DEVELOPMENT OF IOT ENABLED FRAMEWORK FOR LPG LEAKAGE DETECTION AND WEIGHT MONITORING SYSTEM

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ABSTRACT

DEVELOPMENT OF IOT ENAMBLED FRAMEWORK FOR LPGLEAKAGE DETECTION AND WEIGHT MONITORING SYSTEM

This project outlines the development of an Internet of Things (IoT)-enabled framework for anLPG leakage detection and weight monitoring system, designed to enhance the safety and efficiency of LPG usage in various environments. The core components of this framework include an Arduino controller, gas sensor, LED indicators, a buzzer for audible alerts, a GSM module for real-time notifications, and GPRS for sensor value uploading to the Thingspeak server. The primary goal of this project is to detect LPG gas leaks and monitor the weight of LPG cylinders, ensuring timely warnings and remote monitoring. The system collects data from the gas sensor and load cells, processes it using the Arduino controller, and communicates real-time information to users via SMS notifications and cloud-based data visualization on Thingspeak.

The IoT-enabled framework leverages the power of Arduino as the central processing unit, interfacing with a gas sensor capable of detecting LPG gas leaks with high precision. When a gas leak is detected, the system activates LED indicators and a buzzer, providing immediate visual and audible alerts to users in the vicinity. Moreover, the integration of a GSM module ensures that users receive SMS notifications, allowing for timely responses and safety measures. Additionally, the GPRS connectivity facilitates the seamless uploading of sensor values to the Thingspeak cloud server, where users can access real-time data and historical trends through web or mobile applications. This comprehensive project addresses the critical need for LPG safety by combining hardware and software components into a robust and user- friendly solution, ultimately minimizing the risks associated with gas leakage and ensuring theefficient management of LPG cylinder weight.

Keywords: *Arduino, GSM/GPRS, LPG leakage, sensors, Load cell*

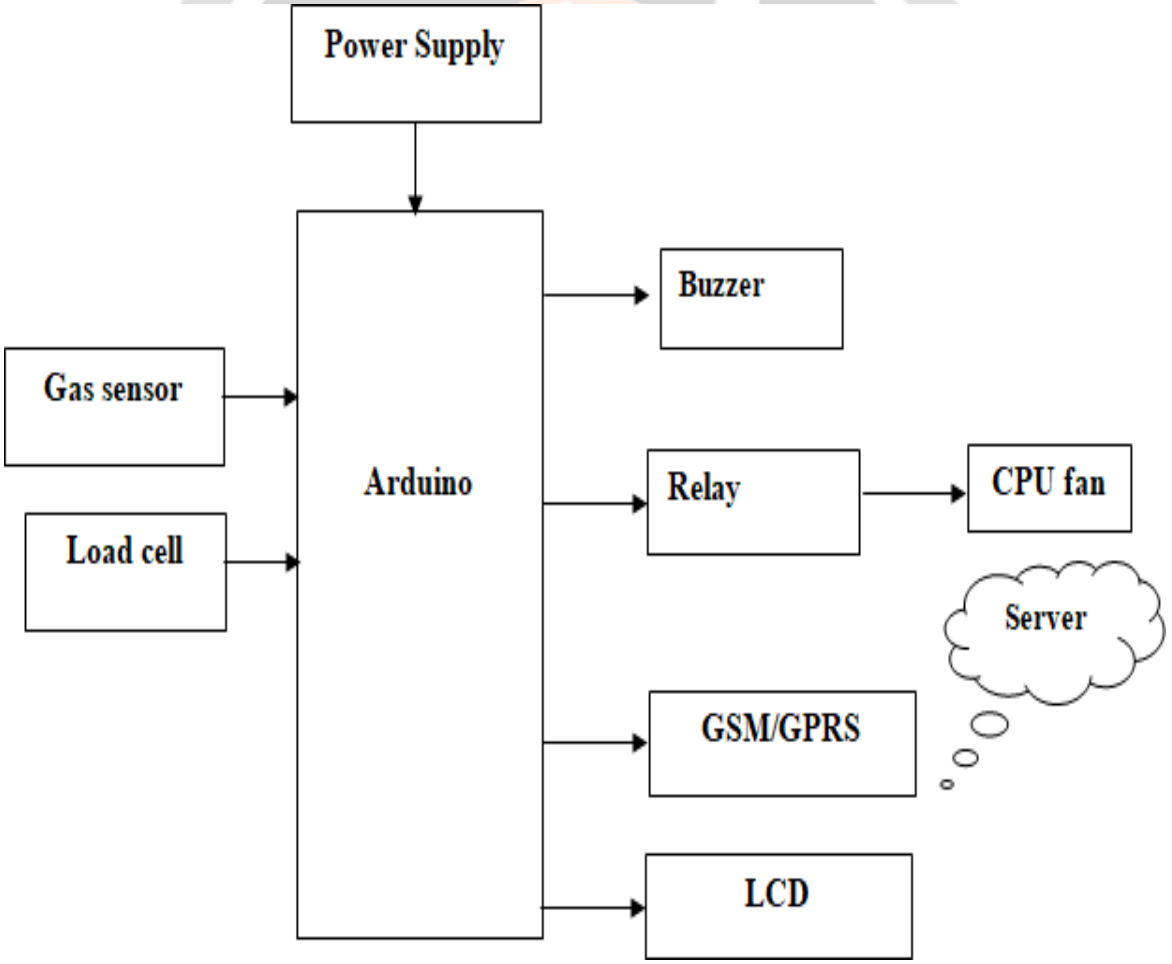
INTRODUCTION

The project "DEVELOPMENT OF IOT ENABLED FRAMEWORK FOR LPG LEAKAGE

DETECTION AND WEIGHT MONITORING SYSTEM" focuses on enhancing safety and efficiency in managing liquefied petroleum gas (LPG) usage. LPG is widely used in householdsand industries for cooking, heating, and other purposes, but it poses potential risks due to leakage and improper monitoring. This project addresses these concerns by leveraging Internetof Things (IoT) technology to develop an advanced framework for detecting LPG leaks and monitoring the weight of LPG cylinders in real-time.

One of the key components of this framework is the integration of IoT devices with LPG cylinders. These devices, equipped with sensors, are capable of detecting even minor leaks of LPG gas, which can be crucial in preventing accidents and ensuring safety. Additionally, weight sensors are incorporated into the system to monitor the quantity of LPG remaining in the cylinder accurately. By continuously monitoring the weight, users can anticipate when a refill is required, thereby minimizing the risk of running out of gas unexpectedly.

3.1 BLOCK DIAGRAM:



Block Diagram of Proposed system

ADVANTAGES:

1. Real-Time Energy Monitoring
2. Interactive User Experience
3. Efficient Energy Management
4. Immediate theft Alert

APPLICATIONS

1. **Residential Safety:** In residential settings, the system ensures enhanced safety by promptly detecting any LPG leaks, mitigating the risk of fire or explosions. Residents can receive immediate alerts on their smartphones, allowing them to take swift action to address the issue, such as shutting off the gas supply or contacting emergency services.
2. **Commercial and Industrial Use:** Industries and commercial establishments handlinglarge volumes of LPG can benefit from the system's real-time monitoring capabilities. It enables facility managers to maintain optimal gas levels, prevent wastage, and ensurecompliance with safety regulations. Timely detection of leaks also minimizes production disruptions and protects valuable assets.
3. **Hospitality Sector:** Hotels, restaurants, and catering services rely heavily on LPG for cooking and heating.. The ability to monitor LPG consumption and cylinder weights remotely facilitates proactive maintenance scheduling and resource planning, optimizing kitchen operations
4. **Transportation and Distribution:** LPG distribution companies can utilize the framework to streamline their operations and enhance customer service. By monitoringcylinder weights and tracking deliveries in real-time, logistics teams can optimize routeplanning, manage inventory effectively, and ensure timely replenishment of cylinders at customer locations
5. **Healthcare Facilities:** Hospitals and clinics utilize LPG for sterilization processes andbackup power generation. Implementing the IoT-enabled framework enables healthcare facilities to maintain uninterrupted services while adhering to stringent safetyprotocols.
6. **Educational Institutions:** Schools, colleges, and universities that use LPG for cooking and heating purposes can benefit from enhanced safety measures offered by the system.Real-time monitoring ensures a secure environment for students, faculty, and staff, while also optimizing operational efficiency by preventing potential disruptions due togas leaks.
7. **Remote Monitoring Stations:** Off-grid installations and remote monitoring stations, such as weather stations or research outposts, often rely on LPG for power generation and heating. Implementing the IoT framework allows operators to monitor LPG levelsand detect leaks remotely, minimizing the risk of environmental contamination and ensuring the safety of personnel working in isolated locations.

HARDWARE REQUIREMENTS

INTRODUCTION TO ARDUINO

- Arduino Uno is a microcontroller board developed by Arduino.cc which is an open-source electronics platform mainly based on AVR microcontroller Atmega328.
- First Arduino project was started in Interaction Design Institute Ivrea in 2003 by David Cuartielles and Massimo Banzi with the intention of providing a cheap and flexible way tostudents and professional for controlling a number of devices in the real world.
- The current version of Arduino Uno comes with USB interface, 6 analog input pins, 14I/O digital ports that are used to connect with external electronic circuits.

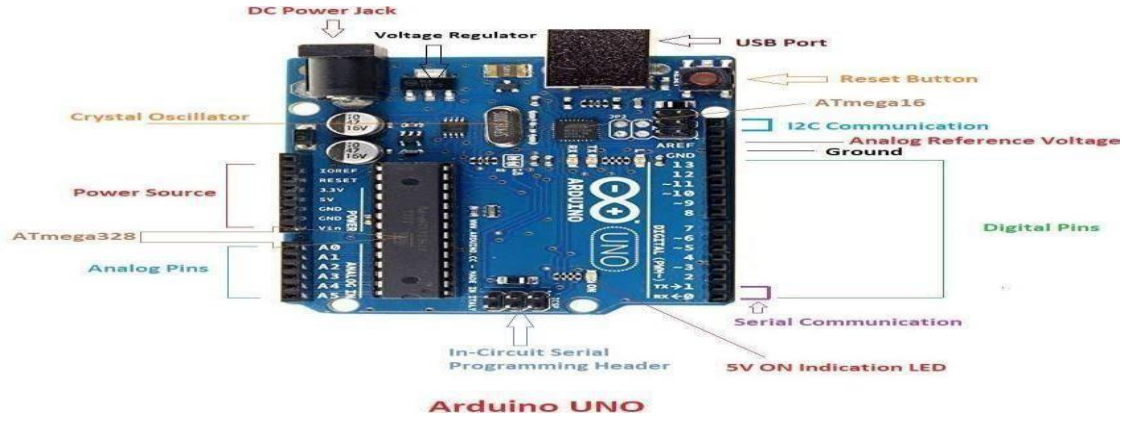


Fig :4.1.1.1 Arduino UNO

This board comes with all the features required to run the controller and can be directly connected to the computer through USB cable that is used to transfer the code to the controller using IDE (Integrated Development Environment) software, mainly developed to program Arduino. IDE is equally compatible with Windows, MAC or Linux Systems, however, Windows is preferable to use. Programming languages like C and C++ are used in IDE.

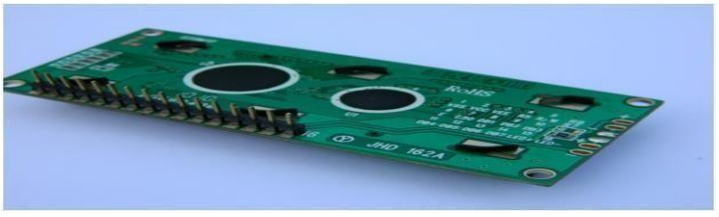
- Apart from USB, battery or AC to DC adopter can also be used to power the board.
- Arduino Uno boards are quite similar to other boards in Arduino family in terms of use andfunctionality, however, Uno boards don't come with FTDI USB to Serial driver chip.
- There are many versions of Uno boards available, however, Arduino Nano V3 and Arduino Uno are the most official versions that come with Atmega328 8-bit AVR Atmel microcontroller where RAM memory is 32KB.

IMAGES OF LCD DISPLAY:-

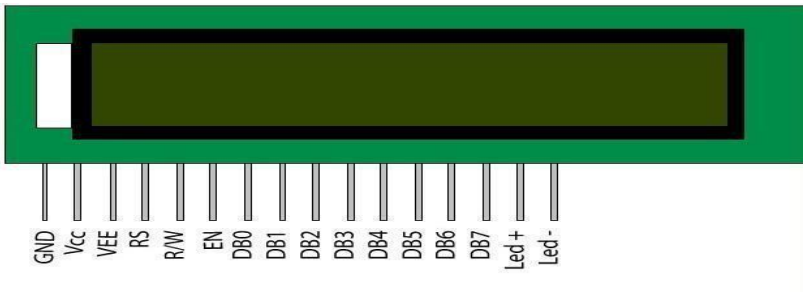
LCD stands for Liquid Crystal Display. It's a type of flat-panel display technology commonly used in TVs, computer monitors, smartphones, and other electronic devices. They offer benefits such as thinness, lightweight, and low power consumption compared to older display technologies like CRT (Cathode Ray Tube).

Fig :4.2.2.1 LCD – Front View

The back view of an LCD typically includes ports for power, video input, and sometimes audiooutput. It may also have mounting holes for attaching the display to a stand or wall mount. Additionally, you might find ventilation slots to dissipate heat generated by the electronics inside the display.



PIN DIAGRAM:



RELAY:

What is a relay?

A relay is an electromagnetic switch that is used to turn on and turn off a circuit by a low power signal,or where several circuits must be controlled by one signal.

Most of the high end industrial application devices have relays for their effective working. Relays are simple switches which are operated both electrically and mechanically. Relays consist of an electromagnet and also a set of contacts. There are also other operating principlesfor its working. But they differ according to their applications. Most of the devices have the application of relays.

Power supply:

A power supply is a component that provides at least one electrical charge with power. It typically converts one type of electrical power to another, but it can also convert a different Energy form in electrical energy, such as solar, mechanical, or chemical.

A power supply provides electrical power to components. Usually, the term refers to devices built into the powered component.Computer power supplies, for example, convert AC currentto DC current and are generally located along with at least one fan at the back of the computercase.

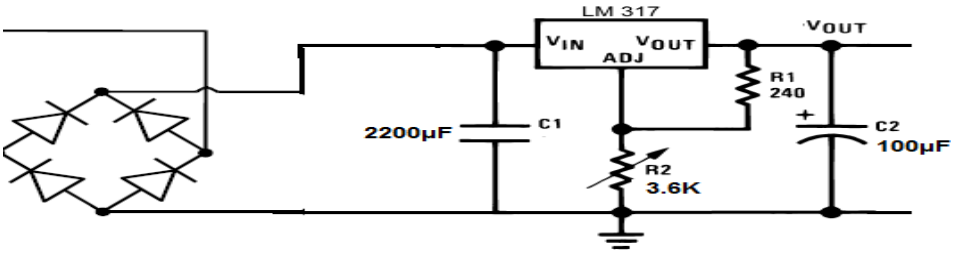


Fig :4.4 Power Supply

Rectifier:

A **rectifier** is an electrical device that convertsalternating current (AC), which periodicallyreverses direction, to direct current (DC), which flows in only one direction. The process isknown as *rectification*, since it "straightens" the direction of current.

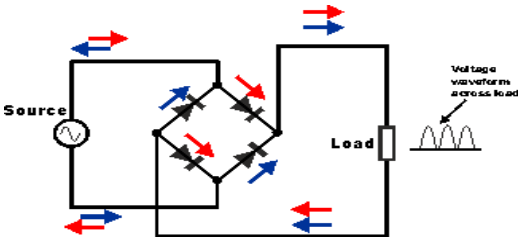


Fig :4.4.1a Circuit of rectifier

fig :4.4.1b Rectifier

CAPACITORS:

Capacitors are used to attain from the connector the immaculate and smoothest DC voltage in which the rectifier is used to obtain throbbing DC voltage which is used as part of the light of the present identity. Capacitors are used to acquire square DC from the current AC experienceof the current channels so that they can be used as a touch of parallel yield.

Fig :4.4.2 Capacitor

BUZZER:

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical,or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of user input such as a mouse click or keystroke. Buzzer is an integrated structureof electronic transducers, DC power supply, widely used in computers, printers, copiers, alarms, electronic toys, automotive electronic equipment, telephones, timers and other electronic products for sound devices.

Fig :4.4.4 Buzzer

MQ2 SENSOR:

In current technology scenario, monitoring of gases produced is very important. From home appliances such as air conditioners to electric chimneys and safety systems at industries monitoring of gases is very crucial. Gas sensors are very important part of such systems. Smalllike a nose, gas sensors spontaneously react to the gas present, thus keeping the system updatedabout any alterations that occur in the concentration of molecules at gaseous state.

Fig :4.4.5a Gas Sensor

GSM/GPRS MODULE :

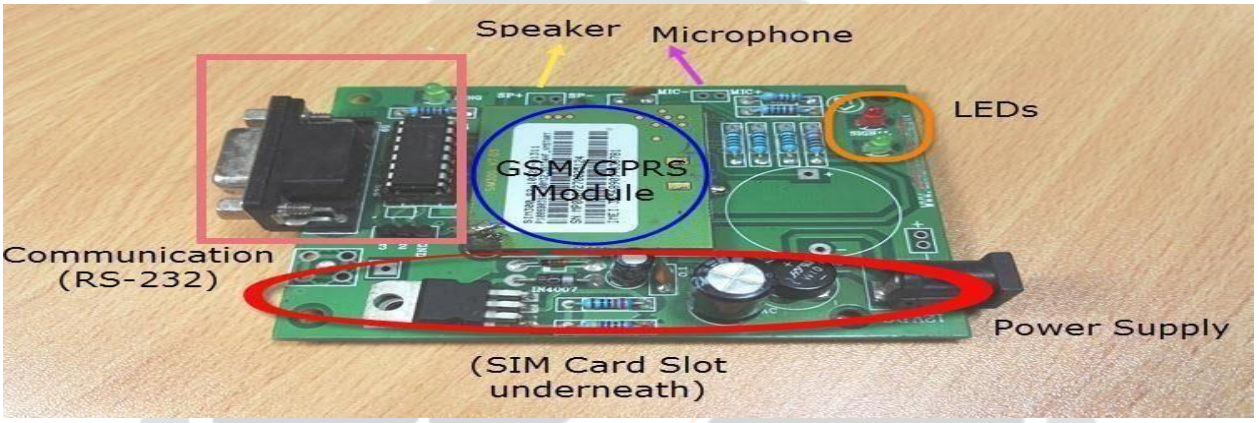


Fig :4.4.6 GSM/GPRS

GPRS Modules are one of the commonly used communication modules in embedded systems.A GPRS Module is used to enable communication between a microcontroller (or a microprocessor) and the GPRS Network. Here, GSM stands for Global System for Mobile Communication and GPRS stands for General Packet Radio Service.

GPRS Modules allow microcontrollers to have a wireless communication with other devices and instruments. Such wireless connectivity of microcontroller opens up to wide range of applications like Home Automation, Home Security Systems, Disaster Management, Medical Assistance, Vehicle Tracking, Online Banking, E – Commerce etc. to name some.

What is GPRS?

GPRS or General Packet Radio Service is an extension of the GSM Network. GPRS is an integrated part of the GSM Network which provides an efficient way to transfer data with the same resources as GSM Network.

Difference between a Module, MODEM and Mobile (System)

A GSM/GPRS Module is a device or chip that is actually responsible for the wirelesscommunication with the GSM Network.

A GSM/GPRS MODEM is device that modulates and demodulates the signals from the Wireless Network and allows internet connectivity. A GSM MODEM generally consists of a GSM Module along with some other components like a SIM Card, a device to modulate and demodulate the signals and power supply.

A System, like a mobile phone for example, is a complete device that has a GSM Module (might be integrated in the processor), a GSM MODEM (even this might be integrated) and other components like processor, screen, keypad, speakers, microphone etc.

4.4.6 CPU FAN

The CPU fan is used to cool the CPU (central processing unit) heat sink. Effective cooling ofconcentrated heat sources such as large integrated circuits requires a heat sink, which can be cooled by a fan. However, using a fan alone does not prevent the small chip from overheating.

A CPU fan is a crucial component in your computer that keeps the central processing unit cool, preventing overheating and ensuring smooth performance. It's the unsung hero that works tirelessly to maintain optimal temperatures, much like a radiator for your car's engine

HX711 Load Cell Amplifier

The Load Cell Amplifier is a small breakout board for the HX711 IC that allows you to easilyread load cells to measure weight. By connecting the amplifier to your microcontroller you will be able to read the changes in the resistance of the load cell, and with some calibration, you'll be able to get very accurate weight measurements.

The HX711 uses a two-wire interface (Clock and Data) for communication. Any microcontroller's GPIO pins should work, and numerous libraries have been written, makingit easy to read data from the HX711. These are commonly colored RED, BLK, WHT, GRN,and YLW. Each color corresponds to the conventional color coding of load cells:

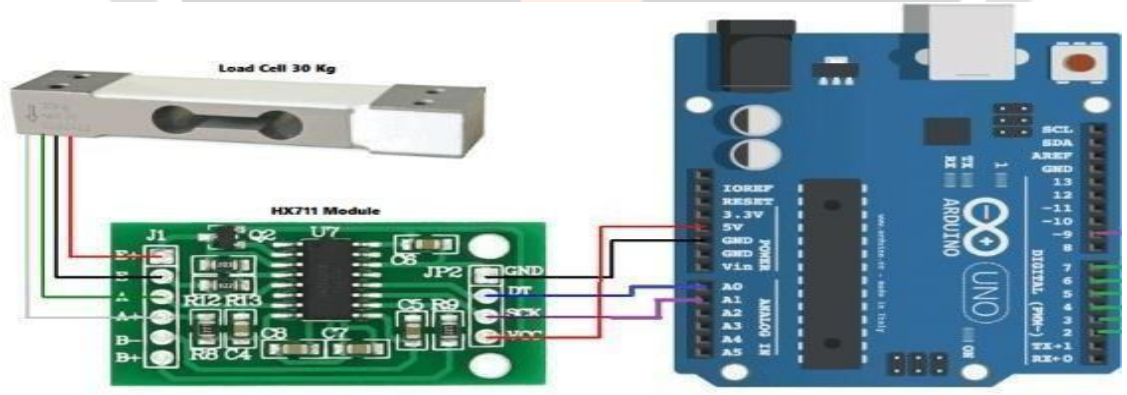


Fig :4.4.8.1 HX711 Cell Amplifier

SOFTWARE REQUIREMENTS

ARDUINO IDE:

Arduino IDE where IDE stands for Integrated Development Environment – An official software introduced by Arduino.cc, that is mainly used for writing, compiling and uploading the code in the Arduino Device. Almost all Arduino modules are compatible with this softwarethat is an open source and is readily available to install and start compiling the code on the go.

INTRODUCTION TO ARDUINO IDE:

- Arduino IDE is an open source software that is mainly used for writing and compiling the code into the Arduino Module.
- It is an official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process.
- It is easily available for operating systems like MAC, Windows, and Linux and runs on theJava Platform that comes with inbuilt functions and commands that play a vital role for debugging, editing and compiling the code in the environment.
- A range of Arduino modules available including Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino Micro and many more.
- This environment supports both C and C++ languages.

CODE

```
include<LiquidCrystal.h> LiquidCrystal
lcd(A5,A4,A3,A2,A1,A0);

#include "HX711.h"

#define calibration_factor 244.70 //This value is obtained using the
SparkFun_HX711_Calibration sketch

#define LOADCELL_DOUT_PIN  3

#define LOADCELL_SCK_PIN 2int
gas=4;
int fan=5;
int buz=6;
int gas_value;
HX711 scale;
float  val; void
setup()
 {

  Serial.begin(9600); pinMode(gas,INPUT);
  pinMode(fan,OUTPUT);
  pinMode(buz,OUTPUT);
  digitalWrite(buz,LOW);
  digitalWrite(fan,HIGH);
  Serial.println("HX711 scale demo");

  scale.begin(LOADCELL_DOUT_PIN, LOADCELL_SCK_PIN);

  scale.set_scale(calibration_factor);          //This value is obtained by using the
SparkFun_HX711_Calibration sketch
  scale.tare(); //Assuming there is no weight on the scale at start up, reset the scale to 0


  Serial.println("Readings:");
  lcd.begin(16,2);
  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("LPG GAS LEAK");
  lcd.setCursor(0,1); lcd.print("WEIGHT
  MONITOR");
}
```

```
void loop()

 {

  Serial.print("Reading: ");
  val=scale.get_units();
//  val=(val,2);

  Serial.print(val); //scale.get_units() returns a float

  Serial.print(" gm"); //You can change this to kg but you'll need to refactor the
calibration_factor
  Serial.println();
  gas_value=digitalRead(gas);
  lcd.clear(); lcd.setCursor(0,0);
  lcd.print("LPG WEIGHT: ");
  lcd.setCursor(0,1); lcd.print(val);
  lcd.setCursor(8,1);
  lcd.print("gms"); delay(1000);
  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("LPG GAS:");
  lcd.setCursor(0,1);
  lcd.print(gas_value);
  if(gas_value==0&&val<100)

  {

    digitalWrite(buz,HIGH);
    digitalWrite(fan,LOW);
    lcd.clear();
    lcd.setCursor(0,0);
    lcd.print("GAS LEAKING..");
    lcd.setCursor(0,1); lcd.print("WEIGHT
    DECRESE..");
    delay(1000);
    sendsms();
    gprs();
  }

  else if(gas_value==0&&val>100)

  {

    digitalWrite(buz,HIGH);
    digitalWrite(fan,LOW);
    lcd.clear();
    lcd.setCursor(0,0);
    lcd.print("GAS LEAKING..");
    lcd.setCursor(0,1); lcd.print("NORMAL
    WEIGHT");delay(1000);
  }

  else if(gas_value==1&&val<100)

  {

    digitalWrite(buz,HIGH);
    digitalWrite(fan,HIGH);
    lcd.clear(); lcd.setCursor(0,0);
    lcd.print("NO GAS LEAK");
    lcd.setCursor(0,1);
    lcd.print("WEIGHT DECREASE..");
```

```
  }
  else if(gas_value==1&&val>100)
  {
    digitalWrite(buz,L
    OW);
    digitalWrite(fan,HI
    GH); lcd.clear();
    lcd.setCursor(0,0);
    lcd.print("NO GAS
    LEAK");
    lcd.setCursor(0,1);
    lcd.print("NORMAL
    WEIGHT");delay(1000);
  }
  else
  {
    digitalWrite(
    buz,LOW);
    digitalWrite(f
    an,HIGH);
  }
}
void sendsms()
 {

  delay(1000);
  Serial.println("AT");
  delay(1000);
  Serial.println("ATE0");
  delay(1000);
  Serial.println("AT+CM
  GF=1");delay(1000);
  Serial.println("AT+CMGS=\"63054060
  71\"");delay(1000);
  Serial.println("LPG GAS LEAKED & WEIGHT DECREASED");
  dela
  y(1
  000
  );
  Seri
  al.w
  rite(
  26);
  lcd.
  clea
  r();

  lcd.setCursor(0,
  0);
  lcd.print("msg
  sent");
```

```
  delay(1000);
  Serial.println("
  msg sent");
  }


   void gprs()

{
  lcd.clear();
  lcd.setCursor(
  0, 1);
  lcd.print("DATA UPLOADING");

  Serial.println("AT
  ");//at test
  delay(1000);
  Serial.println("AT+CPIN?");//This is to check if SIM is unlocked
  delay(1000);
  Serial.println("AT+CREG?"); //This checks if SIM is registered or not
  delay(1000);
   Serial.println("AT+CGATT?");//Check if GPRS is attached or
   notdelay(1000);
   Serial.println("AT+CIPSHUT");//Reset the IP session if any
   delay(1000);
 Serial.println("AT+CIPSTATUS");//Check if the IP stack is initialized
 delay(2000);
 Serial.println("AT+CIPMUX=0");//To keep things simple, I'm setting up a single
connection mode
 delay(2000);

 Serial.println("AT+CSTT=\"Airtel Internet\"");//start task and setting the APN,
 delay(1000);
 Serial.println("AT+CIICR");//Now bring up the wireless. Please note, the response to
this might take some time
 delay(6000);

 Serial.println("AT+CIFSR");//get local IP
 adressdelay(1000);
 Serial.println("AT+CIPSPRT=0");


 delay(3000);
Serial.println("AT+CIPSTART=\"TCP\",\"api.thingspeak.com\",\"80\"");//start up the
connection
 delay(10000);

 Serial.println("AT+CIPSEND");//begin send data to remote server
 delay(10000);
  lcd.clear();
 lcd.setCursor(0,0);
 lcd.print("Data
 uploding...");
String
                                                                    strs="

GET

https://api.thingspeak.com/update?api_key=S817TOAMVKXKSUSV&field1="

+String(val)+ "&field2="+ String(gas_value);
 Serial.println(strs);//begin send data to remote server
```

```
delay(6000);
Serial.write(26);//sending

delay(6000);//waiting for reply, important! the time is base on the condition of internet
Serial.println();
Serial.println("AT+CIPSHUT");//close the
connectiondelay(1000);
Serial.println("Data uploded in
server");lcd.clear();
lcd.setCursor(
0,0);
lcd.print("data
uploded");
}
```

WORKING PRINCIPLE :

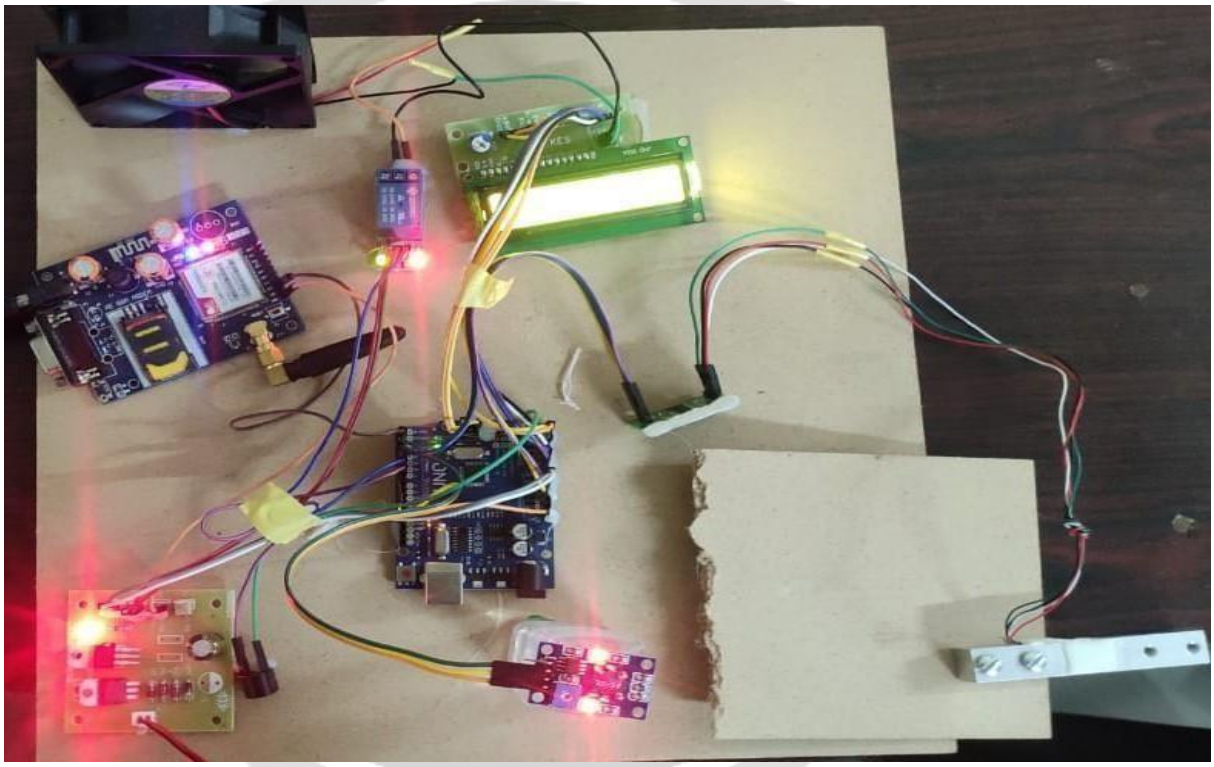


Fig 6.2.1:Working Model of The Project

The circuit is powered with a 12V battery. Arduino Uno microcontroller which is the maincomponent of this work is programmed using embedded C language.LPG gas leakage is continuously measured with MQ2 gas sensor.When the sensor detects the gas leakage andthen automatically the buzzer and cpu fan will ON,and the data will be uploaded to serverand message will be sent to the respective number.

The load cell will monitor the weight of the cylinder,When it was decreased in weight thenautomatically the buzzer will ON.The following figures shows the operating setup for different conditions.

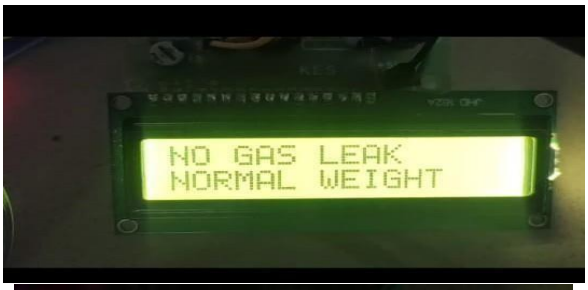


Fig :6.2.2 Display of No Gas Leak and Leak andNormal Weight

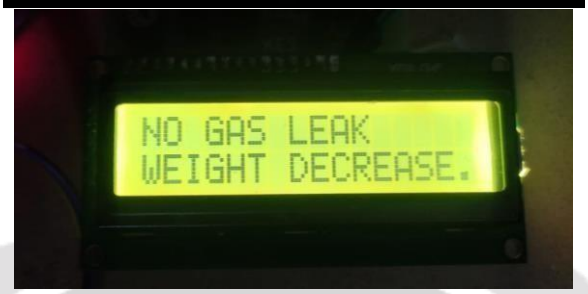


Fig:6.2.3 Display of No Gas Weight Decreases

Fig :6.2.4 Display of Gas Leak and Weight Decreases

Fig:6.2.5 Display of Gas Leak and Normal Weight

Fig:6.2.6 Display of Data Uploading

Fig:6.2.7 Display of Message Sent

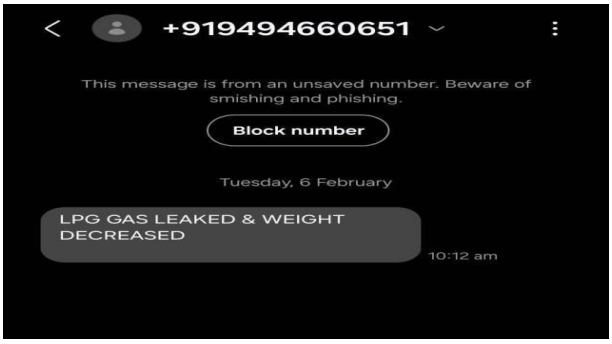


Fig :6.2.8 GSM Result

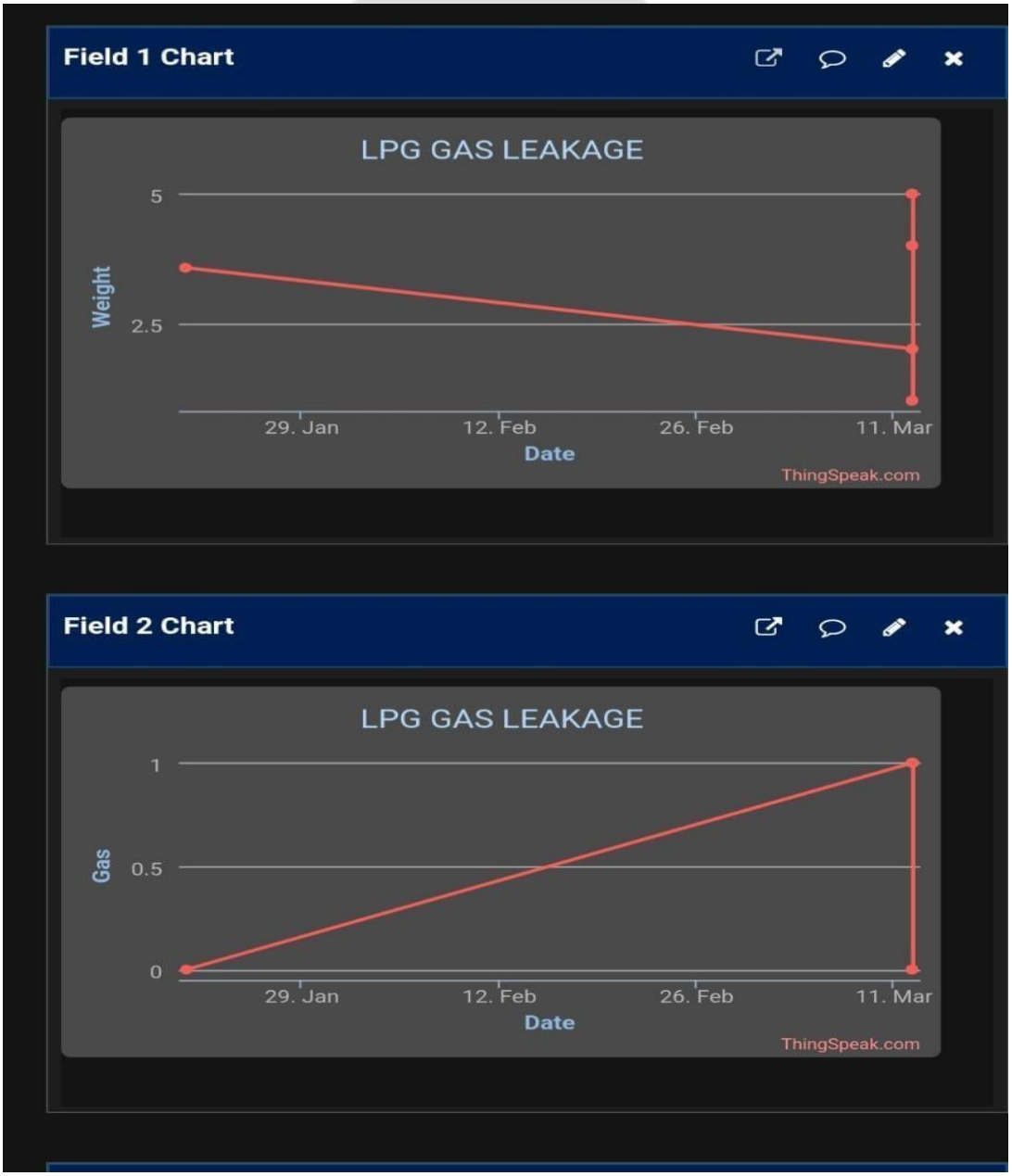


Fig :6.2.9 Things Speak Result

CONCLUSION

In conclusion, the development of the IoT-enabled framework for LPG leakage detection and weight monitoring represents a significant advancement in safety, efficiency, and resource management across various sectors. Through the integration of smart sensors, communication technologies, and data analytics, the system offers real-time monitoring capabilities, proactivealerting mechanisms, and remote management features, ensuring enhanced safety and operational effectiveness.

One key takeaway from this project is the critical role of technology in mitigating risks associated with LPG usage. By leveraging IoT capabilities, stakeholders can gain unprecedented visibility into LPG systems, enabling early detection of leaks, timely response to anomalies, and proactive maintenance interventions. This proactive approach not only enhances safety for individuals and communities but also minimizes the potential for environmental damage and property loss.

Overall, the project marks asignificant step forward in leveraging IoT technology for enhancing safety and efficiency in LPG management, setting a precedent for future developments in the field.

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