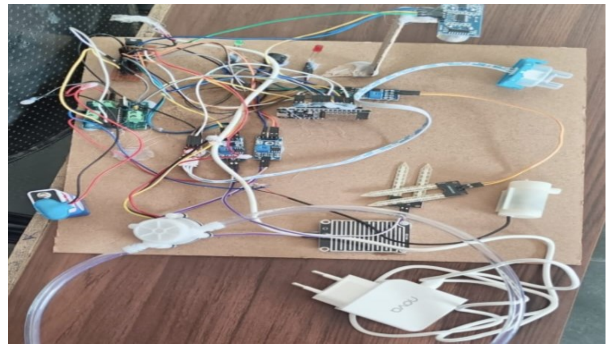

Fig no: 4.2 Practical Representation of Experiment

We are taking the moisture levels at 4000 if t will get decreased the notification will get to the authorities as shown in below, similarly we get notifications from rain sensor and turbidity sensors.

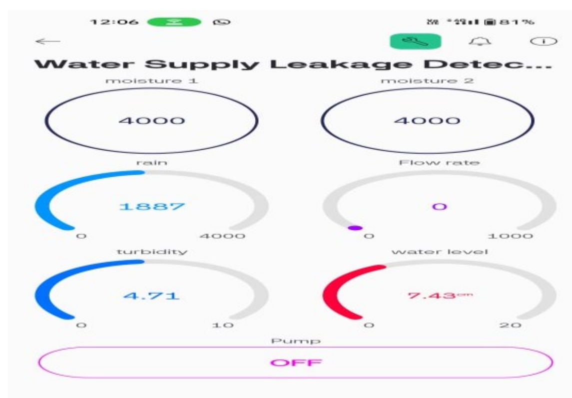

Fig no: 4.3

Fig no: 4.4

V.CONCLUSION

Water Pipeline Leakage Monitoring System based on Internet of Things (IoT) is designed to monitor the pipeline system in the house. Many sensors that been used in this project which is turbidity, water flow and water sensors. The turbidity sensor is more suitable to be placed at the main pipe as the user can know the water quality before the water entered the water tank in the house. There were two water sensor that been set to detect the water leakages so that the user can easily estimate the pipe's location that leaked while the water sensor is used to detect the water level detection as the pump will be automatically stop when the water is full in the water tank. Lastly, the water flow sensor is used the measure the flow of the water within the pipe from main pipe into the water tank of the house. Based the result the system and prototype is successful monitor all parameters that have been proposed. From the result that has been shown, the overall system has many advantages in many ways. Firstly, the IoT system implemented is a real-time system where all data collected from the sensors which water, water flow and turbidity sensors are sent to cloud system at the same time and the user can see the data online. The system has shown that there are multiple ways of given notification to the users either through email or through its own mobile Blynk app. The user also can monitor the recent data from mobile application which more fasters than website. The notification also been displayed in these mobile app as the condition of the data sensor been set by the user. This system however requires a strong connection to the internet in order the data to be sent to Blynk website. If data is not being sent to Blynk website, alert notification to Telegram application is impossible. Furthermore, the power of the microprocessor which is Arduino is not able to support the water pump as the water pump is need 12volt to work properly. So, to solve this problem, the power adapter has been added to support the water pump. Next, the turbidity sensor's values sometimes does not very accurate as other water quality sensors. With increase the sensitivity of this sensor, the problem can be avoided.

VI.REFERENCES

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