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Iot Enabled Pipeline Leakage Detection and Real Time Alert System in Oil and Gas Industry

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Abstract: ***Automation and control systems are necessary throughout oil & gas industries, to production and processing plants, and distribution and retailing of petroleum products. Pipelines are the efficient mode of transportations of fuels for processing plants over long distances. At present Automation is achieved by using PLC's that are communicated through SCADA. But it is complex and remote operation is not possible. With the introduction of IoT, the pipeline leak detection system is improved through real-time monitoring of the pipelines. Our Proposed system is designed to detect even small leakage that occurs within the pipeline. The implementation of IoT in oil and gas industries prevents accidents and to make quick decisions based on real-time data.***

Index Terms- Oil and Gas industries, internet of things (IoT), pipeline leakage.

I. INTRODUCTION

Many people died and so many people were injured in Mexico gasoline pipeline explosion on Jan 22 2019. There are many accidents happened because of leakages in pipelines and it affects agriculture fields also. The main cause for the above-mentioned explosions is leakage in fluid pipelines.

Presently Automation can be achieved in oil and gas industries by using PLC's that are communicated through SCADA. But it involves continuous monitoring and analysis by an operator. Skilled operators are required because of its complexity and when a problem occurs, Operator cannot make quick decisions. Moreover, the operator needs to be present in the plant for accurate monitoring and to give timely information. oil and gas companies are utilizing IoT to ensure safety and security during the extraction and transportation of fuels.

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IoT enables complete plant automation and allows one to control the plant operations anywhere in the world. IoT is used to monitor all sites and assets from a centralized location. Sensors are fixed at a regular distance of the pipeline, alerts are immediately transmitted to control room and it takes appropriate action within a particular time. If the pipeline leakage is more, then the particular pipeline can be shut down. In addition to that gas, sensors detect the combustible gas such as methane.

II. LITERATURE SURVEY

Different approaches are employed to solve the problem of leak in pipelines. Baoyaing Z F Yaeo et al. proposed a real time leakage monitor(based on embedded system) has been developed to detect the leakage of long distance natural gas pipelines. To test the performance of this method a network data acquisition and analysis system is built. This method is used only to detect leakage in gas pipeline [1]. Muhammad Ikmal proposed a system called electronic nose(2 LPG sensors, 1 Temperature sensor) has been developed to monitor and control the gas leakage. It triggers an alarm and indicator lamps in event of leakage [3]. GiusePnpe Qumaglia et al. Proposed an idea that the oil leakage over the pipeline around $0.01cm^3$ has been rectified and achieved by the sensor and acquisition system. Readings can be taken several days after a test has finished [4]. Savitribai Phule developed an IOT technique is used to detect the gas leakage and alert the authorities by sending a short message. The alert messages will not able to reach human operator if there is a low network coverage[5]. Husnain Saeed et al. proposed a Real time leakage monitor to detect the leakage of oil and gas pipelines using wireless sensor network(WSM) has been developed. It consumes more power in data sharing, processing, and transmission/reception and in data routing [7].

III. METHODOLOGY

The basic idea of the working of proposed model will be given by the flow chart given below:

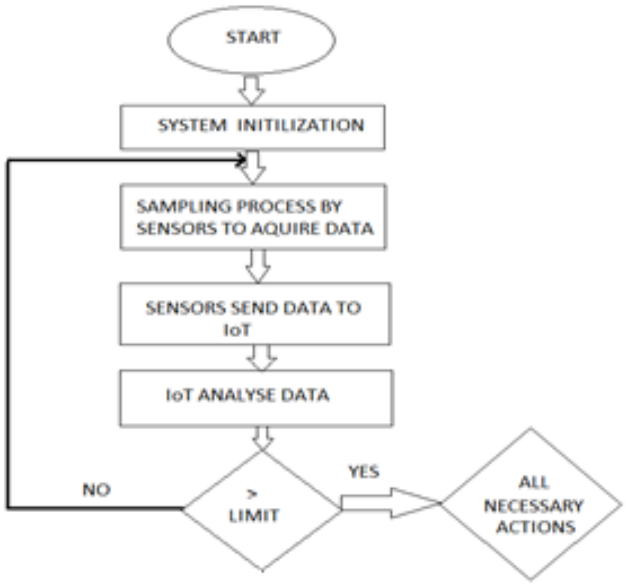

Fig 1. FLOW CHART

The flow chart tells that as the system starts or initialization of the system happens in that the sensors start reading the data of the flow of liquid and the gas and after reading it by the sampling process, they acquire data, and the sensor sends the data to the IoT.

After which the data analysis is done by the IoT, all the sensors are set to some threshold, if the threshold limit of the sensor exceeds or fall behind the necessary actions are taken by the IoT. Actions are audio and visual signal will be sent in the control room, the message with all the information associated with the threshold break along with the time. Meanwhile, the solenoid valve will close the pipeline in which the defect is observed. An alert will be sent to the numbers associated with IoT.

IV. PROPOSED SYSTEM

The system consists of 2 MQ2 gas sensors, 1 SQ1 flow sensor, 1 solenoid valve, a PIC16LF1526 microcontroller, a GSM module SIM900, Relay driver, LCD, Buzzer and a Transformer. In this paper real-time monitoring is done by the measurement of flow rate (rate of flow of the liquid) and it can be achieved by using a flow sensor. The leakages in the pipeline will be indicated by gas sensors placed at regular distances. Normally the length of crude oil pipeline will be large in the order of thousands of kilometres, solenoid valves are placed at regular distances over the entire length of the pipeline. Microcontroller PIC16F1526 is used for monitoring the sensors and taking intelligent decision for critical conditions. GSM module transmits data through IoT devices to remote stations. This is the key to prevent such industrial accidents. It can be controlled from anywhere in the world where internet is available.

The block diagram of the project as follows:

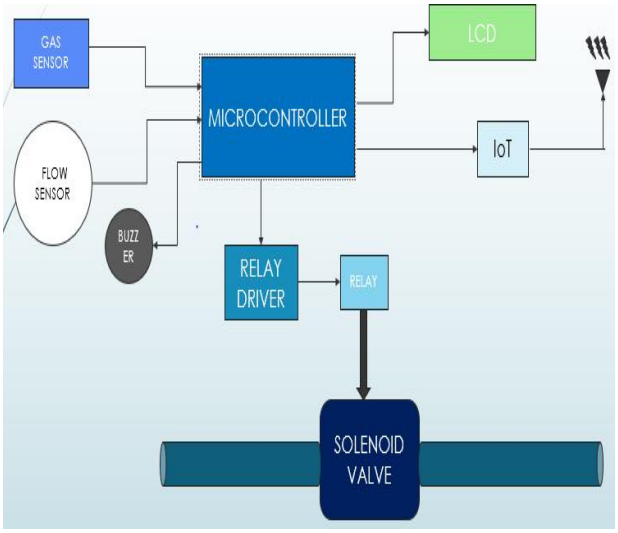

Fig. 2 Block diagram

Some details about the components.

A. Gas sensor MQ2:

MQ type Gas sensors are the most used sensors. These sensors can be used as a module or as a sensor. Gas module is used to prove the presence of the Gas in a certain body. Sensors alone are used to identify and measure the ppm of the Gas.

This helps in gas leakage system and efficient in detecting Liquefied Petroleum Gas, Methane, alcohol, CO, propane or smoke. Due to its high speed and accurate response with high sensitivity which makes it a reliable sensor for our project.

Gas sensors can be operated in +5V. Gas sensor can be either used as Digital or Analog sensor. Preheat duration is 20s. The pins which are present can be used in a dual way either as output or as ground. Two types are H pin are present in which one is given to the source and other to the ground.

It will be used to detect the leakage and if the value of leaking gas exceeds the threshold set by us, then the sensor will notify us by sending the audio signal via a buzzer and visual or digital signal via LCD display.

B. SQ1 Flow Sensor:

The flow sensor consists of two sensors in it & works for low and mid viscous fluids such as water oil etc. It consists of a hall effect sensor – sits in line with waterline and contains a pinwheel sensor to measure how much liquid or fluid have passed through it. It does the same thing as the Gas sensor, but it is applicable on any type of fluid. When fluid is passing through this sensor, we will be getting continuous update of the rate of flow of the fluid inside the pipeline, and if there is any leakage then there will be a decrease in the flow rate of the fluid. And this whole process will be detected by our sensor, if the value exceeds the set value then it will alert through the visual and audio signal.

C. Solenoid valve:

A Solenoid valve is utilized wherever liquid stream must be controlled consequently. It is an electro-mechanical device in which an electric flow is used to produce a magnetic field and in this way the opening and closing of the valve are regulated. The valve includes a solenoid, which is an electronically heating element with a ferromagnetic centre. This centre is called as the plunger. In the rest position, the plunger stops an orifice. An electric flow applies power on the plunger. Due to which the orifice opens. This is the basic rule to open and close solenoid valves. Their undertakings are to close off, discharge, portion, convey or blend liquids. They are found in numerous application regions.

Solenoids give fast and safe exchanging, high quality, long life, great compatibility of the materials utilized, low control power and conservative structure.

D. Relay Driver:

A Relay driver is an Electro-Magnetic Switch. It works on both high power and low power and any power consuming devices can be turned ON and OFF when connected to 220V mains supply. It has a coil in it when it gets power it acts as a MCB and switches the circuit but one difference is that it goes back to normal position when the power is not supplied.

E. GSM MODULE SIM900:

It's a dual-band working module i.e 900/1800 MHz. It's working temperature lies between -39 °C to +84 °C. It has a special function in which the LED blinks continuously if SIM is not connected, ones the SIM is connected it will blink every 3 seconds.

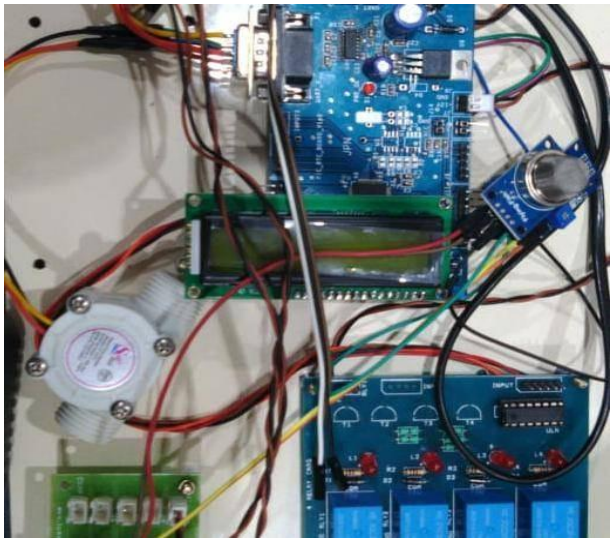

Fig. 3 Hardware section of IOT device

V. SOFTWARE DEVELOPMENT

MPLAB IDE is the software which is used for programming of the Microcontroller. Along with it PICKIT 3 is used to dump the program into the Microcontroller. Embedded C is used as the programming language. Easy EDA is used as the simulation software. Java is used for creation of the cloud of our system. The link to the cloud is http://www.iotclouddata.com/iotlog/009/iot18view.php.

Simulation Diagram given below:

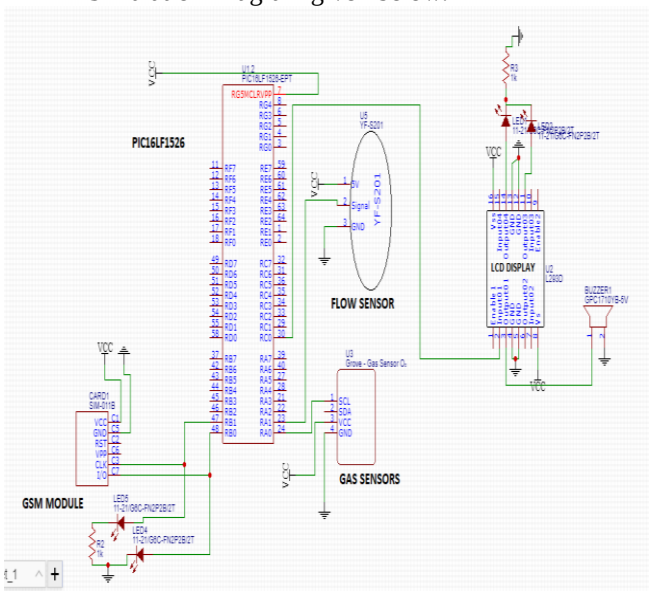

Fig. 4 Simulation setup

The system continuously monitors the gas leakages in the oil pipeline. Whenever gas leaks, the system will detect and stop the distribution of gases by closing the valves and further sends an alert message to the safety team in terms of visual and hearing indication. An intelligent control system along with SCADA works with sensors to detect the pipeline leakage in the oil and gas industries. MQ2 gas sensor and SQ1, flow sensor detects the leakage and the system starts buzzer and it will alert signal to the concerned people.

VI. RESULT AND DISCUSSION

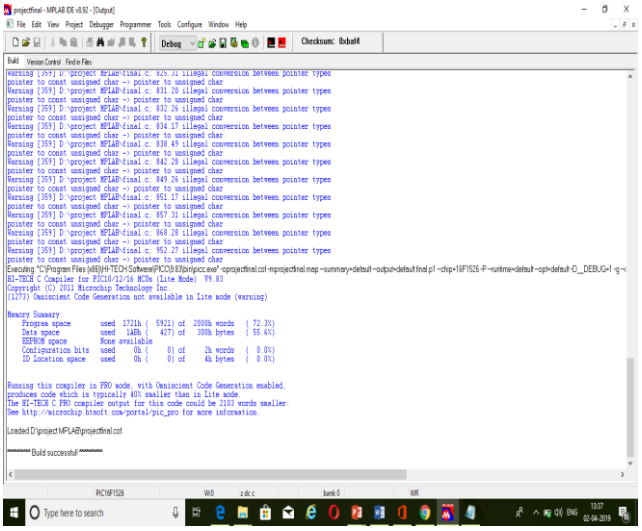

Fig. 5 Simulation result in MPLAB IDE

The figure given is the simulation result of the software i.e. the program has been executed successfully. MPLAB is used for executing the program. When the program is executed it shows "built successfully", and after that PICKit 3 is used to dump the software into the microcontroller.

The figure below are the PICKIT 3 software figures. Figure 1 is the one which tells which microcontroller is used, as every microcontroller has different code which is used to dump the program into microcontroller. Code for PIC16(L)F1526 is 3FE7 3FFF. With every microcontroller, it varies.

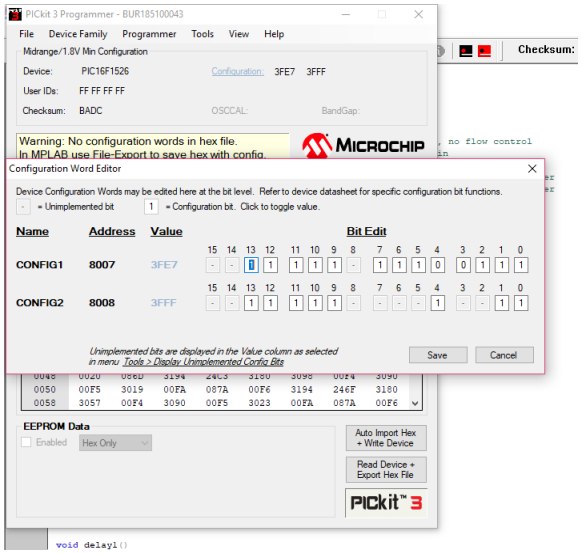

Fig. 6 Simulation result in MPLAB IDE

After dumping the program, the result is ones the gas is detected by the MQ2 sensor and it exceeds the threshold value then, the buzzer will get turned on, the solenoid valve will close the supply from the pipeline and the "abnormal alert" message will be sent to the user via text message.

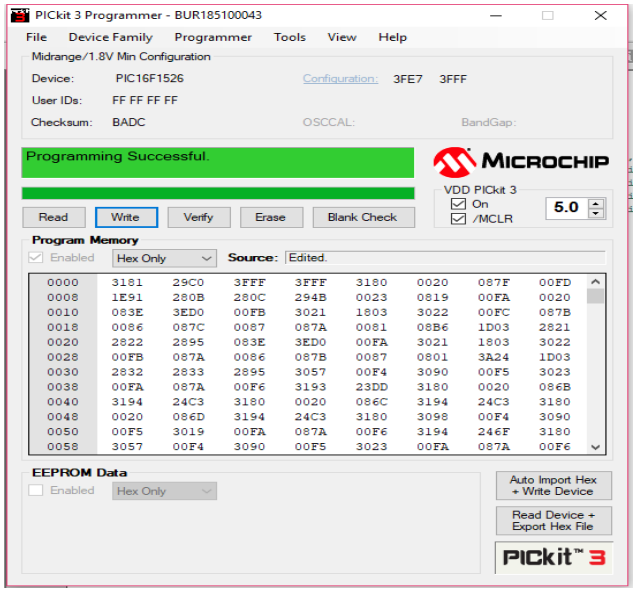

Fig. 7 Hex code output in MPLAB IDE

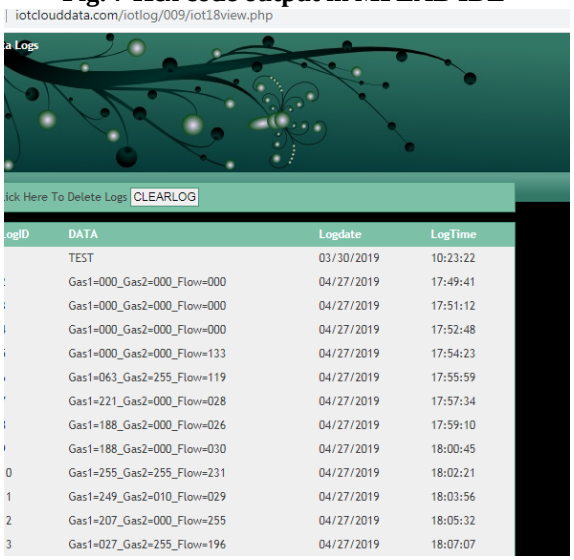

Fig. 8 Cloud page view

Output action initiated by the IOT device for various conditions are tabulated here

Gas Sensor MQ_2	Flow sensor SQ_1	Decision taken by microcontroller PIC16F1526	Condition of solenoid valve
20ppm	345 L/M	Normal condition	Open
200ppm	110 L/M	Alert SMS	Close
500ppm	13 L/M	Alert SMS	Close(Particular pipeline is switch off from remote sensor using IOT)

VII. CONCLUSION

This paper provides a solution to prevent fire accidents by monitoring the pipeline leakages and also communicating the same with IoT network (shown in cloud page view output) .Particular leakage pipeline unit is switch off from the entire oil and gas operations. Safety alarm and sprinklers are the immediate actions which will be automatically on when the sensor detects any leakage. .

FUTURE SCOPE

The basic idea of implementing this model is in the industries because industries are a place where many people die because of fuel leakage in the pipeline. It can also be used in Gas depot for preventing any kind of accident happen when gas leaks from the cylinder, can be used in Kitchen for preventing fire or leakage from cylinders, train yard where Gas or liquid container are kept.

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