WWJMRD 2017; 3(12): 157-160
www.wwjmrd.com
International Journal
Peer Reviewed Journal
Refereed Journal
Indexed Journal
UGC Approved Journal
Impact Factor MJIF: 4.25
e-ISSN: 2454-6615

Gopichand G
School of Computer Science and Engineering, Vellore Institute of Technology, Vellore, Tamil Nadu, India

Santhi H
School of Computer Science and Engineering, Vellore Institute of Technology, Vellore, Tamil Nadu, India

Gayathri P
School of Computer Science and Engineering, Vellore Institute of Technology, Vellore, Tamil Nadu, India

Correspondence:
Gopichand G
School of Computer Science and Engineering, Vellore Institute of Technology, Vellore, Tamil Nadu, India

Gas Leakage Detection Using RF Robot Based on IOT

Gopichand G, Santhi H, Gayathri P

Abstract
Many different wireless sensor nodes for gas pipeline leak detection and location has been proposed. This paper discusses gas, leaking from high pressured gas pipeline. This system can be useful in gas companies or industries where transportation of gas is done.. Here we are using an RF robot to travel through the pipeline. The robot moves as per the directions given by RF remote. This robot is helpful to identify the gas leakage in the pipeline along with the location details. RFID module is interfaced to the robot to identify locations using cards. RFID cards are placed at different locations in the pipeline. An LDR sensor is placed which gives a pulse to the controller when the light is detected. The robot will be moving in the pipeline and notifies about each place. It identifies leakage i.e. damage caused to the pipeline by recognizing light using LDR sensor. All this information will be updated in the web server using IOT module connected to the controller. We are using AT89S52 as our controller. The RF modules used here are Transmitter, Receiver, RF Encoder and RF Decoder. The four switches are interfaced to the RF transmitter through RF Encoder. The encoder continuously reads the status of the switches, passes the data to the RF transmitter and the transmitter transmits the data. This paper uses a 12V battery.

Keywords: RF, RFID, LDR, RF encoder, RF transmitter

Introduction
The easy and inexpensive way to transport large quantities of Crude oil and Gases is through pipeline transportation, which is the current methodology used all over the world. Depending upon the quantity and the rate of flow these pipelines are installed. The installation of this pipelines can be above the ground and underground, basically, it depends on the distance and use of the product which is transported through the pipeline. For example, In Industrial usage, the product should be transported from one plant to another plant here the distance is short and the transportation of the product is within the industrial area. So the pipeline network will be installed above the ground. When it comes to the domestic supply of LPG gas for the household purposes usually underground pipeline network is used as it should cover a vast area. In general, these pipelines have a diameter of 4 to 48 inches and typically buried at a depth of 3 to 6 feet. For the protection of these pipes from impact, abrasion and corrosion, a verity of methods like wood lagging, concrete coating, rock shield etc. are used. Here are some of the statistics from different sources states that around 2,175,000 miles of pipeline have been installed in 120 countries around the world. Of these United States, Russia and Canada had 75% of the entire pipeline. When it comes to India around 24,802 km of the pipeline have been installed all over the country for the transportation of Crude oil, natural gas and other products. In FY15, India had a provisional refining capacity of 223.3 MMTPA, which made India second largest refiner in Asia, and by 2017 it is estimated to reach 310 million tons.

As the above-stated facts, advantages and statistics about the pipeline transportation showed that how important and widely it is used around the world. Well, added to its advantages there are some disadvantages and dangers attached which may cause large destruction and have a great impact on the eco-system and the environment in their encounter. Yes, it is true that the dangers and accidents encountered due to the leakage in the pipelines during the transportation had caused great damage to the infrastructure, environment and also loss of life. Down the line of history, a number of accidents occurred and still the list is increasing.

These are some of the major pipeline accidents occurred around the world during last twenty years (1996 – 2016) that took number of lives and caused great damage to property and ecosystem: 1996, A Colonial pipeline was ruptured at the Reedy River in South Carolina, USA and released 957,600 US gallons of fuel oil into the river water. It cost $20 million and killed around 35000 fishes; 1998, A petroleum pipeline explosion in Nigeria Killed more than 500 villagers; 2000, another pipeline explosion near the town Jesse in Nigeria killed 250 villagers; 2002, A Natural gas pipeline was exploded near Lanham, West Virginia. The valves and other parts of pipeline were blown which made it difficult to contain the fire for several hours. In total it caused $2,735,339 property damage; 2004, Belgium natural gas pipeline explosion in Ghislenghien took 24 lives and 122 wounded; 2006, An oil pipeline in Lagos, Nigeria exploded and nearly 500 people were killed; 2008, A corroded Natural gas pipeline was exploded in Varanus Island, Australia which led to sudden shut down 35% of gas supply in Australia and it is called Western Australian gas crisis; 2010 Dalian pipeline disaster in China caused an ecological disaster and around 11,000 barrels of oil was released into sea; 2012, A 26-inch gas pipeline was ruptured and exploded in north-eastern Gray Country, Texas. It burned 2 acres of agricultural area and telephone poles; 2014, a natural gas pipeline was exploded in Nagaram village, Andhra Pradesh, India causing a death of 16 people; 2016, A Colonial pipeline in Shelby County, Alabama was ruptured and 252,000 gallons of gasoline was leaked. Besides these, there are a vast number of unlisted accidents that occurred due to leakages and this results in the innovation of leak detection systems.

In this work, we are looking towards a much cost effective system to detect any gas leakage. One other important aspect is to report its location with maximum accuracy immediately to notify any possible damage and to prevent it. So we have a leakage detected by detecting any light which enters and we also get to know the location exactly to take any prompt action. Another objective is to maintain a time to time check on the pipe's condition to prevent any hazardous event.

Literature Survey

Well, to increase the safety, monitoring and proper maintenance, and to attain all these at inexpensive and effective has led to the proposal of a number leak detection methods.

Soap Bubble method is a quick, simple, and minimal effort leak detection method. Soap bubble screening includes showering a Soaping arrangement on little, available segments, for example, threaded connections. Soaping is compelling for finding free fittings and associations, which can be fixed on the spot to settle the break, and for rapidly checking the snugness of a repair. Numerous methane emissions sources that are financially savvy to find, measure, and settle are for the most part bigger than the little releases prone to be found by soaping. Even soap leak detection is fast and inexpensive, but still using this method for daily monitoring of long pipeline network can't be helpful in detecting leaks in all cases.

Electronic Screening utilizing little handheld gas indicators or "sniffing" gadgets gives another quick and helpful approach to identifying open leaks. Electronic gas finders have catalytic sensors intended to distinguish the nearness of particular gasses. Contingent upon the affectability of the instrument, identifying leaks in territories with high concentrations of hydrocarbon gas can be troublesome. This makes electronic gas detectors still not a good choice for regular monitoring.

Acoustic leak detection systems ordinarily use acoustic sensors to recognize release of gasses by detecting and analyzing the acoustic waves. The upsides of the framework incorporate discovery of the area of the leaks and in addition non-obstruction with the operation of the pipelines. What's more, they are effectively ported to different sizes of channels. Be that as it may, a substantial number of acoustic sensors is required to screen a broadened scope of pipelines. The innovation is also not able to recognize small leaks that don't create acoustic discharges at levels generously higher than the foundation commotion. Endeavors to recognize small leaks can bring about numerous false alerts.

Gas sampling strategies ordinarily utilize a fire ionization identifier housed in a hand held or vehicle mounted test to recognize methane or ethane. The essential favorable position of gas inspecting techniques is that they are exceptionally touchy to little centralizations of gasses. Along these lines, even exceptionally little holes can be recognized utilizing gas examining strategies. The method is likewise invulnerable to false alerts. The burdens of the innovation are that identification is eased back and restricted to the neighborhood which the gas is drawn into the test for investigation. Hence the cost of checking long pipelines utilizing gas sampling techniques is high.

Software based dynamic modeling screens different stream parameters at various areas along the pipeline. These stream parameters are then incorporated into a model to decide the nearness of petroleum gas spills in the pipeline. The real focal points of the framework incorporate its capacity to screen constantly, and non-impedance with pipeline operations. Notwithstanding, dynamic demonstrating techniques have a high rate of false alerts and are costly to monitor vast system of channels.

In soil checking strategies, the pipeline is first immunized with a little measure of tracer chemical. This tracer compound will leak out of the pipe in case of a break. This is recognized by dragging an instrument along the surface over the pipeline. The upsides of the technique incorporate low false cautions and high affectability. Nonetheless, the strategy is extremely costly to monitor since follow chemicals must be persistently added to the petroleum gas. Also, it can't be utilized for recognizing spills from pipelines that are uncovered.

Thermal imaging recognizes natural gas spills from pipelines because of the distinctions in temperatures among the natural gas and the surroundings. This technique can be utilized from moving vehicles, helicopters or versatile frameworks and can cover a few miles or many miles of pipeline every day. Typically, costly thermal imagers are needed to get the little temperature differential between the releasing gas and the environment. Moreover, Thermal imaging won't be successful when the temperature of the gas is not unique in relation to that of the environment.

Multi-wavelength or hyperspectral imaging can be expert either in Absorption mode or in emission mode. For getting gas concentrations using multi-wavelength emission, the gas temperatures must be significantly higher than the encompassing air. Multi wavelength emission estimations have been normally utilized as a part in the past to get

single point fixations in hot burning items. Multi-wavelength absorption imaging uses the absorbtion of foundation radiation at different wavelengths to specifically picture the gas fixation, even without temperature gradients between the gas and the encompassing air. This method has been utilized to screen petroleum gas spills in modern settings effectively. In any case, multi-wavelength or hyperspectral imaging normally uses extremely delicate and costly imagers.

Problem Statement

The basic functioning and the various concepts involved are mentioned as we start with the RFID module is interfaced to the robot to identify locations using cards. RFID cards are placed at different locations in the pipeline. An LDR sensor is placed which gives a pulse to the controller when the light is detected. The robot will be moving in the pipeline and notifies about each place. It identifies leakage i.e damage caused to the pipeline by recognizing light using LDR sensor. All this information will be updated in the web server using IoT module connected to the controller. We are using AT89S52 as our controller.

The RF modules used cast-off a Transmitter, Receiver, RF Encoder and RF Decoder. The four switches are interfaced to the RF transmitter through RF Encoder. The data about the status of the switches is consistently checked and sent to the transmitter. This system uses a 12V battery.

Other concepts used for this paper are the Digital signal processing concepts to convert the signals being sent and the RF technology which is used for communication with the robot basics of embedded systems for integrating the whole system.

AT89S52 Microcontroller

The AT89S52 has a high performing CMOS 8-bit microcontroller with 8K bytes flash memory. Atmel's high-density nonvolatile memory technology is used in this microcontroller. Flash allows the program memory to be reset in the system or even by a conventional type of memory programmer. With the combination of 8-bit CPU and in-system programmable flash on the monolithic chip, this chip proves to be a very powerful one which supports giving us flexible and also cost effective solutions.

The AT89S52 has the following specified standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. Apart from these the AT89S52 is deliberated with static logic for operation down to zero frequency and supports two software selectable power saving modes.

The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM contents but freezes the oscillator, disabling all other chip functions until the next interrupt or hardware reset.

Pin Configurations

RFID Module

RFID Reader Module, which is also named as interrogators. The RFID tag returns radio waves which are converted into the form which the controllers can make use of. The tags and readers should be at the same frequency so that they can communicate. These systems generally use many frequencies but the most common among them is 125 KHz.

A RFID system consists of two separate components: a tag and a reader.

The tag is nothing but a barcode label which we come across in different shapes and sizes. They consist of an antenna connecting with a small microchip and has 2KB of data. The reader is similar to a bar code reader but the difference is barcode scanner makes use of a laser beam and the RFID Scanner uses the electromagnetic waves.

Now to transmit these waves the scanner makes use of the antenna and sends the signals. The antenna of the tags receives the data from the scanners and sends the data to the specific chip. The data is usually stored in either ROM or Read/Write Memory. ROM as the name says it's read only memory which cannot be edited after manufacturing. The second type which is Read/Write can be edited even after programming while manufacturing and can be changed by definite devices.

The RFID tag comprises of a powered or no powered microchip along with an antenna. The three different types of tags are described below. The cheapest versions of RFID tag are the passive tags because they do not have a built-in power source. Sinc they do not have a power source as the distance increases the reader field diminishes and the practical read ranges that varies about 10mm up to about 5metres.

Light Dependent Resistor (LDR)

An LDR is a sensor which converts brightness to resistance. It is made from CdS (Cadmium Sulphide). As the brightness of the light increases the resistance decreases These LDR Sensors are very effective in light or dark sensor circuits. In general, these LDR sensors have a very high resistance which is around 1,000,000 ohms but when light falls on them the resistance drops vividly.

Therefore in this paper LDR plays a crucial role in monitoring the detection based on the intensity of the light i.e if the intensity is high then there is leakage and if the intensity is low that means there is no light hence no leakage of gas. Accordingly, whenever there is a leakage light comes inside the pipe and affects the resistance of the LDR Sensor.

In the above given circuit we are mainly controlling the load using an LDR device that in turn depends on the transistor and a switch i.e., nothing but the operation of the above circuit behaves like a transistor as a switch.

A transistor is a semiconductor device commonly used to amplify or switch electronic signals.

IOT Module

Internet of things is interconnection or networking of various devices and sensors or other components integrated along with the software and network connectivity that makes sure these objects to collect and exchange the data and also transmit and save the information collected. The main concept in this IOT module we will be referring to is the part where the system makes sure the data is being sent from all the sensors or microcontrollers to a central device or a computer. The IOT chip we are using is ESP8266EX. ESCP is the acronym for Espressif Systems Smart Connectivity Platform which is of high performance, designed WiFi capabilities and high integration wireless System on Chip. The ESP8266 WiFi Module is majorly a self-restricted SOC with integrated TCP/IP protocol stack

which can provide any microcontroller access to our WiFi network. The ESP8266 is competent of moreover hosting an application and to relieve of all the Wi-Fi networking functions from any additional application processor. This component comes along with AT commands firmware that permits you to get functionality like the Arduino Wi-Fi shield.

Proposed System

To test the proposed model the prototype has been implemented using the following system requirements.

Hardware Requirements
AT89S52
RF Transmitter STT-433
RF Receiver STR-433 MHz
RFID Module SM-130
Max 232
Light Dependent Resistor
Crystal Oscillator
IOT Module ESP8266
DC Geared Motors
H-Bridge Driver named L293D
Step-down Transformer
Voltage Regulator
RFID Tags
Resistors (330 0hm)
Buzzer
Software Requirements
Embedded C programming
Keil Micro vision 3 IDE
Flash Magic Software

The complete system satisfying all the requirements mentioned above and the standards the device is connected with all the hardware components and coded by using the software and implemented to work in the environment.

The methodology which we are adopting for our paper is based on mainly two modules notably IOT module and RFID Module.

The main IOT module is to be based on a web server. In this web server, main functionalities details can be available i.e., regarding the leakage, the locations and other details can be found. The web server will have the locations where there is possible damages identified and the results of every location. This web server is maintained by the IOT module which is ESP8266 Wi-Fi module. Wireless connectivity through IOT module is mainly done through the Wi-Fi module.

The major component here is the RFID Module which has a transmitter and a receiver as well as a decoder. The methodology which is implemented in this is that the RF robots are sent into the gas pipes which also have the LDR sensors which change their resistance when light falls on it indicating a leakage in the pipe indirectly. This leakage information is then sent to the web server using the IOT module since we have RFID we will also be knowing the location of it exactly. These RFID cards are tagged at different places along with the RF robot, hence we can also detect the location of the leakage.

The code for the prototype is written in the Embedded C programming and we also used Keil Micro vision 3 IDE. Here is the screenshot the code written.

Conclusion

The movement of the robot inside the pipes is possible with efficiency moving in all directions. The speed of the robot is nominal based on the motors and ensuring proper surveying of the pipe. The system is able to detect the light when it falls on it and activated the buzzer letting us know there is a possible leakage at that point. The data is being sent over IOT Wi-Fi module to the cloud environment which is being observed by the user.

References

1. Hough J.E., 1988, “Leak testing of pipelines uses pressure and acoustic velocity”, Oil and Gas Journal, vol. 86, pp. 35-41.
2. Griebenow G., and Mears M., 1988, “Leak detection implementation: modeling and tuning methods”, American Society of Mechanical Engineers, Petroleum Division, vol. 19, pp. 9-18.
3. Tracer Research Corporation, 2003, www.tracerresearch.com.
4. Weil G.J., “Non-contact, remote sensing of buried water pipeline leaks using infrared thermography”, Water Resources Planning and Management and Urban Water Resources, 1993, p404-407
5. Sivathanu, Y. R., and Gore, J. P., 1991, “Simultaneous Multiline Emission and Absorption Measurements in Optically Thick Turbulent Flames,” Comb. Sci. & Tech., vol. 80, pp. 1-21.
6. D. Surie, O. Laguionie, T. Pederson, —”Wireless sensor networking of everyday objects in a smart home environment”, Proceedings of the International Conference on Intelligent Sensors”, Sensor Networks and Information Processing- ISSNIP- 2008, pp. 189 – 194
7. J. Tsado, O. Imoru, S.O. Olayemi, —”Design and construction of a GSM based gas leak Alert system”, IEEE Transaction, IRJEEE Vol. 1(1), pp. 002-006, September, 2014.
8. M. Eisenhauer, P. Rosengren, P. Antolin, —”A Development Platform for Integrating Wireless Devices and Sensors into Ambient Intelligence Systems”, pp.1-3.
9. V. Ramya and B. Palaniappan, “Embedded system for Hazardous gas detection and Alerting,” in Proc. of International Journal of Distribted and parallel system(IJDPS), vol. 3, no. 3, May 2012.
10. H. Huang, H. Bainand S. Zhu, “A Greenhouse Remote Monitoring System Based on GSM,” in Proc. of IEEE International Conference on information management, pp. 357-360, 2011.
11. Fraiwan, L.; Lweesy, K.; Bani-Salma, A.Mani, N, “A wireless home safety gas leakage detection system”, Proc. of 1st Middle East, Conference on Biomedical Engineering, pp.11-14, 2011.
12. Sheikh Rafik Manihar, Komal Prasad Dewagan, Jayant Rajpurohit Multiple Gas journal AnalyzerInternational Journal of Modern Engineering Research (IJMER) Vol.2, Issue.4, July-Aug. 2012 pp-2753-2755
13. Pal-Stefan Murvay, Ioan Silea, “A Survey on gas leak detection and localization techniques,” Journal of Loss Prevention in the Process Industries, vol. 25, no. 6, pp. 966-973, Nov. 2012.
14. S.Rajitha, T.Swapna,“Security alert system using GSM for gas leakage”International Journal of VLSI and Embedded Systems-IJVES
15. http://www.pipelineandgasjournal.com/