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# Rover in Mines

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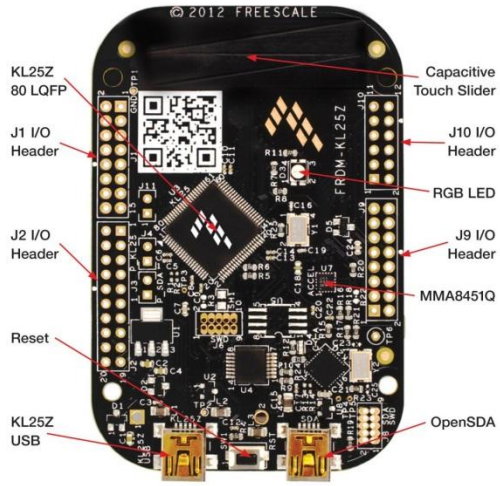
**Abstract:** ***Safety of human life is an important factor to improve life safety, many systems have been developed. While working in mines environment, safety is an important factor because mines are underground tunnels. Different accidents may takes place due to various hazardous gases so that many workers are injured and died. This robotic system helps people who are working in mines. Robot enters and moves in mines to detect hazardous gases, provides information and alert people. The control system uses FRDM-KL25Z connected wirelessly to a motor robotic vehicle which accordingly realizes qualitative identification for different gases using various sensors. The acquired data is transferred to the administrator through ESP8266 module. So using this robotic system, probability of accident is reduced.***

## 1. Introduction

Safety is one of the main aspects related to industries specially the mining industry. In the underground coal mines, human safety is most important thing which needs to look. To avoid any types of unwanted phenomena all mining industry follows some basic precaution and rules. Communication is the main key factor for any industry today to monitor different parameters and take necessary actions accordingly to avoid any types of hazards. In recent years, disasters in coal mine occur frequently, which lead to great loss of possession and life. The accidents happening in mines are due to the complexity of mine environment and the variety of work condition of coal mine, so it is necessary to monitor mine working environment. To avoid loss of material and damaging of human health, protection systems well as faithful communication system is necessary inside the underground mines. To increase both safety and productivity in mines, a reliable communication must be established between workers moving in the mine and a fixed base station or control room. A robot equipped with different sensors for detecting various poisonous gases and if value of hazardous gases crosses set limit then system provides safety to workers who are working in mines. When the robot reaches the mine site, it detects and sends the environmental conditions, presence of poisonous and dangerous gases.

## 2. Hardware Implementation

### a) FRDM-KL25Z



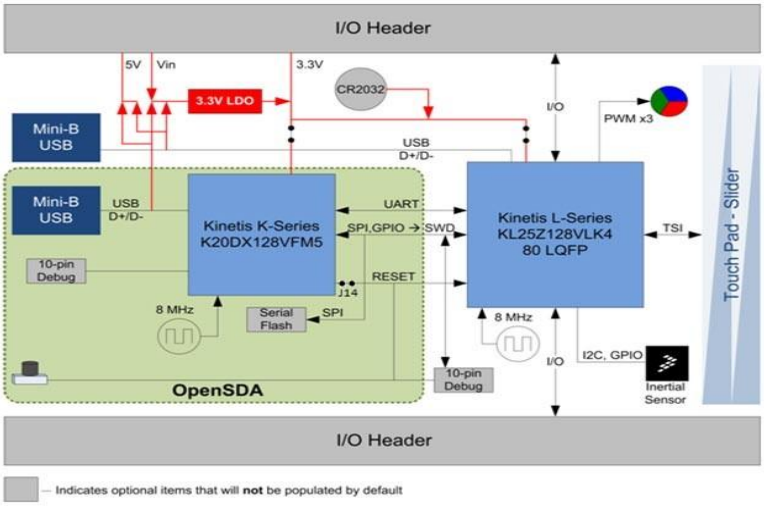

The FRDM-KL25Z has been designed by Freescale in collaboration with mbed for prototyping all sorts of devices, especially those requiring the size and price point offered by Cortex-M0+ and the power of USB Host and Device. It is packaged as a development board with connectors to break out to strip board and breadboard, and includes a built-in USB FLASH programmer. Thus it is ideal for rapid prototyping of microcontroller-based applications. The **Freescale** Freedom **KL25Z** hardware, **FRDM-KL25Z**, is a simple, yet sophisticated design featuring a Kinetis L Series microcontroller, the industry's first microcontroller built on the ARM® Cortex™-M0+ core.

The features of the FRDM-KL25Z include:

- MKL25Z128VLK4 in an 80 LQFP package
- Capacitive touch slider
- MMA8451Q accelerometer
- Tri-colour (RGB) LED
- Flexible power supply options – USB, coin cell battery, external source
- Battery-ready, power-measurement access points
- Easy access to MCU I/O via Arduino ™ R3 compatible I/O connectors
- Mass storage device flash programming interface
- P&E Debug interface provides run-control debugging and compatibility with IDE tools

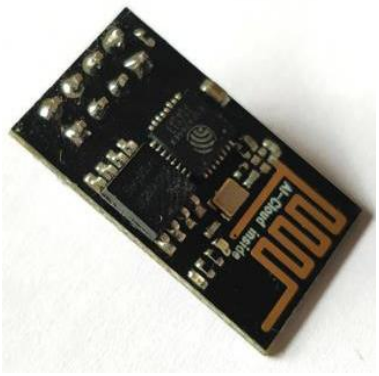
### b) CMSIS

DAP interface: new ARM standard for embedded debug interface. There are multiple power supply options on the FRDM-KL25Z. It can be powered from either of the USB connectors, the $V_{IN}$ pin on the I/O header, an on-board coin cell battery, or an off-board 1.71-3.6V supply from the 3.3V pin on the I/O header.




**c) ESP8266 Wi-Fi Module**

ESP8266 offers a complete and self-contained Wi-Fi networking solution, allowing it to either host the application or to offload all Wi-Fi networking functions from another application processor. When ESP8266 hosts the application, and when it is the only application processor in the device, it is able to boot up directly from an external flash. It has integrated cache to improve the performance of the system in such applications, and to minimize the memory requirements. ESP8266 on-board processing and storage capabilities allow it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. With its high degree of on-chip integration, which includes the antenna switch, power management converters, it requires minimal external circuitry, and the entire solution, including front-end module, is designed to occupy minimal PCB area.



**d) MQ Gas Sensors**

The MQ series of gas sensors use a small heater inside with an electro-chemical sensor. They are sensitive for a range of gasses and are used indoors at room temperature. They can be calibrated more or less (see the section about "Load-resistor" and "Burn-in") but a known concentration of the measured gas or gasses is needed for that. The output is an analog signal and can be read with an analog input of the FRDM-KL25Z.The preferred wiring is to connect both 'A' pins together and both 'B' pins together. It is safer and it is assumed that is has more reliable output results. Although many schematics and datasheets show otherwise, you are advised to connect both 'A' pins together and connect both 'B' pins together.

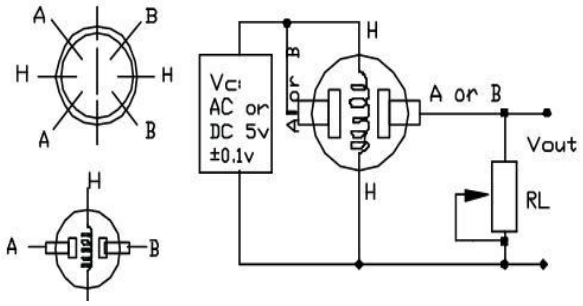
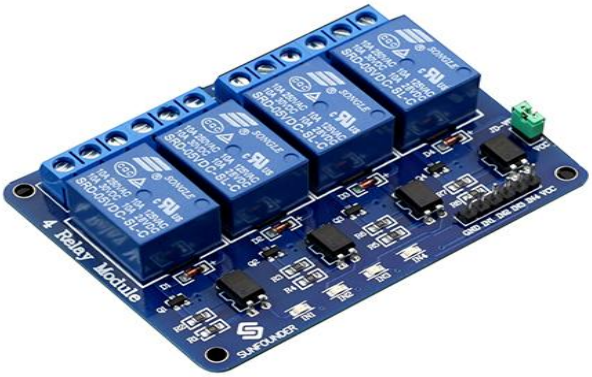



**Figure 3.4(b):** Wiring of MQ gas sensors

In the above picture, the heater is for +5V and is connected to both 'A' pins. This is only possible if the heater needs a fixed +5V voltage. The variable resistor in the picture is the load-resistor and it can be used to determine a good value. A fixed resistor for the load-resistor is used in most cases.

**e) 4 Channel Relay Modules**



**f) 4 Channel Relay Module**

This is a 5V 4-channel relay interface board, and each channel needs a 15-20mA driver current. It can be used to control various appliances and equipment with large current. It is equipped with high-current relays that work under AC250V 10A or DC30V 10A. It has a standard interface that can be controlled directly by microcontroller.

Pin Description
Input: Analog
VCC: Positive supply voltage
GND: Ground
IN1--IN4: Relay control port

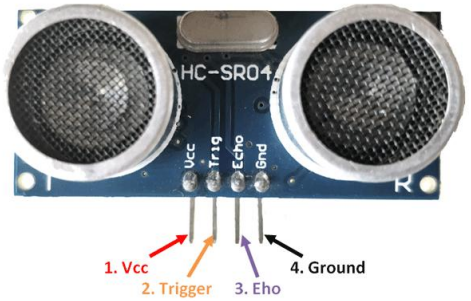
**g) Ultrasonic Sensor HCSR04**

Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules include ultrasonic transmitters, receiver and control circuiT. The basic principle of work:

(1) Using IO trigger for at least 10us high level signal,

(2) The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back.

(3) IF the signal back, through high level , time of high output IO duration is the time from sending ultrasonic to returning.




**HCSR04 Sensor**

Features

- Stable performance
- Accurate distance measurement
- High-density
- Small blind.

**h) 12V DC Geared Motor**

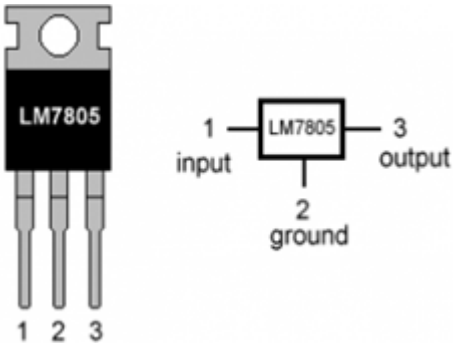
If voltage in continuous applied to a motor in a locked rotor condition, the motor will heat up and fail in a relatively short time. Therefore it is important that there is some form of protection against high temperature rises. A motor's basic rating point is slightly lower than its maximum efficiency point. Load torque can be determined by measuring the current drawn when the motor is attached to a machine whose actual load value is known. We will select the most suitable motor for your application after receiving your information [20].

**12V DC Gear Motors**

When the power supply to the motor is switched off, it is advisable to allow the motor to stop rotating before reversing the supply polarity. Failure to do this will result in a very high instantaneous current. These motors are having the speed of 100 rpm enough to pull the robotic system.

**i) IC78XX Voltage Regulators**

Different parts of a robot require different voltages. Motors usually run on high voltages, like 12V or 36V. Microcontrollers run on 3.3V or 5V. Electromagnets work on even greater voltages and currents. If you didn't have the 78xx ICs, you'd have more batteries on your circuits. One for 5V, another for 36V, another one for 24V, etc. And that would increase weight and space occupied. These ICs save a lot of space and make your robot lighter, and let you conveniently step down to a specific voltage output. The 78xx ICs have 3 pins. Two pins with positive , polarity and one with negative. The negative polarity pin is common between the input and output voltages. For input, one positive polarity pin is used and for the output, the other one is used.




**j) 12V Rechargeable Lead Ion DC Battery**

Typically, starting uses less than three percent of the battery capacity. For this reason, automotive batteries are designed to deliver maximum current for a short period of time [18]. They are sometimes referred to as "SLI batteries" for this reason, for Starting, Lighting, and Ignition. SLI batteries are not designed for deep discharging, and a full discharge can reduce the battery's lifespan. As well as starting the engine, an SLI battery supplies the extra power necessary when the vehicle's electrical requirements exceed the supply from the charging system. It is also a stabilizer, evening out potentially damaging voltage spikes. While the engine is running, most of the power is provided by the alternator, which includes a voltage regulator to keep the output between 13.5 and 14.5 V. Modern SLI batteries are lead-acid type, using six series-connected cells to provide a nominal 12 volt system.

**Features**

- Voltage: 12 volts.
- AH Rating: 1.2 AH
- Meets or Exceeds Original Battery Specifications
- Non-spoilable Valve Regulated Lead Acid (V.R.L.A.) Design.
- Advanced absorbed glass mat technology
- Sealed construction for operation in any position except upside down.
- Wide operating temperature range.
- High discharge rates and low self-discharge rates.


**12V Rechargeable DC Battery**
SOFTWARE REQUIREMENTS

**Software Specifications**
Operating System: os.mbed
Qt for os.mbed
Platform: HCSRO4, ESP8266 (Libraries in os.mbed)

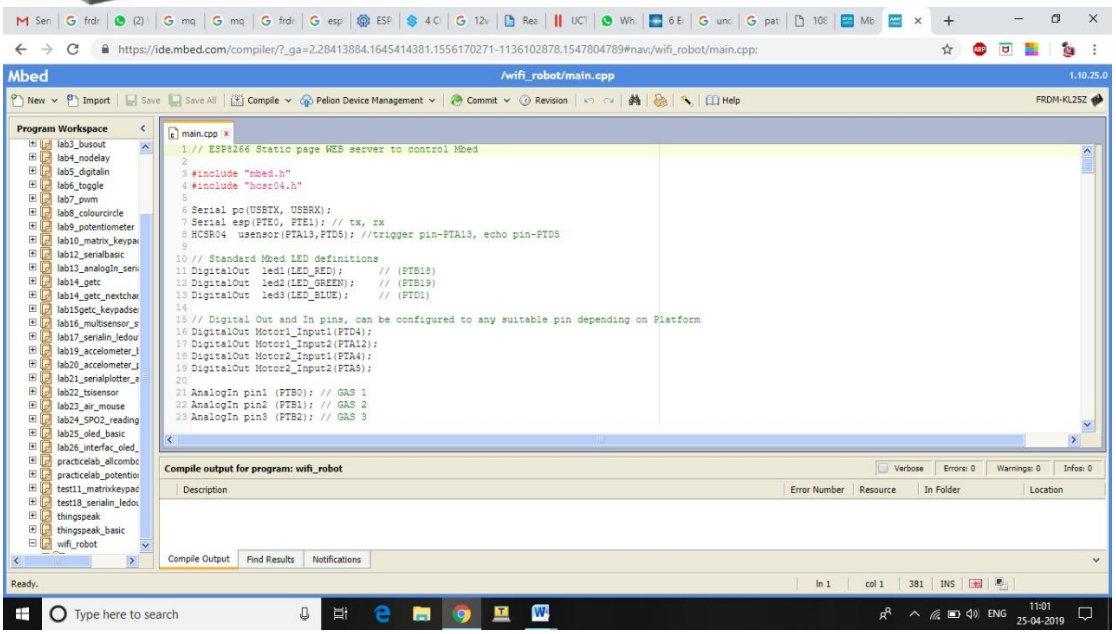



**Figure (a)** MBED OS Platform

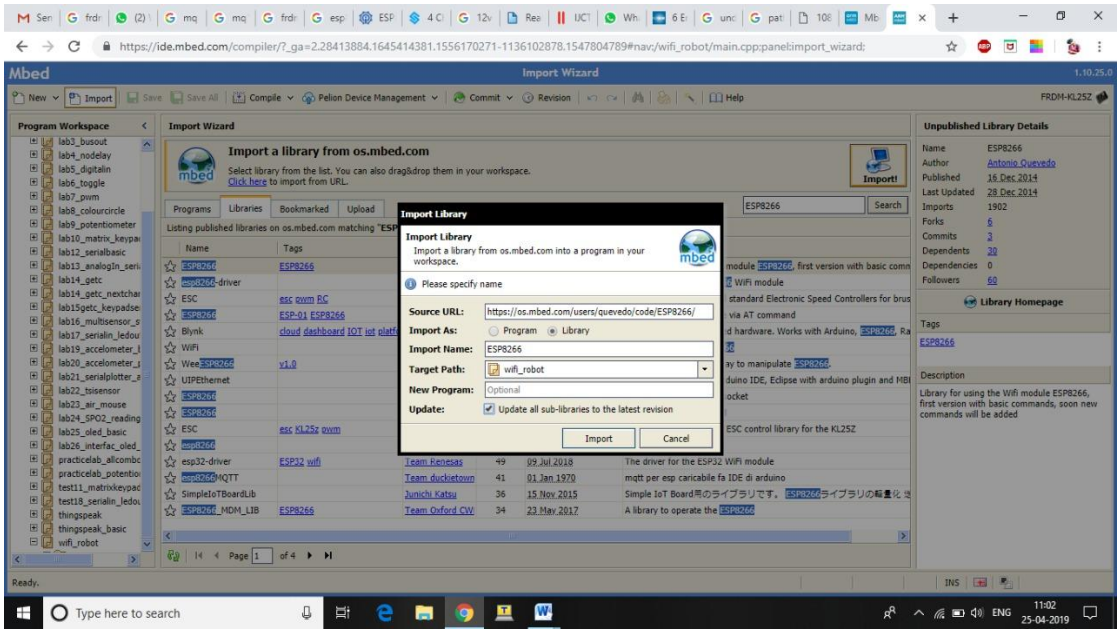
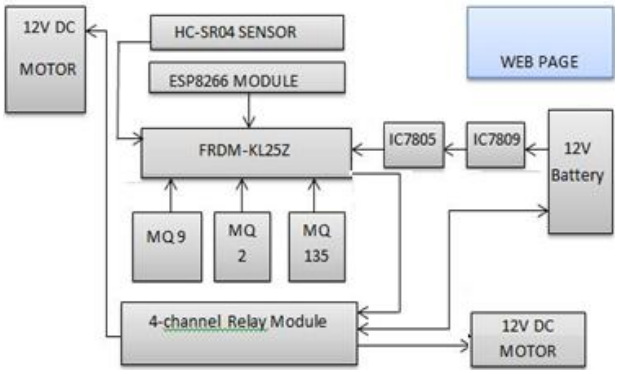



**Figure (b)** Importing Libraries

## 3. Proposed System

This monitoring system mainly consists of two units. First one is Sensor Unit another one is Monitoring unit. An autonomous robotic system is developed and interfaced with the controller. The various sensors are interfaced to the FRDM-KL25Z and the relay module is used to control the rotation of motors. The supply is given to all the components from a 12V DC lead ion battery with necessary voltage regulators in order to prevent any damage to the system caused by excessive energy.

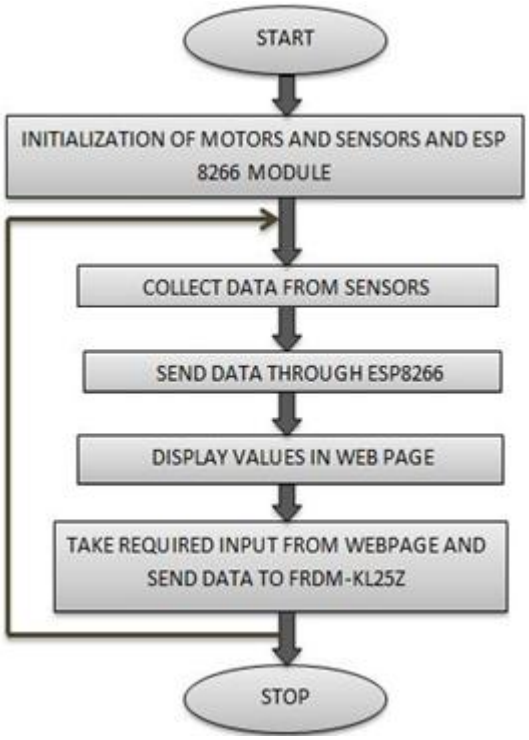
The Proposed Model




**Block Diagram of Robotic system**

The device consists of a battery in the working voltage limit of 12V. It is programmed on OS mbed platform for microcontroller named FRDM-KL25Z, is the main building block of the system. This microcontroller works in a voltage range of 3.3to 5V. A Direct Control (DC) motor is used for providing the mechanical as well as electrical support for the system. The various sensor values are transferred to the administrator on the web page in real time through a Wi-Fi module known as ESP8266. The robotic system is controlled over the commands given by the administrator through the same web page generated through the IP address of the Wi-Fi signal generated by the ESP8266 connected to the microcontroller. Thus, the to and fro of the system is processed by the ESP8266.

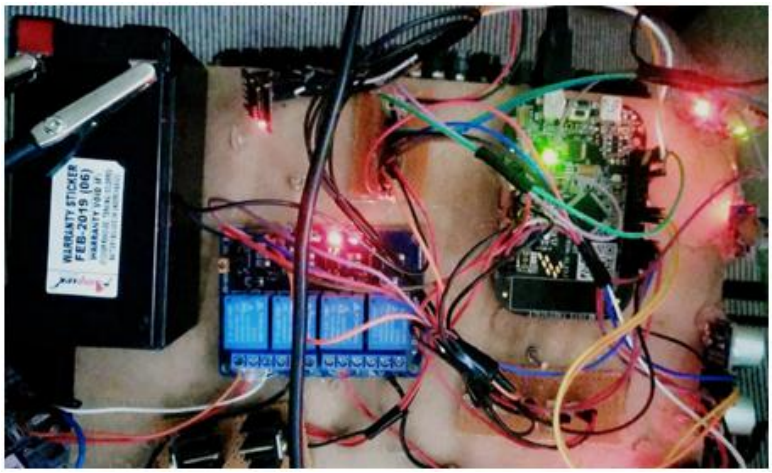
## 4. Flow Chart

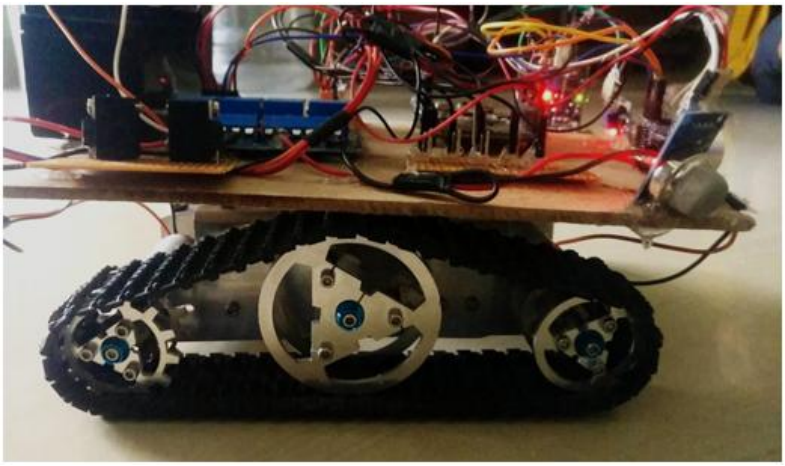



## 5. Flow Chart of Process

All the sensors are run in real time and gives information to the FRDM-KL25Z connected to the analog pins. The power is supplied to all the components from the DC battery. The path of robot is defined by the administrator by giving the commands from web page communicating through ESP8266. When any gas is sensed by the MQ gas sensors present on the robotic system, the level of gas is indicated on the web page in the predefined units. The voltage regulators along with heat sink are present to provide amount of supply needed to the components.

## 6. Results





## 7. Conclusion

- Portable and does not require internet connection.
- Communication establishment between sensors and WIFI is easy.
- Detection of different toxic gases within mining environment.

## 8. Future Enhancement

- Gas values can be more accurate in future
- This system can also be developed by using advanced robotic technology (humanoid robot) in future.

## References

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