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GAS LEAKAGE DETECTION SYSTEM USING ARDUINO UNO

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ABSTRACT

One of the main reasons for mishaps in homes and businesses is gas leaks, which may lead to ex plosions, fires, and serious health risks.In order to prevent such disasters and guarantee the prote ction of people and property, early identification of gas leaks is essential.The creation of a gas lea k detection system using an Arduino UNO Microcontroller, a buzzer, and a MQ5 gas sensor is co vered in this article.The suggested technology detects dangerous gasses like methane and LPG in real time and sounds a warning when it does.Because of the design's emphasis on dependability, affordability, and ease of use, it may be widely used in households. industries and workspaces. This creative method helps to raise safety standards internationally while satisfying the increasin g need for inexpensive safety gadgets.In order to improve safety in homes and businesses, this ar ticle describes the creation of a gas leak detection system that incorporates an Arduino UNO mic rocontroller, LCD display, buzzer, and MQ-5 gas sensor. Key Words: Gas leakage detection, MQ-5 sensor , Arduino UNO , Safety systems ,Real-time monitoring , LPG detection

I. INTRODUCTION

One of the most serious safety risks in both residential and commercial settings is gas leaks. Uncontrolled releases of flammable gases, such as propane, butane, or liquefied petroleum gas (L PG), can have serious repercussions, such as fires, explosions, asphyxia, and a large loss of life a nd property.Even a tiny, undiscovered gas leak can quickly build up and produce a potentially ex plosive environment in domestic kitchens, hotels, workplaces, labs, and gas storage facilities.
The risk of gas leakage is still significant because of human carelessness, aged gas pipes, malfun ctioning regulators, or incorrect handling of gas cylinders.To address these safety concerns, a **Gas Leakage Detection System using Arduino Uno** has been developed to provide an

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effective, automated, and reliable solution. The proposed system continuously monitors the concentration of combustible gases present in the surrounding environment using a gas sensor. When the detected gas level exceeds a predefined safety threshold, the system immediately responds without requiring human intervention.

Upon detection of gas leakage, the system activates multiple safety mechanisms simultaneously. An audible **buzzer alarm** is triggered to alert occupants and nearby personnel about the potential danger. At the same time, an **exhaust fan** is switched ON to ventilate the affected area and disperse the leaked gas, thereby reducing gas concentration and minimizing the risk of ignition. Additionally, the system controls the **gas regulator using an ON/OFF mechanism**, automatically shutting off the gas supply to prevent further leakage. Once the gas concentration returns to a safe level, the system can reset itself based on programmed logic.

1.1 Objectives

The primary objective of this project is to design and develop a reliable and automated **Gas Leakage Detection System using Arduino Uno** that enhances safety in both domestic and industrial environments. The specific objectives of the system are as follows:

- **To identify gas leaks early on**
  The system's goal is to continually check the surroundings for flammable gasses like LPG .Early detection lowers the risk of fire, explosion, or asphyxia by avoiding the buildup of gas to hazardous levels.To use a buzzer to give an instant warningThe device sounds an a udible alarm when it detects gas leakage that exceeds a certain safe level.
  By ensuring that residents and surrounding staff are immediately aware of the dangerous situation, this alarm system facilitates prompt evacuation and remedial action.
- **To turn ON the exhaust fan to remove leaked gas**

  The system is designed to automatically switch ON an exhaust fan when gas leakage is detected. The exhaust fan helps in ventilating the area by expelling the leaked gas, thereby lowering gas concentration in the environment and minimizing the chances of ignition.

1.2 Block Diagram Description

The block diagram of the **Gas Leakage Detection System using Arduino Uno** represents the overall flow of data and control signals between different components of the system. It clearly illustrates how gas leakage is detected, processed, and handled through automatic safety actions. The system is divided into three main stages: **sensing**, **processing**, and **actuation**.

Gas Sensor (MQ-2)

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The MQ-2 gas sensor forms the sensing unit of the system. It is used to detect the presence of combustible gases such as LPG, propane, butane, methane, and smoke in the surrounding environment. The sensor continuously monitors gas concentration and produces an analog voltage output proportional to the detected gas level. This analog signal changes depending on the concentration of gas present in the air. When the gas concentration exceeds a predefined safe threshold, the sensor output increases, indicating a potential gas leakage condition. The MQ-2 sensor provides real-time monitoring and acts as the first line of defense in the system.

Arduino Uno (Microcontroller Unit)

The Arduino Uno acts as the central processing and control unit of the system. It receives the analog signal from the MQ-2 gas sensor through its analog input pins. The microcontroller continuously analyzes the sensor data by comparing it with a predefined threshold value stored in the program. Based on this comparison, the Arduino decides whether the detected gas level is safe or hazardous. If gas leakage is detected, the Arduino generates control signals to activate various output devices. The Arduino Uno ensures fast decision-making, accurate control, and reliable automation of the safety mechanisms.

Output and Safety Control Devices

The output section consists of multiple safety and alert devices, including a **buzzer**, **exhaust fan**, and **gas regulator control mechanism** using a relay module or solenoid valve.

- The **buzzer** is activated immediately when gas leakage is detected to provide an audible warning. This alerts occupants and nearby personnel to the hazardous situation, even if they are not visually monitoring the system.
- The **exhaust fan** is turned ON to ventilate the area by expelling the leaked gas and allowing fresh air to circulate. This helps reduce gas concentration and lowers the risk of fire or explosion.
- The **gas regulator or solenoid valve**, controlled through a relay or servo mechanism, automatically turns OFF the gas supply. This prevents further leakage and ensures complete isolation of the gas source during emergency conditions.

These output devices work simultaneously to provide a multi-layered safety response, ensuring rapid hazard mitigation without human intervention.

II. OVERALL SYSTEM OPERATION

In summary, the block diagram demonstrates a closed-loop automated safety system where the gas sensor detects leakage, the Arduino Uno processes the sensor data, and the output devices take immediate preventive action. This integrated approach enhances safety, reduces human

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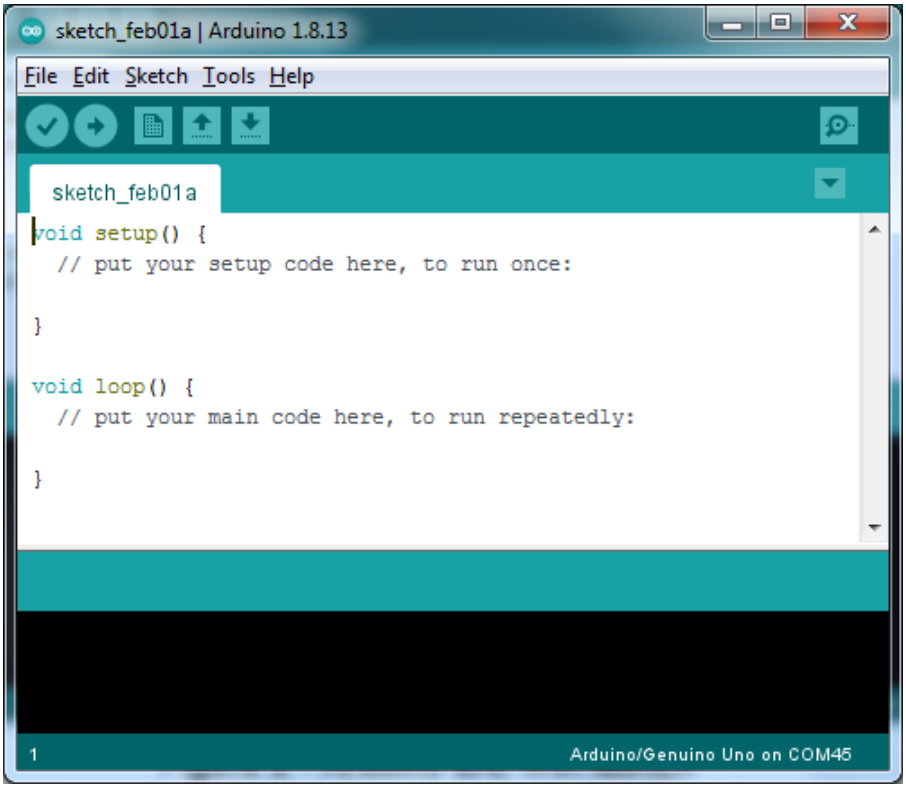
dependency, and minimizes the risk of gas-related accidents in domestic and industrial environments.

2.1 Components Used

- Arduino Uno

Introduction to Arduino IDE:



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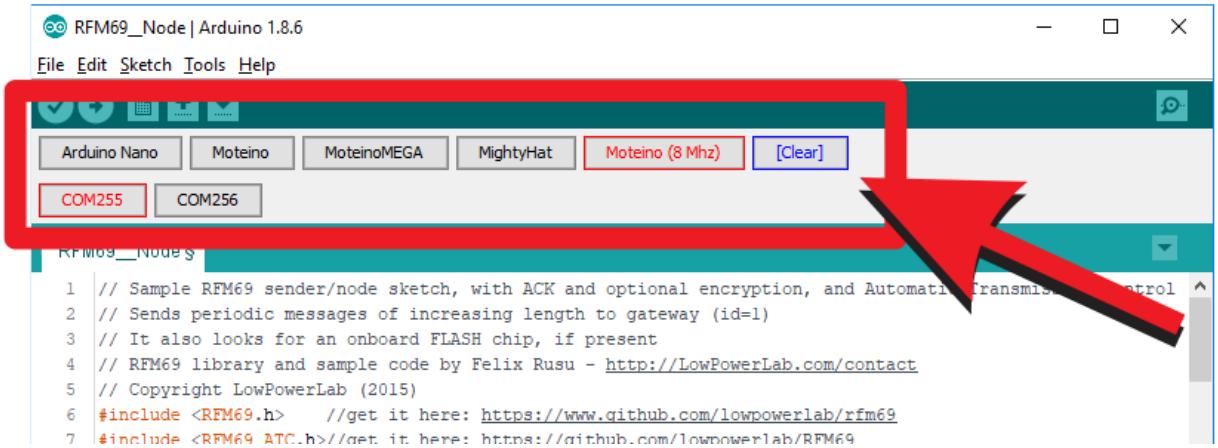

2.2 What is Arduino IDE?

The Arduino IDE is an **open-source application** developed by Arduino that allows users to create programs (called **sketches**) for Arduino microcontroller boards. It supports programming in a simplified version of **C/C++**, which makes microcontroller programming easier to understand and implement.

2.3 Main Features of Arduino IDE

- Easy-to-use code editor
- One-click compile and upload
- Built-in examples and libraries
- Cross-platform support (Windows, macOS, Linux)
- Open-source and free to use

III. WORKING PRINCIPLE

The MQ-2 sensor works on the principle of **chemiresistance**. It contains a **sensitive material (SnO_2 – Tin Dioxide)** whose electrical resistance changes when exposed to smoke or combustible gases.

- In clean air, the sensor's resistance is high.
- When smoke or gas is present, the resistance decreases.
- This change in resistance is converted into an electrical signal.

The sensor includes a **built-in heating element** that heats the sensing material to the required operating temperature, enabling accurate detection.

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3.1 Gases Detected by MQ-2 Sensor

The MQ-2 sensor is sensitive to:

- Smoke
- LPG (Liquefied Petroleum Gas)
- Propane
- Methane
- Hydrogen
- Alcohol vapors

3.2 Pin Configuration (MQ-2 Module)

- **VCC** – Power supply (5V)
- **GND** – Ground
- **AO (Analog Output)** – Provides variable voltage based on gas concentration
- **DO (Digital Output)** – HIGH or LOW output based on preset threshold

3.3 Working Principle

1. The **MQ-2 gas sensor** continuously senses the presence of combustible gases in the surrounding environment.
2. When the gas concentration exceeds a predefined threshold value, the sensor sends a signal to the Arduino Uno.
3. The Arduino Uno performs the following actions:
    - □ **Buzzer turns ON** to alert people nearby
    - □ **Exhaust fan turns ON** to expel leaked gas
    - □ **Gas regulator turns OFF** to stop further gas supply
4. Once the gas level returns to a safe range:
    - Buzzer turns OFF
    - Exhaust fan turns OFF
    - Gas regulator can be turned ON again (depending on program logic)

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1. Gas Sensor Block

The gas sensor is used to continuously monitor the surrounding environment for combustible gases such as LPG. Under normal conditions, the sensor detects a low level of gas and sends a low analog signal to the Arduino.
When gas leakage occurs, the gas concentration increases and the sensor output voltage rises accordingly. This analog signal is continuously sent to the Arduino microcontroller for further processing. The gas sensor acts as the primary detection unit in the system.

2. Arduino Microcontroller Block

The Arduino microcontroller acts as the central control unit of the system. It receives the analog signal from the gas sensor and continuously compares it with a predefined threshold value programmed in the system.

- If the gas level is **below the threshold**, the Arduino keeps all output devices in the OFF state.
- If the gas level **exceeds the threshold**, the Arduino identifies it as a gas leakage condition and immediately activates safety mechanisms.

The Arduino ensures fast decision-making and automatic control without requiring any human intervention.

3. Buzzer Block (Alert Unit)

When gas leakage is detected, the Arduino sends a digital signal to the buzzer, turning it ON. The buzzer produces a loud audible alarm to alert occupants about the gas leakage. This immediate warning helps people take quick action, such as evacuating the area or switching off electrical devices. The buzzer remains ON as long as the gas level is above the safe limit.

4. Exhaust Fan Block (Ventilation Unit)

Simultaneously, the Arduino activates the exhaust fan through a relay module. The exhaust fan helps in ventilating the area by removing leaked gas and allowing fresh air to circulate. This reduces gas concentration in the environment and significantly lowers the risk of fire or explosion. The exhaust fan continues to operate until the gas level returns to a safe range.

5. Gas Regulator ON/OFF Block (Safety Control Unit)

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The gas regulator ON/OFF block is responsible for controlling the gas supply. When gas leakage is detected, the Arduino sends a control signal to turn OFF the gas regulator. This can be achieved using a relay-controlled solenoid valve or a servo motor mechanism. By automatically shutting off the gas supply, the system prevents further leakage and enhances overall safety. The regulator remains OFF until the system is manually reset or the gas level becomes safe.

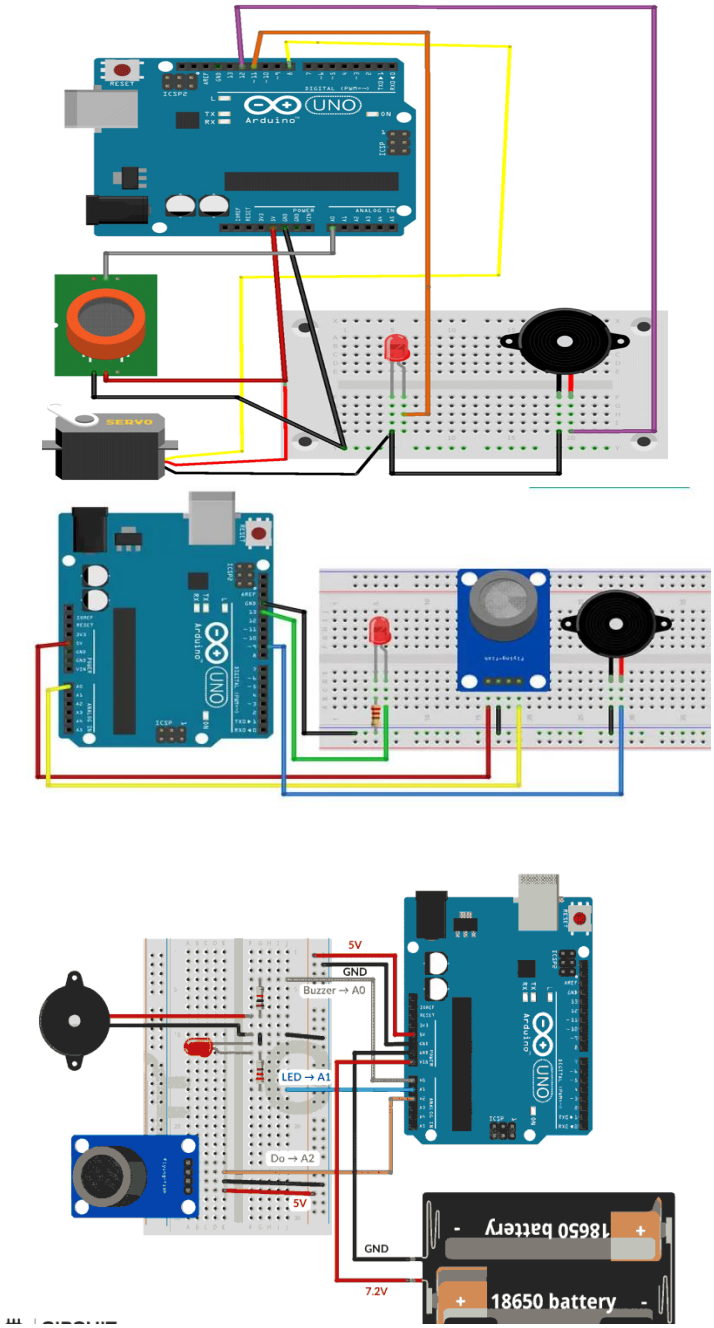

Fig.1- Demonstrated diagram

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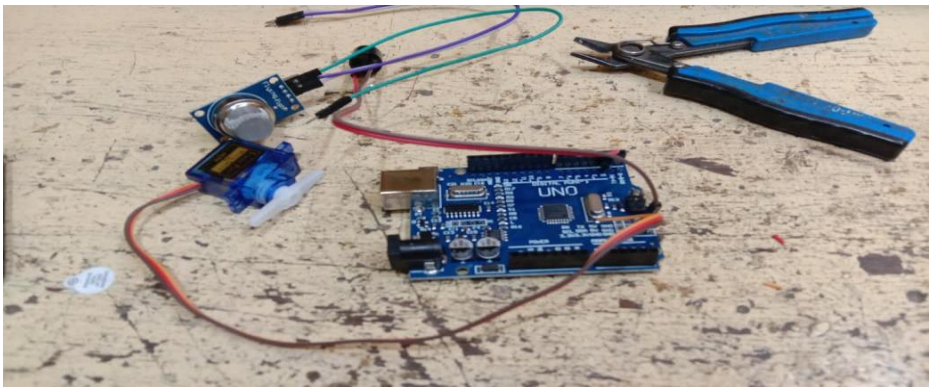
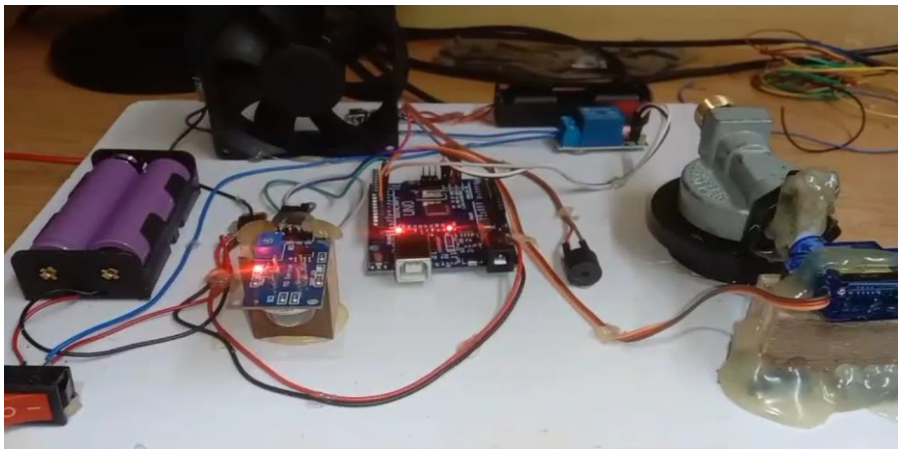
IV. CONCLUSION AND RESULT

An efficient and dependable safety solution is the Arduino Uno Gas Leakage Detection System. When it finds a gas leak, it acts quickly to stop it by turning on alarms, turning on ventilation, an d managing the gas regulator.This approach improves overall safety and drastically lowers the lik elihood of acidents.





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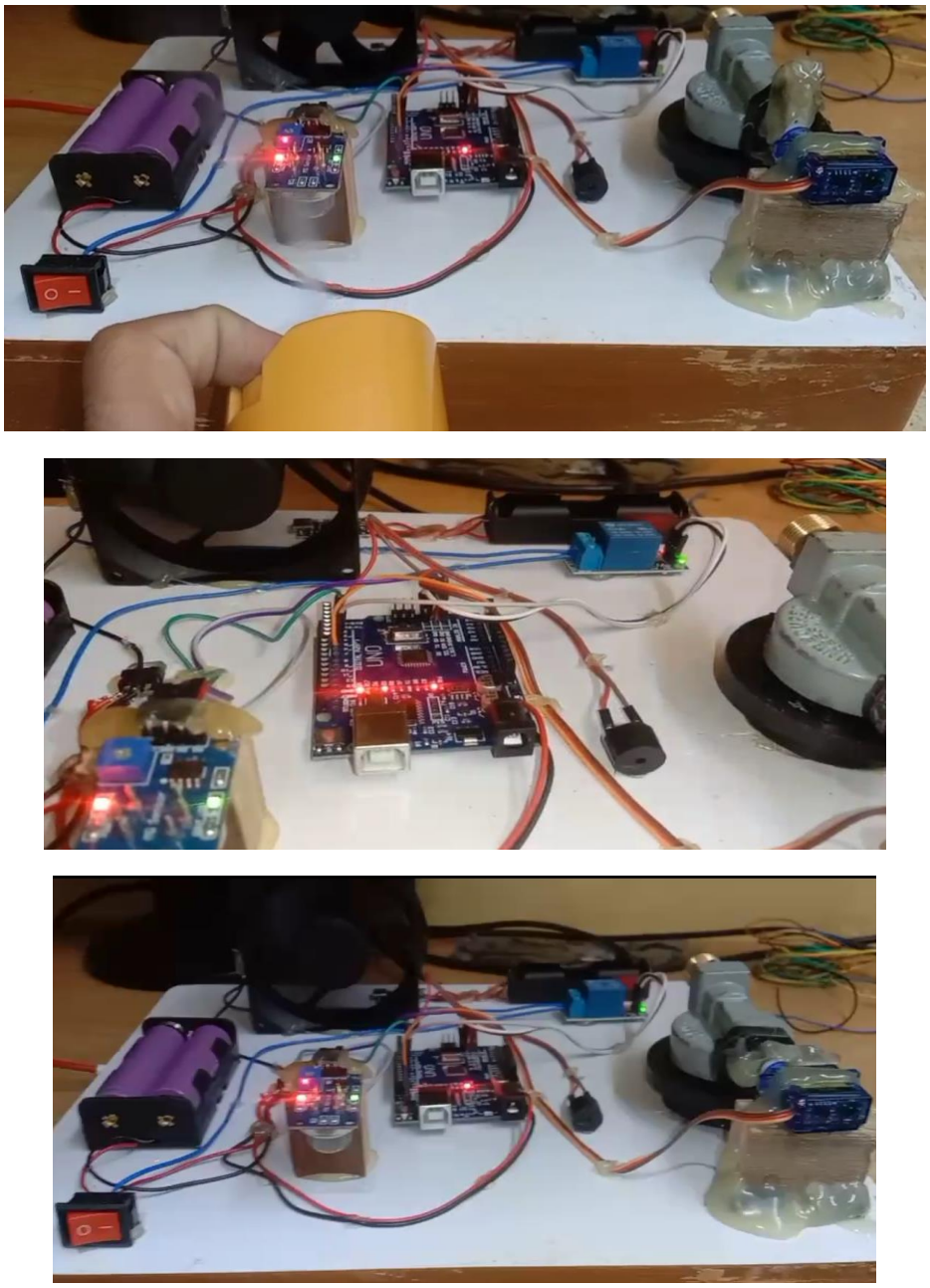

Fig.2 – Circuit and model diagram

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