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Article

Implementing IoT for Society with GDR System and Air Pollution Monitoring System

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A B S T R A C T

Gas leakage and Air pollution are one of the prominent threats not only for humans but for the environment as well. Many of the tragedies like Vizag gas leakage on 7th May 2020, explosion of cylinders due to leakage of LPG gas, toxic contaminants present in air intensely effect the human life and nature. This paper introduces two distinct applications of IoT i.e., The GDR System (Gas Detection and Regulating System) and Air Pollution monitoring system to mitigate & control the consequences of above mentioned threats. The GDR System is designed for automatic detection and regulation of the source from where the leakage of gas occurs whereas the Air Pollution Monitoring system is to monitor the level of gases present in the air and will alert the people if the level of gases reaches beyond the required level. The main motive of this project is to implement IoT for the sake of society.

Keywords: IoT, Arduino Uno, Arduino IDE, Node MCU, Sensor, Microcontroller

Introduction

Many of the catastrophes like gas cylinder explosions or air pollutions occur somehow due to the irresponsibility or negligence of humans for which they ultimately suffer a great loss. Imagine if all these issues are properly monitored and necessary actions are taken in time without human intervention. This is possible with IoT. Therefore we employed IoT technology to implement certain applications to combat such uncertain threats

IoT stands for Internet of Things, which refers to the interconnection of devices with embedded expertise, enabling them to exchange information through a connectivity or platform to perform necessary actions as per the user's preference and without/ less of the user's intervention.[1]

How IoT works?

Collect

There must be some data based on which the necessary actions are performed, and that data is collected from the real time environment through the sensors and subsequently the sensors convert the retrieved physical data into electrical signal. There are various types of sensors, each sensor[2] is used to collect specific data. For example, DHT11 is a temperature and humidity sensor for detecting the level of temperature and humidity in the atmosphere.

Communicat

The physical data in electrical form is communicated over a platform or cloud.[3]

Analyse & Act

The data stored in the cloud or any memory is analyzed by certain processing units aka Micro-controllers or microprocessors. This is the main functional block of entire system where the data is analysed to check if it

satisfies certain conditions then the necessary actions are performed. What conditions the data should compared with and what actions to be performed is instructed by the user in the form code written in certain programming languages and that code is embedded in the microcontrollers or microprocessors, thus everything is done as per the user's preference and without the user's intervene.[4]

IoT Based GDR System

As discussed earlier how the leakage of toxic gases in the environment is harmful to the living organisms. Moreover in homes, the explosion of gas cylinders due to the negligence in turning off gas regulators properly leads to severe issues.

To combat certain tragedies occurring due to the gas leakage, an IoT based GDR System (Gas Detection and Regulating System) is implemented.

The GDR system is designed to detect the leakage of certain gases like LPG gas, isobutene, propane, alcohol, cooking fumes and cigarette smoke. This system will automatically turn off the regulator of a gas cylinder if it finds any leakage of gas.

A GSM module is embedded in the system which will enable the user to operate the system using a mobile phone. That means a user can turn on or off the cylinder's regulator by sending a text message from his/ her phone no matter how far the user is.[5]

Tools Required

Table 1

Hardware Tools		Software Tools
Arduino Uno	GSM Module SIM900A	Arduino IDE Required programming knowledge in C
MQ6 Gas Sensor module	Motor Driver L2189	
DC Motor 12V, Side Shaft, 30RPM	Voltage Regulator 7805, 7812, 7809	
Step down Transformer, 1A 12-0-12V	DC power Jack Module	
Capacitors, Resistors and diodes, LEDs, Buzzer	Connecting wires, USB cable, Limit switch	

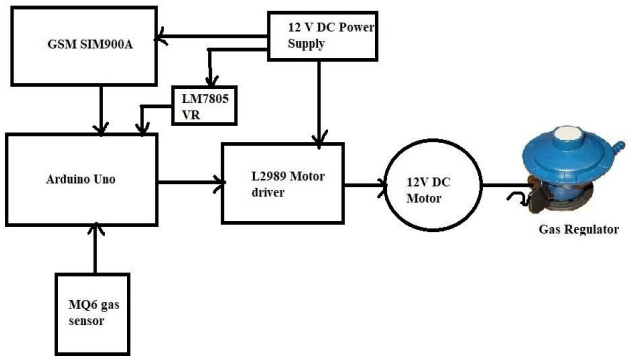

Figure 1.Block Diagram of GDR System

Methodology Hardware Setup

A 12V power supply is connected to power up the system. As Arduino Uno and MQ6 Gas sensor operate at 5V, hence a LM7805 voltage regulator is employed to regulate the power to 5V which is provided to the Arduino Uno microcontroller board and MQ6 Gas sensor module. The Analog Output pin (AO) of MQ6 Gas sensor Module is connected to the A5 analog input pin of the Arduino Uno Board. The TXD & RXD s of GSM Module are connected to Digital pin D2 & D3 of Arduino Uno for serial transmission and reception respectively.

The digital pin 13 & 12 of Arduino Uno are connected to the Motor A input pin IN1& Motor A input pin IN2 of the motor Driver.

A buzzer is connected to the D9 pin of Arduino board and an LED is connected to the D12 pin of Arduino board for indication purpose.[6]

Software Setup

The code/ program written in C language in Arduino IDE (Integrated Development Environment) which is installed in PC or laptop. That code is embedded in the Arduino Uno microcontroller board using a 2.0 USB cable. The whole system works according to the instructions uploaded in the microcontroller board.[7]

The following steps are done at the software part to upload the code in the Arduino Uno microcontroller board

- Select "Tools"->"Board"-> [Arduino board]. In this case it is Arduino Uno.
- Then select "Tools"->"Serial port"-> [Your serial port used for communication with Arduino]. In our case it is /dev/tty.usbmodem1411.
- Click on "File"->"Upload" to upload code to Arduino

At the PC/laptop side Arduino IDE is running which compiles the application program and sends its compiled hex code to the Arduino Uno board over USB cable serially.[8]

Hardware Implementation

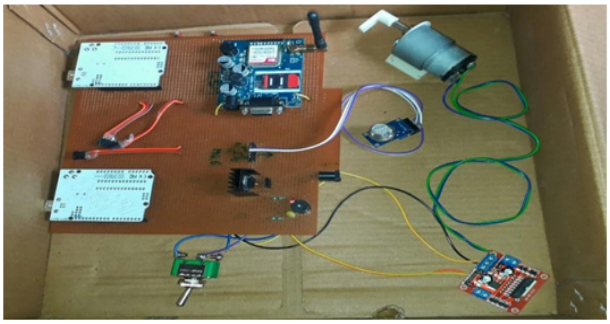

Figure 2.Hardware setup of GDR System

Testing & Observation

The GDR System can operate in two ways:

- Involuntary detection and regulation
- Can be operated manually by the user through a mobile phone

Automatic Detection and Regulation

To test the working of GDR system, we turned ON the regulator of the gas cylinder for few seconds until the gas starts leaking from the cylinder. The leakage of gas from the cylinder is detected by the MQ6 Gas sensor and it communicates the information to the Arduino Uno microcontroller board in the form of electrical signal through its analog output pin connected to the analog input pin (A5) of the board. The retrieved information is analysed based on the condition specified in the code written in Arduino IDE i.e. If (analogsensor >sensorthres) where sensothres=450 (threshold value). Which means if the amount of gas detected is greater than the threshold value then it indicates that the gas is leaking to that extent which is harmful. A buzzer (D9, GND) and an LED (13, GND) are connected to the Arduino Uno board started beeping and glowing when the collected value reached beyond the threshold value. The Arduino sends the input to the motor driver either high or low i.e., if leakage of gas detected then '1' otherwise '0'. Upon receiving the high input from the Arduino Uno, the motor driver drives the 12V Dc motor rotate till the regulator till turns OFF.[9]

Manual Operation through a Mobile Phone

To manually operate the system, an SMS (#relay1on) is sent from any mobile to the number of SIM inserted in the GSM module to turn ON the regulator. The training from GSM module is serially transmitted to Arduino Uno through its TXD pin. Upon receiving the instruction, the Arduino Uno sets a high input to the D13 pin connected to the motor driver which drives the DC motor to rotate and turn the regulator ON. And its delay time is set to 2 seconds after which a low input is given to the motor driver which will cause the dc motor to stop rotating.

Similarly, an SMS (#relay1off) is sent to turn off the regulator.

IoT Based Air Pollution Monitoring System

Conferring to WHO report, air pollution is one of the prominent threat to child health. Giving to the study they conducted they found that over 1lakh children of same age group died since of air pollution in India in 2016. There are many sources causing air pollution which include, industrial smoke, cigarette smoke, burning of fossil fuels, smoke emission from vehicles etc. All these sources can be controlled if we could monitor the level of certain gases like CO2, Nitrogen, Oxygen, etc., present in the air properly. To achieve this, we implemented an Air Pollution Monitoring System based on IoT to monitor the level of gases present in the air and accordingly alert if the pollution occurs when the level of gases exceed the required level. In this system, the air quality can be monitored in its display screen as well in the webpage which can be accessed through Wi-Fi hotspot.

Tools Required

Table 2

Hardware Tools		Software Tools
Arduino Nano	Node MCU	Arduino IDE Required programming knowledge in C and HTML
MQ135 Gas Sensor module	16x2 character display LCD	
DHT11 (Humidity & Temperature Sensor)	Mini-B USB cable	

Methodology Hardware Setup

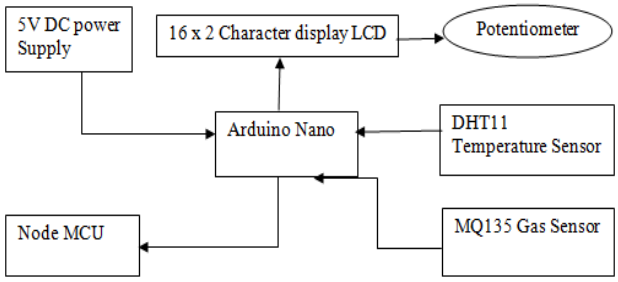

Figure 2.Block Diagram of Air Pollution Monitoring System

Software Setup

Two different codes for Arduino Nano and Node MCU written in C and HTMl are uploaded via mini USB cable.

Hardware Implementation

The air quality (having a wide range of gases like NH3, NOx, alcohol, benzene, smoke and CO2) detected by MQ135 sensor and the level of temperature & humidity detected by DHT11 (temperature and humidity sensor) up to a certain range.

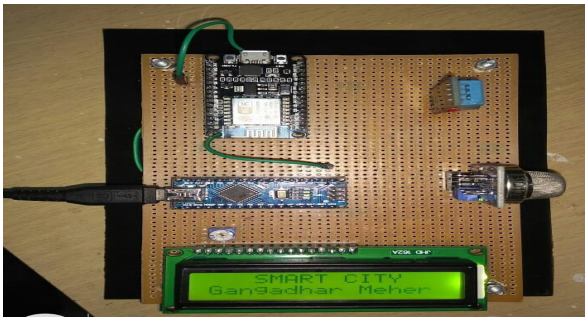

Figure 3.Hardware implementation of Air Pollution Monitoring System

The values retrieved by these two sensors are sent to Arduino Nano microcontroller from the analog output pin of the sensors to the analog input pins A0 and A1 of the microcontroller. The values detected by these two sensors are displayed in the 16x2 character display LCD connected to Arduino Nano and the serial monitor of Arduino IDE.

The data collected by the sensors can be monitored in a web page (written in HTML which is embedded in the code uploaded in Node MCU through Arduino IDE) with the help of NodeMCU which acts as a Web Server.

The TX1 pin of Arduino Nano is connected to RX pin of NodeMCU for serial transmission of collected data from DHT11 and MQ135 to the Node MCU.

A specific code is written in Arduino IDE for NodeMCU. After uploading the code, it will generate an IP address which can be fetched from the serial monitor of Arduino IDE.

The IP address of the Node MCU will vary according to the SSID and password of given mobile hotspot connection.

Hotspot connection of mobile whose SSID and password is given in code is turned ON and another mobile is connected to it through Wi-Fi. By hitting the IP address in the connected devices will redirect to the webpage from where the values of DHT11 sensor and MQ135 can be monitored.

Observation

The below observation table shows the values of MQ135 and DHT11 sensor in different scenarios:-

From the above table, we can observe that the air quality is more degraded when incense sticks are brought near the system.

Future Scope

- The GDR system has a wide scope in future as it is prominently meant for the safety of the society from being exposed to the tragic gas explosions due to the leakage of gas from the cylinders at home.
- Add on features are employed to further develop the GDR system to function as home automation system.

Conclusion

Thus, to save the society from being exposed to such uncertain gas leakages, gas cylinder explosions and hazardous air pollutions, the above two applications are built based on IoT. Though the issues can be monitored and mitigated even without or less human intervention through such applications, but being humans it is our responsibility to take our own self-care and maintain a clean and sustainable environment.

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Table 3

S.No.	Scenario	MQ135	DHT11	
			Temperature	Humidity
1.	At a particular room in Bhubaneswar	180 PPM	25°C	50
2.	At a particular room in Sambalpur	213 PPM	29°C	62
3.	Burned incense sticks & brought near the system	300PPM	38°C	54