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Development of an Arduino Based Device for Early Detection of Gas Leakage in Hospitals & Industries

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Abstract: Leakage of gases in a system makes infrastructures and users vulnerable, it can occur due to its environmental conditions or old groundwork. Hospitals and industries where many types of gases are used like nitrogen, mono oxide, due to small amount of concentration in air can cause toxicity whereas detection of small amount of gas at its initial stage is very difficult task. Many systems have been developed which were failed in past to give accuracy in its implementation. In this research a portable detection system for the small leakage of gases has been developed, gas sensor (MQ-2) is used to find leakage when it is at its initial phase. The sensor and transmitting module senses the change in level of gas by using a sensing circuit. When a concentration of gas reach at a specified threshold level it will activate an alarm and sends a text massage to receiving module. The proposed system works well in hospitals, home, and industries.

Keywords: Gases; Detection; Arduino; MQ-2; Alarm

I. INTRODUCTION

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In the 19th century, there was greater usage of natural gases than ever before which mainly consist of methane which was also harmful for working conditions if exceeded a limit. Exposure or inhalation to gas can cause many diseases like pulmonary edema, bronchiolitis, pneumoconiosis which can also lead to cancer if they are not treated at initial stages [1]. Detection of harmful gas leakage is usually done by detectors along with an audible alarm for alerting team if any injurious gas comes in contact with the sensor. So far, many sensors are used for detection like ultrasonic sensors, infrared point sensors, semiconductor sensors and electrochemical sensors [2]. These all sensors are used at different places like hospitals, industries, homes, vehicles etc. number of systems are developed for the detection of gas at various stages which shown different results with respect to accuracy. This research represents a project which is based on Arduino and gas detection sensor for the recognition of small amount of gas this project's competence is not only limited to its low cost, also its structure is practical and can be installed easily in factories, industries and also in hospitals which are in danger of exposure of gas [3]. This automatic system of recognizing gases not only save lives but also saves time due to its simple installation system.

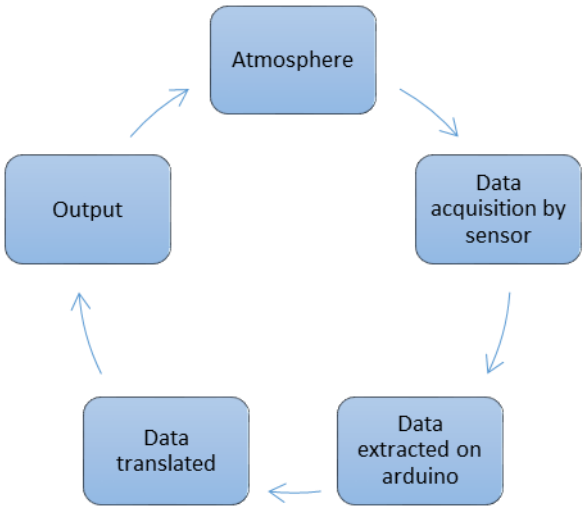

Figure 1. summary of gas leakage detection system

II. RELATED WORK

In early industrial ages workers were used to carry canary birds with them in mines in order to sense harmful gases; kyle Schmidt [4]. According to health administration carbon dioxide gas which is odorless and colorless gas, is a poisonous gas which can cause many deaths. Canaries which are in cages along with the worker warn them by making sound when they detect presence of carbon dioxide. According to BBC report which was published in 1986, along with canary birds' mice were also use to detect gases in mines but accurate and reliable result was got by using canaries due to their instant respond to physical response and

sensitivity to deadly gases. Richard E. Soltis et all in their research stated that, in 21 century canaries were replaced by electronic gas indicators which were more reliable in detecting poisonous gases.

EHS in their report showed that valve was used in first gas monitor system which was capable enough to measure methane gas in the atmosphere was manual whereas nowadays all detectors work automatically [5]. There are also some detectors present which are used to monitor the presence of various gases at time and record them in the database; like gas-ranger it is capable to identify level of hydrogen, methane, sulfide and oxygen in air.

Luay et all worked on a sensing circuit which was designed to detect variation in gas concentration within house and sends an alarm to authorize person. Semiconductors are also widely used for the detection of dangerous gases like carbon monoxide and methane which are the cause of explosions or toxic accidents at different places, Emil et all in their research present a detection method along with its characteristics which were helpful for the future designing [6]. Parsanth Krishnan and D.Jackson in their successful experiment, found the presence of CH4, H2s, CO and O2 concentration level in atmosphere along with the temperature effect in order to check cross sensitivity between sensors. Numerous software simulations are also used in order to find the absorption of gas Zhou Bin et all shown that on the basis of phase lock algorithm and wavelength modulation harmonic curve and concentration of targeted gas are obtainable [7]. Sahil Adsui et all in their research stated a method for detecting different parameters like pressure, sound, temperature and humidity, based on these thing they used a microcontroller along with a sensor to make system easy to use and potable [8].

Comparatively our proposed system shows promising results than previous work in terms of portability, it's specificity and results along with new methods of sending message to the three assigned numbers in an emergency conditions, which is not being used previously by any researcher. Earlier, microcontroller and semiconductors are used for the configuration but we have used Arduino which is easy to understand and operate by anyone.

III. METHODOLOGY:

The methodology is divided into three main steps. The first step is to detect the leakage of gas by using MQ-2 sensor. Secondly after the detection of presence of gas MQ-2 sensor, it gives signal to Arduino software which in last was used to send signal to GSM module and alarm. The detailed methodology is shown in flow chart given below;

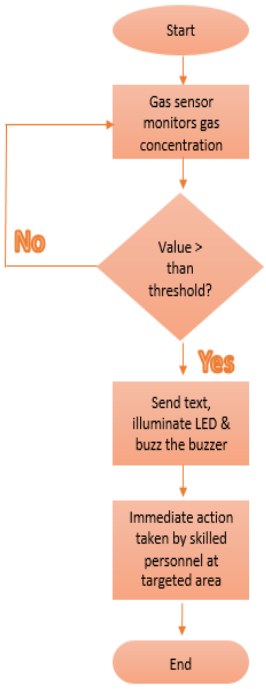

Figure 2. Flow chart of detailed methodology

A. Hardware: Brief Preliminaries

1) MQ- Gas Sensor

The irresistible specialty of generating analog output in MQ gas sensors is remarkably effortless. Exposure of sensor is likely to interact with environmental gases and start analyzing it. Further the process generates voltages which is conveyed as current to the output pins. The sensing element is based inside superficial structure of sensor. Current is directly related to the sensing section. Once the current reaches the sensing element it is then ionized and thus known as heating "heating current". Hence it is directly proportional to the resistance, it alters the values accordingly in the order of resistance and current relationship. It has the ability to fluctuate the values as required in accordance with the precision of gas detection regulated by the potentiometer resides inside it [9].

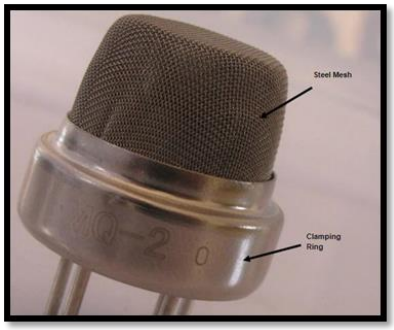

Figure 3. MQ-2 Sensor P.C. Google

1) Features

TABLE I. Features of MQ-2

Sensitive for	Butane, Methane and LPG
Operating voltage	2.5V-5.0V
Dimensions	40.0mm*21.0mm
Fixing Hole size	2.0mm

2) Arduino Hardware

Arduino is easy to use and open source platform for beginners especially who have no previous experience of high level electronics. Many interactive objects which can respond by signals can be developed by this open plat form. Due to its special features and high performance it is a perfect microcontroller for this project. Arduino consists 14 input or output pins, 16 Mega Hertz crystal oscillator along with 6 analog inputs, a power jack, reset button and a USB connector. Arduino microcontroller can be programmed with the help of integrated development environment (IDE). For loading a new program code, it does not need any separate hardware just it requires only connection with USB cable [10].

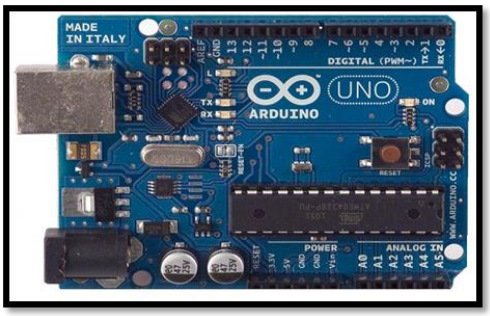

Figure 4. Arduino hardware

3) GSM MODULE

The circuit of arduino is interfaced with arduino based GSM module (SIM mini 900) for the remote alarming purpose. It facilitates the allocated personnel to get alert at remote via text message in order to cope up with the danger immediately.

Figure 5. GSM module

4) Threshold value

Threshold value has been set according to the environmental occupational safety. Detection of various gases like methane and nitrogen has been checked where green light showed the normal state with the no alarming sound whereas Red light showed above threshold values that are customary according to the environment and distance from sensor. The normal ranges checked were from 100 PPM to 10000 PPM.

IV. RESULTS AND INTERPRETATION

In this project there are two phases of results. Normal state and Harmful/ Emergency state, analyzed results and observations are as follows,

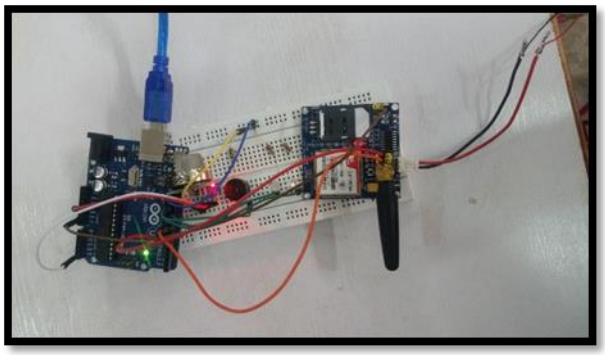

Figure 6. complete circuit

A. Normal state

After compilation and uploading of program, it is firstly calibrated.

Secondly the green LED is turned on, indicating normal state when there is no indication of dangerous gases and all gases lie within their normal range

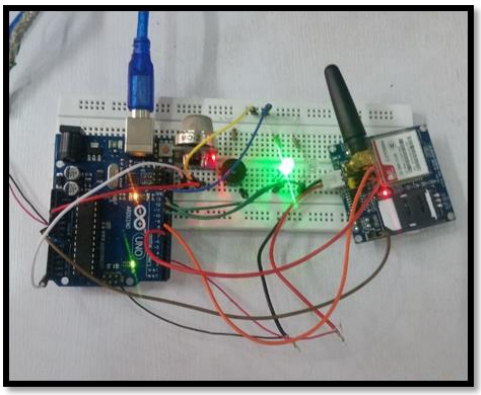

Figure 7. Green LED at Normal State

And the values are shown in PPM on the serial monitor of Arduino.

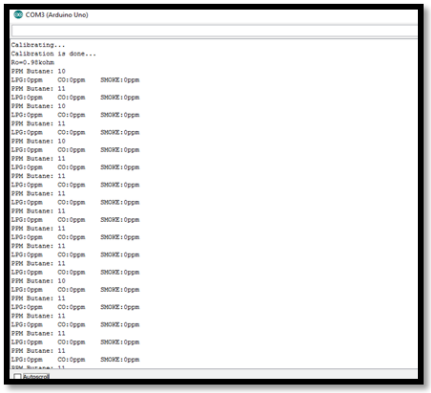

Figure 8. PPM values in Serial Monitor at Normal State

B. *Harmful State*

Whereas during harmful state the overall process remains same but when the particles per minute (PPM) exceeds the threshold value the green LED shifts to red LED indicating harmful state.

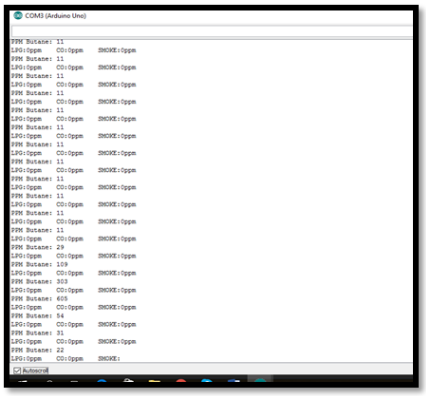

Figure 9. PPM Value Higher than Threshold in Serial Monitor

When the sensor is exposed to gas more than threshold, red LED is turned on.

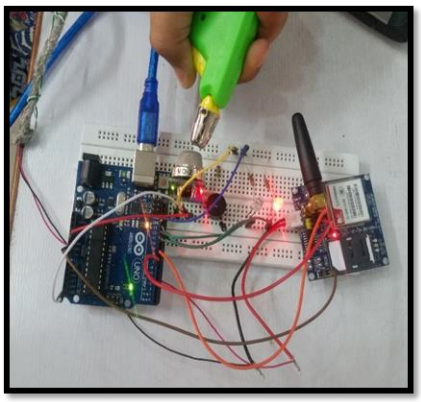

Figure 10. Red LED Indicating Danger

C. *Output of GSM*

At harmful state, message will be delivered to the assigned numbers (at least three numbers) which are added to the module for sending alert through GSM module. The message sent by the Arduino can be modified depending on the operator/the one who is using it, as we have for testing purpose written the message “BAD PPM” and was delivered as it was written.

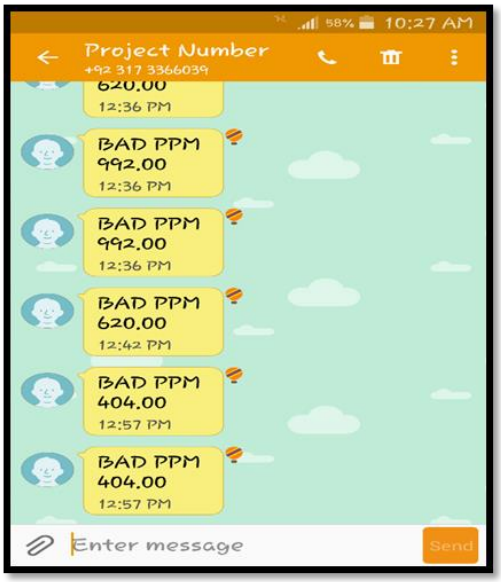

Figure 11. SMS Delivered and Received

V. CONCLUSION

Purpose of this paper is to make a low cost detection system of gas which helps to reduce the incidents. Aim of our research was to reduce the ratio of unexpected deaths due to leakage of hazardous gases at work place. The gas leakage monitoring system by using MQ-2 sensor and Arduino was successfully developed and implemented. There are many projects which are made for the detection of gases but this project consists many different features like due to its light weight and portability, it can be carried and easily installed anywhere. Our proposed system shown the promising results. Hence, we would like to expand our proposed prototype in future by adding temperature sensor as well.

With the advancement in technology, such early gas detection sensors could be easily approachable to users in everyday life, where life comes into contact with gases either directly or indirectly. Not only hospitals but homes, industries, cars with gas kits, fueling stations etc. can implement this device and receive long lasting boons. This device with more accurate precision and long range of sensation will make its place in higher industrial areas.

VI. ACKNOWLEDGMENT

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