Gas Leakage Detection and Automatic Control System using Arduino
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Abstract—Liquefied Petroleum Gas (LPG) is ineluctable one in day-to-day life. LPG is used as a fuel in a wide range of applications including heating and cooking appliances, industrial applications, in vehicles and as a propellant and a refrigerant. Gas leakage is one of the major concerns with commercial premises, residential and gas powered transportation vehicles. Leakage of LPG produces hazardous and environmental unfriendly gases which effect human beings and other living creatures. As safety plays a major role in today’s world, it is necessary that good safety systems are to be implemented in places of domestic or industrial. Preventive measure that can be taken to avoid the danger associated with gas leakage is to setup a gas leakage detector at vulnerable locations. The main objective of the proposed Gas Leakage Detection and Automatic Control System (GLDACS) is to provide a solution by designing an automatic system which can detect the leakage of liquefied petroleum gas (LPG) at home and control it by turning off the cylinder knob. At the same time the window of that room gets opened automatically using DC motor and an SMS alert will be sent to the owner of the house using GSM module.

Key words: LPG, MQ6 gas sensor, DC motor, SMS, GSM module, servo motor, Arduino, IDE

I. INTRODUCTION

Liquefied Petroleum Gas (LPG) is a mixture of propane and butane which is highly flammable chemical. It is odorless gas due to which Ethaneol is added as powerful odourant, so that leakage can be easily detected. LPG is one of the alternate fuels used these days. LPG is also used as an alternate fuel in vehicles due to rise in the prices of petrol and diesel. Some people have a low sense of smell, who may or may not respond on low concentration of gas leakage. In such a case, some high security systems become an essential technique and help to protect from gas leakage accidents. Gas leakage detection is not only important but controlling leakage is equally essential. A system is designed which senses the leakage of LPG gas and controls it by turning off the cylinder knob. At the same time the window of the room gets opened to let the leaked gas out of the room and an SMS alert is sent to the owner of the house.

II. SYSTEM OVERVIEW

The system comprises of consists of Arduino UNO, Gas sensor (MQ6), GSM module (SIM 300), DC motor (12V, 10rpm), limit switch, Servo motor (9g), Motor driver L293D, rack and pinion as shown in Fig 1.

A. Arduino Uno

Arduino refers to an open source electronics platform. To program an Arduino we use the Arduino Programming Language and the Arduino Software (Integrated Development Environment (IDE)) based on the processing. The Arduino software runs on Windows, MAC and Linux. Arduino Uno is a platform or board based on the ATmega328P microcontroller. This board consists of 14 digital input/output pins, 6 analog input pins, 16 MHz quartz crystal, a USB connection, a power jack, in-circuit serial programming (ICSP) header and a reset button. It can be connected to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

Table 1: Specifications of Arduino Uno

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microcontroller</td>
<td>Atmega328p</td>
</tr>
<tr>
<td>Operating voltage</td>
<td>5V</td>
</tr>
<tr>
<td>Input voltage</td>
<td>7-12V</td>
</tr>
<tr>
<td>Digital I/O pins</td>
<td>14</td>
</tr>
<tr>
<td>PWM digital I/O pins</td>
<td>6</td>
</tr>
<tr>
<td>Analog I/O pins</td>
<td>6</td>
</tr>
<tr>
<td>DC current per I/O pin</td>
<td>20Ma</td>
</tr>
<tr>
<td>DC current for 3.3V pin</td>
<td>50Ma</td>
</tr>
<tr>
<td>Flash memory</td>
<td>32KB</td>
</tr>
<tr>
<td>SRAM</td>
<td>2KB</td>
</tr>
<tr>
<td>EEPROM</td>
<td>1KB</td>
</tr>
<tr>
<td>Clock speed</td>
<td>16MHz</td>
</tr>
<tr>
<td>LED_BUILTIN</td>
<td>13</td>
</tr>
<tr>
<td>Length</td>
<td>68.6mm</td>
</tr>
<tr>
<td>Width</td>
<td>53.4mm</td>
</tr>
</tbody>
</table>
B. MQ6 Gas Sensor

The MQ6 gas sensor is a gas sensor module. This gas sensor is highly sensitive to Liquefied Petroleum Gas (LPG), isobutane and propane. It is used for detection of leakage of gas at home and industry. The module has 4 pins for interfacing of which two pins are VCC and ground, one pin is analog output and one pin is digital pin via a comparator (LM358). There is a heating element inside the sensor which becomes hot at 5 volts and remains stand by. When the sensor detects gas molecules between 200 ppm to 1000 ppm, in the atmosphere, its output turns high. The analog output pin of the module is used for detecting the concentration level of gas leakage and interfaced with the A0 analog input pin of the Arduino board.

\[
\text{Concen} = 1036.5 \times R^{2.392} \quad (2.1)
\]

Where the Concentration of leaked gas in ppm is calculated according to the following formula-

Where \( \text{Concen} \) is the concentration of LPG in ppm

\( R \) is the ratio of \( R_s \) the resistance of the sensor to \( R_0 \) which is the resistance at 1000ppm at 20 degree Celsius and 65% humidity.

C. Servo Motor

In this system SG90 9g micro servo is used to turn off the knob of the cylinder. This servo motor work just like the standard kinds, but smaller and can rotate approximately 180 degrees (90 in each direction).

D. DC Motor

A DC motor is a rotary electrical machine that converts electrical energy into mechanical energy. Here the electrical energy supplied to DC motor is direct current (DC). The most common types depend on the forces produced by magnetic fields.

A DC motor consists of a current carrying armature which is connected to the supply end through commutator segments and brushes. The armature is placed in between north and south poles of a permanent or an electromagnet. When the direct current is supplied to the armature, a mechanical force acts on it due to the electromagnetic effect of the magnet and motor starts rotating. In practical DC motor, the permanent magnet is replaced by a field winding which produces the required flux called main flux and all the armature conductors, mounted on the periphery of the armature drum. It gets subjected to the mechanical force. Due to this overall armature experiences a twisting force called torque and armature of the motor starts rotating.
E. Motor Driver

L293D is a Motor Driver IC which allows the DC motor to rotate in both clockwise and anti-clockwise direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously. This IC works on the concept of the H-bridge circuit. When a positive voltage is applied across the motor driver the motor starts rotating in one of the directions and by reversing the voltage the motor starts rotating in the opposite direction. Hence H-bridge ICs are used for driving a DC motor.

In a single L293D chip there are two H-Bridge circuit inside the IC which can rotate two dc motors independently. Due its size it is used in robotic applications for controlling DC motors.

![Motor Driver](image1)

Fig. 7: Motor Driver

F. Limit Switch

A limit switch is an electromechanical device which consists of an actuator mechanically linked to a set of contacts. It is a switch that is operated by the motion of a machine part. They are used for controlling machinery as part of a control system, safety interlocks and to count the objects passing through a point. When an object comes in contact with this actuator, it operates the contacts to make or break an electrical connection.

Usually the safety limit switches are in series with the supply. NO is the normally open contact (open if the plunger is free), NC is the normally closed contact (closed if the plunger is free) and COM is the common. NO will normally remain open with respect to COM. NC will be shorted with the COM. When the object hit the plunger, NO will be shorted with COM while NC will be open with respect to COM.

![Limit Switch](image2)

Fig. 8: Limit Switch

G. Rack and Pinion

Rack and pinion is one of the linear actuators that consists of a pair of gears which changes rotational motion into linear motion. A circular gear called "the pinion" occupies teeth on a linear "gear" bar called "the rack". Rotational motion applied to the pinion causes the rack to move relatively in the direction of the pinion, thereby translating the rotational motion of the pinion into linear motion. A generating rack is a rack outline used to indicate tooth details and dimensions for the design of a generating tool, such as a hob or a gear shaper cutter.

In this system, the pinion is attached to the DC motor and the rack is attached to the window. To open the window of the room, DC motor starts rotating in one of directions when the rack which is attached to the window hits the plunger of limit switch and the motor stops rotating and the window remains open.

![Rack and Pinion](image3)

Fig. 9: Rack and Pinion

III. Working

The MQ6 gas sensor senses the leakage of liquefied petroleum gas (LPG) and sends the signal to ATmega328p microcontroller. As soon as the microcontroller receives the signal, the knob of the cylinder is turned off by rotating the servo motor. Then an SMS alert is sent to the user through the GSM module saying that there is a gas leakage at home. At the same time one of the windows of that room gets opened automatically by using a DC motor which is connected to rack and pinion. After sometime the gas sensor again senses the gas. If the gas leakage is stopped, the DC motor rotates in the opposite direction and the window is closed.

In this way we can detect the leakage of LPG and reduce the dangerous fire accidents.
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IV. RESULT

Gas leakages in households and industries cause risk to life and property. A huge loss has to be suffered for the accident occurred by such leakages. A solution to such a problem is to set up a monitoring system which keeps on monitoring the leakage of any kind of flammable gases and protects the consumer from such accidents. This circuit is a basic circuit which consists of a MQ6 gas sensor, Arduino Uno, servo motor to turn off the knob of the cylinder, a DC motor to open and close the window, GSM module to send a message to user that there is a gas leakage at home.

By this system we can detect the leakage of LPG gas and prevent many accidents and save lives and property.

REFERENCES


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