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Smart IoT-Enabled Bot for Gas Pipeline Leak Detection and Real-Time Video Monitoring

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Abstract. This paper proposes a simple system for monitoring a water pipeline, detecting leaks and cracks, and initiating preparatory actions. The sensing element will continually measure the pressure in the pipeline. The sensed data is sent into a processor, which compares the measured value to the predicted hydraulic pressure. This comparison must be made on a constant basis to keep the proper pressure in the pipe. This real-world data (device result) is constantly updated on the cloud platform. Therefore, in research, a gasoline leakage detecting system was developed using a motion detection algorithm implemented on the Raspberry Pi control board. A webcam is used to collect real - time video. A technique running on the Raspberry Pi is used to efficiently execute the training and classifying tasks. In the event of a gas leak, emergency mail will be sent to security agents for more action. It is mounted above the motorized bot and equipped with an ultrasonic sensor.

Keywords: Gas pipeline, leakage detection robot, Surveillance system, Email alert, IoT

INTRODUCTION

The Internet of Things is a network of physical objects, known as "things," that are connected to the Internet. It's a system that lets you monitor and control the things in your life remotely through an app or web portal [1]. The Internet of Things can make your life easier, safer, and more efficient. It can also help you save money and live better [2]. We live in a world that's getting smarter and more connected every day. From the moment we wake up, we're surrounded by devices that collect and transmit data, making our lives easier and better. But what if we could harness the Internet to build a smarter world that's better for the environment, too? That's the dream behind the Internet of Things [3].

It has the potential to change the world. But what does this mean in practice? We've already seen the impact of IoT in industries such as manufacturing, where the introduction of smart sensors and smart machines has had a transformative effect on the way that factories operate. Today, we're starting to see the same thing in the world of logistics, where the introduction of smart devices to the supply chain has had a similarly transformative effect. Natural gas has been hailed as the cleanest-burning fossil fuel. But when it's drilled from the ground, the gas itself doesn't cause the biggest environmental problems [4]. It's when the gas is piped through the ground to a power plant or a home that the problems start sometimes when gas pipes leak, and the gas seeps into the water supply or the air [5]. These pipelines are the primary link between suppliers and users but maintaining them is an expensive endeavor. It is extremely difficult for humans to pinpoint the exact location of a leak on a pipe. These locations are found by a robot using the altitude and latitude idea, which sends data to a user or operator who then discovers the actual place [6]. As a result, the user will turn off the switches and avoid an accident in the future. These are necessary for good governance, long-term economic development, and security [7].

One issue is detecting gas leaks in pipelines as early as feasible, especially in gas pipelines. It is critical to discover leaks in the pipeline as soon as feasible. If the identification of the gas leak in the pipeline fails, it might have catastrophic consequences for the environment as well as the human population in the surrounding region. Corrosion develops in the gas pipeline because of structural flaws [8]. Nigeria's extensive network of oil and gas transmission pipes forms a massive system of safe transportation. Monitoring and surveillance of these pipes will eventually replace traditional approaches [9]. This can result in more lives being saved as well as an increase in the efficiency and efficacy of pipeline maintenance. In this work, we developed a platform for monitoring the structural

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and functional state of the pipeline, with the goal of using the monitoring system's data to activate the drone in the event of a leak or vandalism [10].

In this paper, we employed the fuzzy logic technique to combine information from two sensors (pressure and vibration). For future studies, we propose using a neural network to build a knowledge base of varied vibration and pressure patterns to detect leaks and forecast vandalism [11]. We were able to develop a web console that would aid in the monitoring of the UAV. To improve this work, we will need to consider more characteristics and include digital signal processing to eliminate false alarms and acquire more precision [12]. The success of creating the LPG gas leakage detector would aid in properly detecting LPG gas leaks and avoiding the risk of fire and pollution, so saving lives and property [13]. A gas leak in the oil and gas sector is harmful to employees and industrial operations. A rapid identification and alarm would reduce the risks of a gas leak [14]. Wireless technologies are being employed in a variety of applications, and numerous methods have been used to monitor pipelines. Many systems are used to pinpoint the location of leaks. Some technologies enable a remote system to identify leaks or detect and communicate the locations of any leaks to the operator [15].

PROPOSED METHODOLOGY

As presented in Figure 1, this project proposes a simple system for monitoring a water pipeline, detecting leaks and cracks, and initiating preparatory actions.

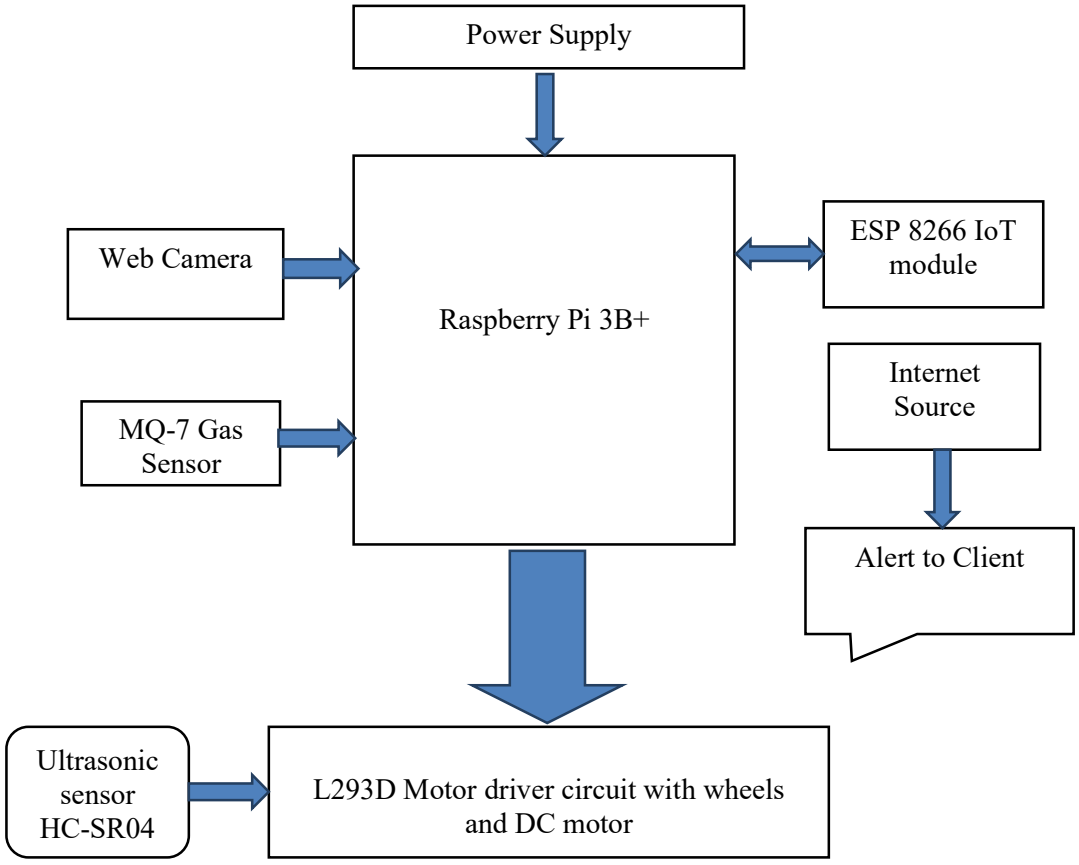

Figure 1. Proposed Module

The pressure sensor will continually measure the pressure in the pipe. The sensed data is sent into a

microcontroller, which analyzes the measured value to the predicted hydraulic pressure. This assessment must be performed on a constant basis to keep the proportioning valve in the pipeline. This real-time data is constantly updated on the cloud network. As a result, physical supervision in faraway areas could be eliminated. ThingSpeak is an internet service that connects MathWork's Math tool to track information from back channels such as different sensors.

The Raspberry Pi is a series of small single-board computers, designed and manufactured by Raspberry Pi Foundation in-partnership with Premier Farnell and Element 14. The first Raspberry Pi was launched in 2012, and since then they have become the most popular computer in the world, with almost 20 million units sold. They are used in all kinds of applications - from robots, to drones, to web servers, and everything in between. They are also great for hobbyists, who use them to build everything from home security systems to video games, to music streaming devices. The Raspberry Pi camera is a small digital camera module that can be added to a Raspberry Pi to enable it to capture photos and videos. It's a great way to add photography capabilities to a Raspberry Pi project without needing to design, build, and test a camera fromscratch.

The gas sensor is a sensor that measures the concentration of gases in the air. The gas sensor is one of the most common sensors in use today, with many consumer devices like the CO detector and smoke detector featuring a gas sensor. The gas sensor is extremely useful in the home, as it can help alert users to dangerous levels of carbon monoxide, which can build up in the home from leaks and appliances, or from a leaky gas stove. It can also detect other common gases, like hydrogen, which can be an early sign of a leak in a gas line.

In many automated factories and industrial facilities, ultrasonic sensors are employed to detect and measure the distance to targets. Sensors with on or off digital output are required to detect the presence of objects [16], although sensors with an analogue output that fluctuates proportionately to the detector to target path length are available on the market.

RESULTS AND DISCUSSIONS

Figure 3 depicts the workflow of the Gas drain monitor IRobot. A gas leakage detecting Robot has been created that can detect gas leaks. The Embeddings and the Sensor module sensing have been configured. If there is a gas leak, the sensor, which is mounted on the robot, detects it. The buzzer is activated, signaling the presence of a gas leak. The robot comes to a halt after detecting the leak. Mail is used to send a warning notification to the administrator. When there is no evidence of a gas leak, no action is being taken.

The software and hardware are merged to create the proposed system. Every system requires testing. As a result, this technology must be evaluated in a real-world setting. The gas leak detecting system works correctly as shown in Figure 4. A webcam is used to collect real - time video. A technique running on the Raspberry Pi is used to efficiently execute the training and classifying tasks. In the event of a gas leak, emergency mail will be sent to security agents for more action. It is mounted above the motorized bot and equipped with an ultrasonic sensor. Figure 5 shows the mail alert.

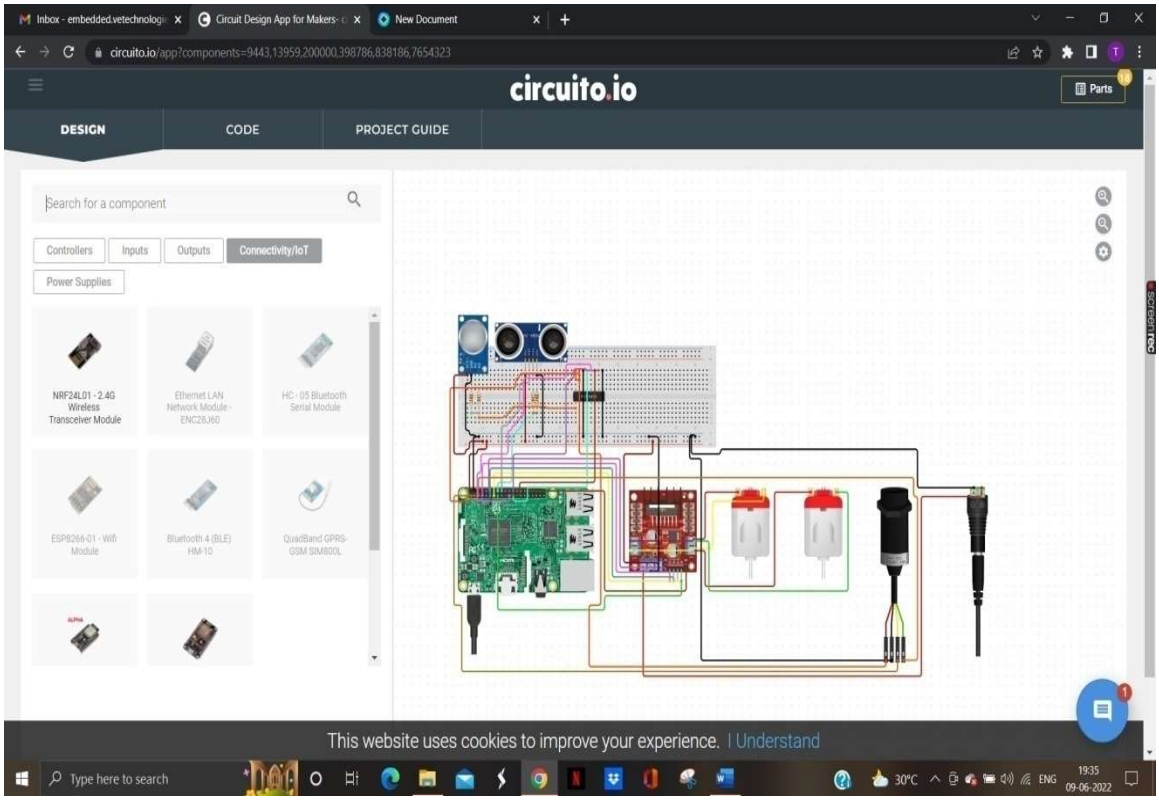

FIGURE 2. Circuit diagram

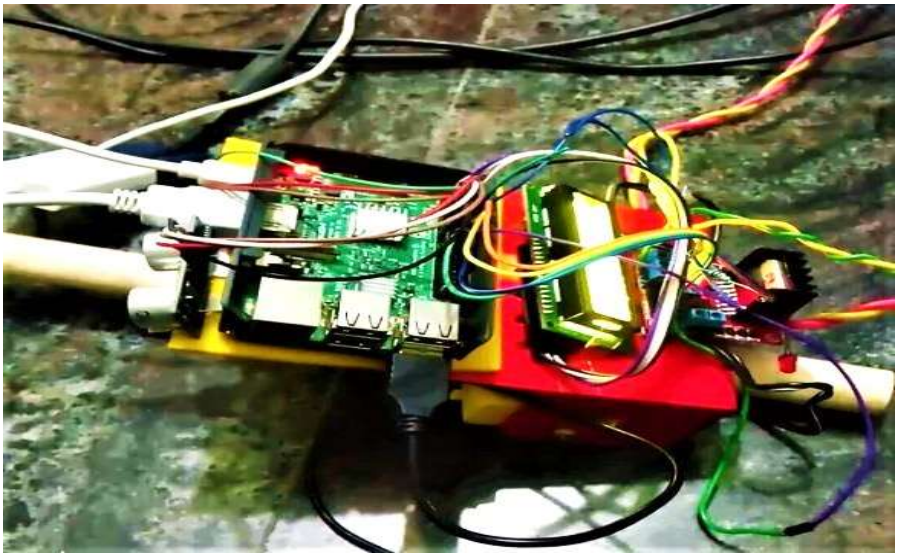

FIGURE 3. Proposed module implementation

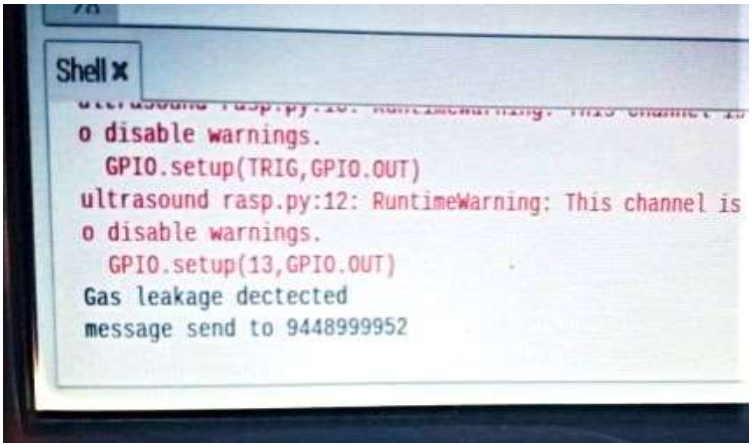

FIGURE 4. Leakage alert

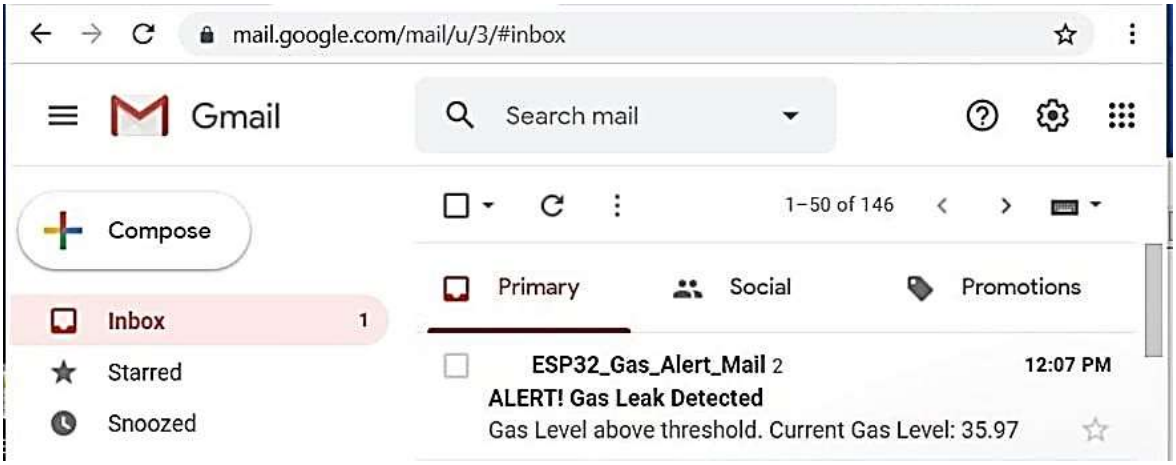

FIGURE 5. Gas leakage email alert

CONCLUSIONS

The Raspberry Pi-3 includes built-in Wi-Fi and Bluetooth. This suggested surveillance system may be improved further by utilizing mail to deliver security alerts to user smart phones via mobile Apps. The suggested framework is low-cost and compact. The process optimization leakage of gas using a MQ-135 gas sensor and an ultrasonic sensor and notifies the customer of the leakage. Whenever a Gas Leakage is detected above a particular Given Threshold, an email is instantly sent. As a result, the ESP32 Electronic mail Status indicator system alerts users to promptly close the valve or conduct any other action. Through the Local Central Server, the system may be enabled or disabled. If we disconnect, we will no longer receive email alerts whenever the gas price is surpassed. This System may be used as a safety mechanism in manufacturing or at household. A sizable system of secure transportation is made up of the extensive global network of oil and gas transmission pipes. The traditional approaches will eventually be replaced by the monitoring and surveillance of these pipes. This might result in more lives being saved while also improving the efficacy and efficiency of pipeline maintenance. In this study, we developed a platform for tracking the structural and operational state of the pipeline so that, in the event of a leak or vandalism, the drone could be launched using the information gathered from the monitoring system.

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