IOT BASED GAS LEAKAGE MONITORING SYSTEM USING FPGA

Amatul Munazza [1]
Dept. ECE
GITAM School of Technology
Bengaluru, India

Rupa Tejaswi [2]
Dept. ECE
GITAM School of Technology
Bengaluru, India

Tarun Kumar Reddy [3]
Dept. ECE
GITAM School of Technology
Bengaluru, India

Mrs. Saranga Mohan [4] (Guide)
Assistant Professor, Dept. ECE
GITAM School of Technology
Bengaluru, India

ABSTRACT

Safety plays a major role in today's world and it is essential that good safety systems are to be applied in places of education and work. This work modifies the existing safety model connected in industries and this system also be used in homes and offices.

The foremost object of this work is to monitor gas leakage in any industries using gas sensor and Spartan 6 FPGA process. Structure a cloud-based monitoring system is very important to reduce the cost of preserve servers, to avoid data misplaces and to make the access easy with multiple internet linked devices (computer, tablet, mobile phone) at the similar time anywhere in the world. With Internet of Things (IOT), we can control any electronic equipment in homes and industries. Additionally, you can read a data from any sensor and analyse it graphically from anywhere within the world. FPGA KIT fetches an information of numerous gas sensors like MQ5 sensors and process it and provide it to ESP82666 module. ESP8266 is a Wi-Fi module, it is one of the top platforms for internet of Things.

Keywords: Gas, sensor, FPGA, ADC, UART.

I. Introduction

The internet of Things is a developing topic of technical, social, and economic significance.

Consumer products, hard-wearing goods, cars and trucks, industrial and utility Components, sensors, and additional everyday objects are being united with Internet connectivity and powerful data analytic competences that promise to transform the method we work and all other routines as well.

The Internet of Things (IOT) is a significant topic in technology industry, policy, and engineering circles and has become front-page news in both the specially press and the popular media. This technology is embodied in a wide spectrum of networked products, systems and sensors, which take the advantages of development in computing power, electronics miniaturization, and network interconnection to offer new abilities not previously possible.

An abundance of conferences, reports, and news articles discuss and debate the prospective impact of the "IoT revolution" from new market opportunities and business models to concern about security, privacy, and technical interoperability.

IoT technologies offer the possibility to transform agriculture, industry and energy production and distribution by increasing the availability of information along the value chain of production using networked sensors.

Here, we can read gas leakage industries at a time we can measure and upload it to a ThingSpeak cloud using FPGA and ESP8266- module. FPGA KIT fetches a data of different gas sensors like MQ5 sensors and process it and give it to an ESP82666 module. ESP8266 is a Wi-Fi module, it is one of the leading platforms for internet of Things, which transfers data to IOT cloud.

II. Literature Review

In the year 2019 a paper: "Gas Leakage Detection Based on IOT" [1] put forth a new planned system which is microcontroller-based application of gas booking and gas detection systems using IOT. The sensor used in this model can sense and detect the leakage of the gas, and the user receives notification regarding to remaining percentage of gas in the cylinder as well certain action can be taken to pre-book the new cylinder without any barrier. This unit can be simply combined with an alarm unit, or a visual indication of the LPG awareness for further benefits.

This planned system can be beneficial in marketing sectors like hotels, shop etc. The main purpose of this work is to ensure safe and easier way of gas booking and gas leakage detection to avoid disasters that may occur due to carelessness.

In the year 2013 a paper: "GSM based gas leakage detection system" [2] described a new method for gas leakage detection system at a low concentration. The leakage is sensed with the help of MQ-6 gas sensor. Sensor sends a signal to microcontroller. In the following step microcontroller sends an active signal to additional externally connected devices. Multiple SMS can be sent by altering programming GSM module. To change the SIM card, we have to make variations in program.

In the year 2018 a paper: "Internet of Things (IoT) based gas leakage monitoring and alerting system with MQ6 sensor" [3] focuses on gas leakage and monitoring system was shown by functioning the Raspberry pi3 model attached with embedded system with required input and output gas level with aid of gas sensors. This result in a more efficient in operation because it is connected to a common free IoT based web page specially built to notify or email the responsible authority automatically so reduces the stress of constant monitoring. The choice of using a real time gas leakage monitoring and detecting the output levels of has been clearly detected by the of this system.

In the year 2019, "An IoT based LPG Leakage Sensing and Alerting System" [4] the paper focus on framework produced utilizing the Raspberry Pi 3. Raspberry Pi may be digital computer which might create and adjusted completely different ways it permits us to run different projects and moreover bolster distinctive peripherals that are to ways in which it permits us to run different projects and moreover bolsters numerous peripherals which are to be utilized in our framework MQ6 sensors are introduced on the point of the LPG Supply to acknowledge the spillage of gas, Once the button edge is achieved it will send an alarm message to power versatile, The message is send to Email. LED is warned while gas spillage takes places. The sound sign is associated with the framework. This data is kept in a webpage utilizing it. The whole working on the framework can be accomplished by executing a python code and by introducing the required sensor libraries.

In the year 2016, "FPGA-GSM based gas leakage Detection System" [5] focus on, detecting gas concentrations anywhere from 200 to 10000 ppm and has fast

response time. In FPGA, the data from ADC is measured and compared with a threshold. If a leakage is sensed, a decision is made to initiate a call by reading the mobile number stored in a memory and transfer it to the GSM module. A universal Asynchronous Receiver/Transmitter (UART) is used as an interface between the FPGA and GSM module for sending the data.

III. METHODOLOGY

IV. System Overview

An overview of the gas leakage detection system is shown in fig 5.1. It consists of 2 sensors, Analog to Digital converter (ADC), FPGA and a WIFI module. The sensor detects the gas leakage. Here MQ-5 sensor is used as it is suitable for sensing LPG concentration in air. They are also suitable for detecting LPG, coal gas, Methane. It can detect gas sensor anywhere from 300 to 10000ppm and has fast response time. The sensor's outputs an analog resistance. An 8-bit ADC changes the sensor analog voltage into digital. In FPGA, the data from the ADC is measured and compared with threshold. If a leakage is detected, a decision is made to initiate a warning by the buzzer as well as SMS alert to the user and indication of the level of leakage in ThingSpeak cloud.

V. DESIGN & Working

This proposed system consists of Spartan-6 FPGA starter kit, ESP8266-WiFi Module, 2 Gas Sensors, GSM Module SIM900S, Relay and ADC converter.

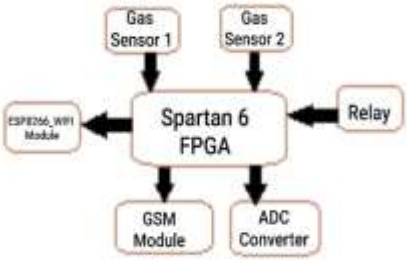

Fig 5.1. System block diagram

Structuring a cloud-based monitoring system is very vital to reduce the cost of preserving servers, to avoid data losses and to make the access easy with multiple internet connected devices at the identical time wherever in the world.

Here we can read gas leakage in industries. Also, we can read any information from a sensor and analyse it graphically and transfer it to the ThingSpeak cloud using FPGA and ESP8266 Module.

FPGA KIT fetch a information of various gas sensors like MQ5 sensors and process it and give it to ThingSpeak cloud via ESP8266 Module.

If the gas leakage is sensed more than the Threshold, the warning alarm will be generated by the buzzer and also the GSM modem gets command message, “Gas Leaking” from the microcontroller, it will send the message to the mobile number which is already stored in the microcontroller. This alarms the user that there is gas leakage in the particular area. Alternatively, the main power supply is turned off by the relay and the exhaust fan is turned on to prevent further leakage.

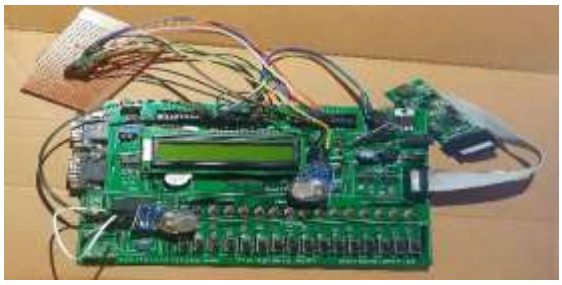

Fig 5.2. Overall hardware setup

VI. Hardware Description

6.1 Spartan 6 FPGA kit

The Spartan 6 FPGA Project Board is a digital system development board which features Xilinx Spartan6 FPGA, 4Mb of external non-volatile memory and enough I/O devices and external connectors to interface a variety of digital applications. It consists of several peripherals, power supply and supporting device circuitry systems. Spartan-6 Board provides a basic development platform for the FPGA device by all I/O accessible to the user. The device may be programmed i circuit through the JTAG port from the PC. We meet all the basics specifications standards with this product.

Fig 6.1. FPGA KIT

6.2 ESP8266-WiFi Module

The ESP8266 WIFI module is a self-sufficient SOC with integrated TCP/IP protocol stack which can give any microcontroller access to your WIFI network. The ESP8266 is capable of either

hosting an application or offloading all Wi-Fi networking functions from alternative application processor. This module comes with AT commands firmware which allows you to get functionality like Arduino WIFI shield, however we can load different firmware's to make your own application bon the modules memory and processor. It's a very economic module and has huge and growing community support. This module has on board 80Mhz low power 32-bit processor which can be used for custom firmware's. This also means that we can host small webpages without any external controller.

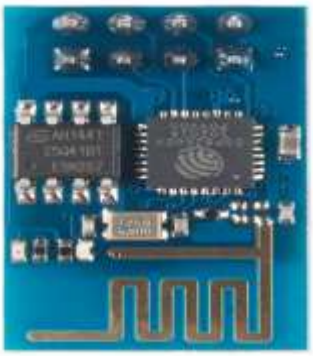

Fig 6.2. WIFI Module

6.3MQ5 Gas Sensor

This the MQ5 gas detection module which is mostly used for investigation gas spilling in the particular area of this sensor module. It is mainly used to judge concentration. It is mostly identifying LPG, Coal, Alcohol etc. It mainly contains 6 pins; 4 pins are used to get signals when spilling happens. The other two pins are not used. The other four pins are digital output, Analog output, VCC and GND. The VCC contain a positive power supply in between (2.5 to 5.0)

Features of Gas sensor

1. High affect ability to LPG, gaseous petrol, Town gas

2. Small affect ability to liquor, Smoke

3. Fast Reaction

4. Stable and long life

5. Simple drive circuit.

Fig 6.3. MQ5 Gas Sensor

6.4 Analog to Digital Converter

An analog to digital converter is a system that converts an analog signal, such as a sound picked up by a microphone or light entering a digital camera, into a digital signal. An ADC may also offer an isolated measurement such as an electronic device

that converts an input analog voltage or current to a digital number representing the scale of the voltage or current.

The ADC converts the waveform to a binary value that can be stored in memory, operated upon and displayed on a screen. Almost all modern microcontrollers have a built in ADC, the most common being the Arduino based on the AT Mega 328p with a 10-bit resolution and the TM32 with s 12-bit resolution.

Fig 6.4. ADC Converter

6.5 GSM Module SIM900A

The Global System for Mobile Communication is a standard developed by the European Telecommunications Standard Institute to describe the protocols for second generation digital cellular networks used by the mobile devices such as mobile phones and tablets. A GSM requires a SIM Card to be operated and operates over a network range subscribed by a network range subscribed by the network operator. It can be connected to a computer through serial, USB or Bluetooth connections.

Fig 6.5 GSM Module SIM900A

6.6 Relay

Relay are the switches which aim at closing and opening the circuits. When the contact is open (NO), the relay isn't energizing with the open contact. However, if it is closed (NC), the relay isn't energize given the close contact. However, when the energy is supplied, the states are prone to change.

Fig 6.6 Relay

VII. Operation of system

7.1 ThingSpeak Cloud

ThingSpeak is an IoT analytics platform service that allows you to aggregate visualize and analyse live information streams in the cloud. ThingSpeak provides instant visualization of information posted by your devices to ThingSpeak with the ability to execute MATLAB code in ThingSpeak you can perform online analysis and processing of the information as it comes in ThingSpeak is often used for prototyping and proof of concept IoT systems that need analytics.

7.2 VHDL

VHDL (VHSIC-HDL) (Very High-Speed Integrated Circuit Hardware Description Language) is a hardware description language which is used in electronic design automation to describe digital and mixed-signal systems such as field programmable gate arrays and integrated circuits. VHDL can similarly be used as a general-purpose parallel programming language.

A VHDL model is interpreted into the “gate and wires” that are mapped onto a programable logic device such as a CPLD or FPGA, then it is the real hardware being configured, moreover the VHDL code being “executed” as if on some form of a processor chip.

VIII. Result

Monitoring and detection system are planned and when a small leakage occurs, the system sensors detects the leakage and the sends the alert message to the user and activates the alarm. On the other hand, the system monitors the amount of leakage occurred.

Fig 8.1. Gas Sensor 1 Output

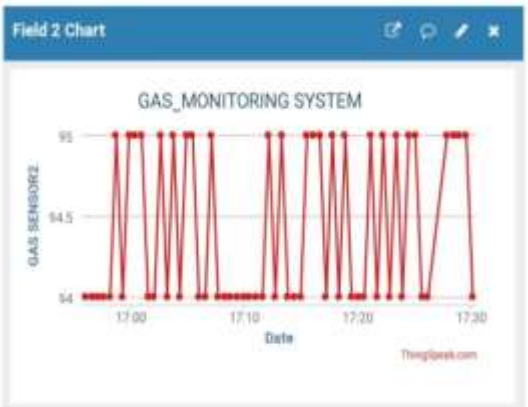

Fig 8.2. Gas Sensor 2 Output

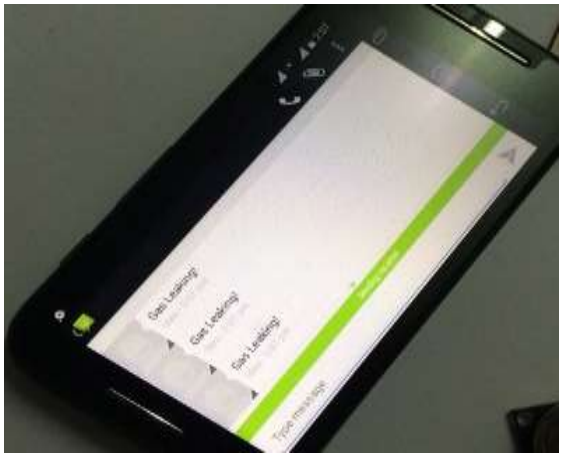

Fig 8.3. SMS Alert from GSM Module

If the gas leakage is sensed more than the Threshold, the warning alarm will be generated by the buzzer and also the GSM modem gets command message, "Gas Leaking" from the microcontroller, it will send the message to the mobile number which is already stored in the microcontroller. This alarms the user that there is gas leakage in the particular area. Alternatively, the main power supply is turned off by the relay and the exhaust fan is turned on to prevent further leakage.

IX. Conclusion

In the nutshell, gases are essential in our surrounding due to today's developments. Gases are everywhere. Gases helps human and gases also can harm human if not handle properly.

From this project the hope is very high to make it successful because this innovation can bring benefits to human life. This project enables collection of the data about the gas leakage and analyses it and prevent the leakage occurred.

The estimated source location of gas leakage can be determined by analysing the gas leakage level reading detected on different gas sensor position.

Besides, by merging IoT system, the gas leakage can be easily analysed anywhere in the world.

At the end of this project, the user can easily monitor the safety of the house or industry in case of gas leakage even from far place.

X. References

1. **Gas Leakage Detection Based on IOT**

   Suma V, Ramya R Shekar, Akshay Kumar A. Dept. of Information Science and Engineering.

2. **GSM BASED GAS LEAKAGE DETECTION SYSTEM**

   Ashish Shrivastava, Ratnesh Prabhaker, Rajeev Kumar and Rahul Verma Associate Professor, Galgotias College of Engineering and Technology, Greater Noida.

3. Internet of Things (IoT) based gas leakage monitoring and alerting system with MQ6 sensor

Rohan Chandra Pandey, Manish Verma, Lumes Kumar Sahu, Saurabh Deshmukh Kalinga University, Department of VLSI and Embedded system, Chhattisgarh.

4. An IoT based LPG Leakage Sensing and Alerting System

P. Kanaka Maha Lakshmi, P.S. G Aruna Sri, P. Gopi Krishna

5. FPGA-GSM based gas leakage Detection System

Arpitha. T, Divya Kiran, V.S.N. Sitaram Gupta and Punithavathi Duraiswamyi, Department of Electronics and Communication Engineering, M. S. Ramaiah University of Applied Sciences, Bangalore.