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Development Of An Internet Of Things(IOT) Based Industrial Security And Safety System Using Arduino

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ABSTRACT: *Internet of things (IOT) is a rapidly increasing technology. IOT is the network of physical objects or things embedded with electronic software, sensors, and network connectivity which enables these objects to collect and exchange data. In this project, we have tried to develop a system which will automatically monitor the industrial applications and generate alerts/alarms or take intelligent decisions using concept of IOT. This system has been designed to protect industries from accidents caused due to leakage of gases, absence of sufficient light and abrupt changes in temperature which might lead to catching of fire, ultimately resulting to a huge loss. The proposed system uses a combination sensor network with a system architecture and concept implementation, which are described mainly for an industrial safety monitoring scenario. The information is gathered by the deployed sensor network with focus on four main factors: temperature, fire, gas leakage and light intensity, and according to the readings derived from the sensors, a signal of threat or precaution along with the monitor readings will be sent to the desired user.The system makes use of arduino to achieve the above mentioned functionality and it is programmed in such a way that it is capable of taking necessary precautionary and safety actions which will save the industry from incurring a huge loss in cases of emergency.*

Keywords: *Internet of things(IOT), arduino, sensors, industry, safety.*

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I. INTRODUCTION

Automation is one of the increasing need within industries as well as for domestic applications. It reduces the human efforts by replacing them with systems that are self-operated. The internet is one way of growing the platform for automation, in which new advancements allow the users to monitor as well control the system using the internet facility. As people are making use of the Internet, the system becomes secured and live data monitoring is possible using IOT. Recently the current industries have been demanding sophisticated instrumentation for monitoring and control of environmental risk parameters in the danger-prone areas. Human safety and property losses are the essential to maintain a balance between industry and industrial environments. According to survey, these four basic factors are the reasons for an accident to occur: low light, gas leakage, abrupt rise in temperature and fire. An industrial accident usually occurs individually to the above mentioned factors or as the result of their combined effects. In this project, combining the virtual monitoring technology with hazardous risk management together, a wireless multi-sensory monitoring system of hazardous site environment is created. Within industries the various hazardous gasses are being processed, various machines are running, a huge number of people are employed to perform various activities. Hence in order to provide security to those employees working within the industry, it is really important to work on their safety. This proposed project is designed in a way such that, if a leakage of gas takes place or there is an abrupt rise in temperature or there is a detection of fire, then these system alerts the employees by turning ON the alarm and LED indicator and if there is a change in required light intensity, it switches ON or OFF an additional light according to requirement. The system also helps the users take some crucial decision from any point within a location radius by sending the controller real time data directly into the phone through an established wifi connection.

II. LITERATURE SURVEY

The concept of the internet of things was introduced by the members of the radio frequency identification development community in 1999. This concept is very popular because of the growth of mobile devices, embedded and real time communication, cloud computing and data analytics. The internet of things is a network of physical objects embedded with electronics, software and sensors having the ability to collect data from the world around us and share data across the internet.The term internet of things refers to the general idea of things, especially everyday objects that are readable, locatable, recognizable, addressable and controllable through the internet, irrespective of the communication means such as wired or wireless LAN, WAN or any mean.The things or objects of real world can be People, Location (object), Time of information (object) or Condition. These things can easily get integrated in the virtual world enabling anytime, anywhere connectivity.[1]

Many existing Industry Supervising systems are based on wired communication. This does not pose a problem if predetermined and installed during the physical construction of the industry. But for an already existing Industry the implementation expenses goes very high. In this contrast, Wireless Supervising systems can be of great benefit and effective. With the advancement of wireless technologies such as Wi-Fi, cloud networks in the recent past, the wireless systems become routine in our daily life. This is the reason for introducing wireless communication in our Industry Supervising System.[2]

The past decade has witnessed a rapid development of technology which has led us to getting introduced to smarter objects with larger capabilities and connectivity. With increase in IOT technology, in the past few years there have been quite a lot attempts towards developing a monitoring security system that will keep the controller updated with real time data, alert the employees in case of danger and if required, might take smart actions in cases of emergency. Several successful attempts have been taken towards the fulfillment of the above such as, by implementing IOT using Raspberry Pi software and sending real time data to the controller using local internet browser like in paper [3], by using Raspberry Pi in Linux Coded OS using C++ program and sending data via internet like in paper [4], by using a PC based temperature monitoring and control system using virtual instrumentation LabVIEW, which will display the data on the LCD of the microcontroller and this data will be shown in the PC of the controller with the help of Ethernet LAN, like in paper [5]. Most recently, there have been attempts to develop such security systems using arduino like in paper [6] and reference link [7], which serves as an inspiration for our work.

III. SCOPE OF STUDY

When the heat is emitted from a source, it gives a different degree of burning and if an individual gets about 30% or more of burning wounds then the possibility of survival becomes very less. Moreover, the smoke emitted from combustion will have an adverse effect on the senses of a person like loss of vision, difficulty in breathing and loss to the sense of direction. [8] Hence, in this project, the mainaim is to construct an intelligent circuit with the help of Arduino based on the concept of IOT which is very much user friendly as compared to the previous systems regarding the protection of the industry and has the capability to detect fire, leakage of gas, change in intensity of available light and abrupt rise or fall in temperature of the industry environment in order to reduce the accidents taking place in industries so that one can take precautionary measures, thus preventing loss of lives and materialistic losses. This system not only detects and raises an alarm to notify the employees of the industry in cases of emergency but also sends real time data directly into the controller's phone making the person aware of the scenario and has the capability to adjust light intensity by switching ON or OFF an additional light connected with the circuit. The data sensed by the respective sensors are displayed all the time on the LCD connected to the circuit for convenience of the user.

Today's Scenario

The study of accidents revealed that the information of the disaster was known only when the case was spread and after it had made an impact on human lives and infrastructure and these accidents could have been avoided if there have been a prior or before impact information available before the disaster which was pretty easy to do. It is noted that most of the fire accidents happening, the fire was detected only when it has been spread over the place and was visible outside the building. So, this project aims at providing a prior information about the risk of a disaster [9] in order to prevent huge losses within the industry environment.

Advantages of a wireless system

The use of wireless technologies gives several advantages such as:

1. Less installation expenses: Wired communications require long cables which increases the cost and complexity. Whereas the wireless communication systems incur less cost. In this project we designed lowcost Supervising system by using Arduino rather than raspberry pi and other microcontrollers which are more complex and requires more cost and effort at the same time being not so user friendly.

2. System scalability and easy extension : This is a wireless automated system which is highly scalable and we can expand or resize by including or excluding various sensors by using them as per our requirement.
3. Remote monitoring: The wireless Supervising system privilege the user to access the stored data and monitor from anywhere around within a given sphere of radius.

Commercial Utility

It can be used in high-risk factor industries like chemical, petroleum industries as well as homes as a security and device which can detect the problems early and generate an alert. Minimization or addition of the system can be done based on specialized designs featuring only essential requirements. The main key point of this project is that it is user friendly, easy to implement, easy to construct and implement, and is very much cost effective.

IV. AIM OF PROJECT

The main motive of this project work is to provide a cost effective, easy to construct system that monitors the environment of an industry with an user friendly interface which alerts the employees of the industry even if there is a slight chance of an accident due to a slight fire or leakage of gas or abrupt change in temperature or loss of light. The system is developed to allow the employees of the industry to take precautionary measures before these slight factors result into a huge accident.

V. SYSTEM OVERVIEW

System Overview

This system comprises of an Arduino UNO R3 board that takes analog input from the sensorsand displays the reading on the LCD connected, and sends real time data into the phone of the user using the concept of IOT with through the connected wifi module with the help of Blynk android application.

Block Diagram

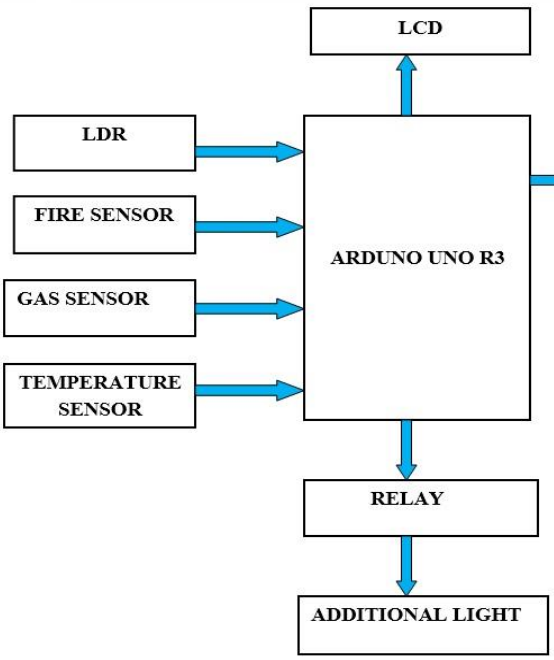

Fig.1. Block Diagram

Hardware Components

1. Arduino Uno R3 board :The Ardunio UNO R3 is a microcontroller board based on Atmega328. It has 14 digital input/output pins(of which 6 can be used as PWM outputs,6 analog inputs).A 16MHz ceramic resonator, an USB connection a power jack, an ICSP header and a reset button.It consists of everything needed to support; we can connect it to a computer with a USB cable or power it with a AC to DC adapter or battery to get started.

TECHNICAL SPECIFICATIONS :

Microcontroller	Atmega328P – 8 bit AVR family microcontroller
Operating Voltage	5V
Recommended Input Voltage	7-12V
Input Voltage Limits	6-20V
Analog Input Pins	6 (A0 – A5)
Digital I/O Pins	14 (Out of which 6 provide PWM output)
DC Current on I/O Pins	40 mA
DC Current on 3.3V Pin	50 mA
Flash Memory	32 KB (0.5 KB is used for Bootloader)
SRAM	2 KB
EEPROM	1 KB
Frequency (Clock Speed)	16 MHz

Table. 1. Arduino UNO R3 Technical Specification

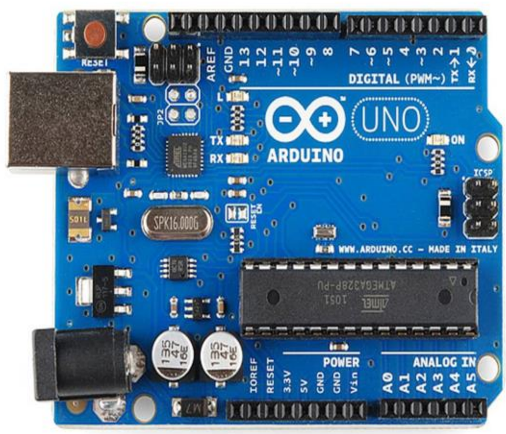

Fig.2. ArduinoUNO R3

2. <u>20 x 4 Arduino LCD display module</u> :This is a 20x4 Arduino compatible LCD display module with high speed I2C interface. It is able to display 20x4 characters on two lines, white characters on blue background.Generally, LCD display will run out of Arduino pin resource. It needs 6 digital pins and 2 power pin for a LCD display. If you want to build a robot project, it will be a problem with Arduino UNO and LCD display. This I2C 20x4 LCD display module is designed for Arduino microcontroller. It is using I2C communication interface, with this I2C interface, only 2 lines (I2C) are required to display the information on any Arduino based projects. It will save at least 4 digital/analog pins on Arduino. All connector are standard XH2.54 (Breadboard type). One can connect it with jumper wire directly.

TECHNICAL SPECIFICATIONS :

a. I2C Address: 0x20-0x27(0x20 default)
b. Number of Characters: 20 characters x 4 Lines
c. Blue LED backlight with white char color
d. Adjustable contrast
e. Supply voltage: 5V(via Pin) 3.3V(via IDC10)
f. Interface: IIC/TWI x1,IDC10 x2
g. View direction: Wide viewing angle
h. Dot size: 0.55 x 0.55 mm(0.02x0.02")
i. Dot pitch: 0.60 x 0.60 mm(0.023x0.023")
j. Character size: 2.96 x 4.75 mm(0.11x0.19")
k. Character pitch: 3.55 x 5.35 mm(0.14x0.21")
l. Size: 98x60x24mm(3.86x2.36x0.94")

Fig.3. LCD Display Module

3. 5V 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.Relays consist of three pins normally open pin, normally closed pin, common pin and coil. When coilpoweredon,magnetic field is generated the contacts get connected to each other. The working of relay,depends on magnetic field generated from the coil so there is powerisolation between the coil and the switching pins so coils can be easily powered from Arduinobyconnecting VCC and GND bins from Arduino kit to the relay module kit after that we choose Arduinooutput pins depending on the number of relays needed in project designed and set these pins to outputand make it out high (5 V) to control the coil that allow controlling of switching process.

TECHNICAL SPECIFICATIONS :

a. Trigger Voltage (Voltage across coil) : 5V DC
b. Trigger Current (Nominal current) : 70mA
c. Maximum AC load current: 10A @ 250/125V AC
d. Maximum DC load current: 10A @ 30/28V DC
e. Compact 5-pin configuration with plastic moulding
f. Operating time: 10msec Release time: 5msec
g. Maximum switching: 300 operating/minute (mechanically)

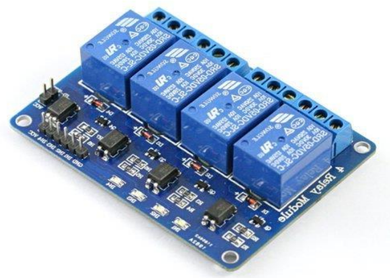

Fig.4. 5V Relay Module

4. ESP8266 NodeMcuWiFi Development Board :NodeMCU is an open source IOT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module. The term "NodeMCU" by default refers to the firmware rather than the development kits. The firmware uses the Lua scripting language. It is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266. It uses many open source projects, such as lua-cjson and SPIFFS.

TECHNICAL SPECIFICATIONS :

POWERINPUT	4.5V~ 9V(10VMAX),USBPowered
CURRENT	70mA(200mA)
TRANSFERRATE	110-460800bps
DIGITALI/O	9(D0-D8)
ANALOGI/O	1(A0)
WORKINGTEMPERATURE	-40◦C~ +125◦C
DRIVETYPE	DualhighpowerH-bridge
FLASHSIZE	4Mbyte
CPU	ESP8266(LX106
OPERATINGSYSTEM	XTOS

Table.2. ESP266 NodeMcuWiFi Development Board Technical Specification

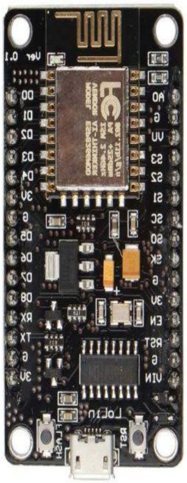

Fig.5. ESP266 Node Mcu-WiFi Development Board

5. Light Dependent Resistor : Photo resistors, also known as light dependent resistors (LDR), are light sensitive devices most often used to indicate the presence or absence of light, or to measure the light intensity. In the dark, their resistance is very high, sometimes up to 1MΩ, but when the LDR sensor is exposed to light, the resistance drops dramatically, even down to a few ohms, depending on the light intensity. LDRs have a sensitivity that varies with the wavelength of the light applied and are nonlinear devices. They are used in many applications but are sometimes made obsolete by other devices such as photodiodes and phototransistors. Some countries have banned LDRs made of lead or cadmium over environmental safety concerns.

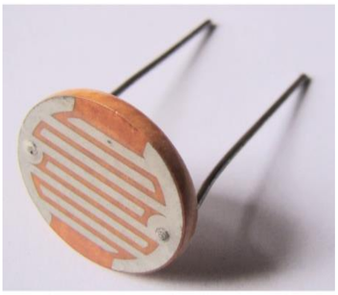

Fig.6. Light Dependent Resistor

6. Flame Sensor Module (RKI-3100) : A flame detector is a sensor designed to detect and respond to the presence of a flame or fire. Responses to a detected flame depend on the installation, but can include sounding an alarm, deactivating a fuel line (such as a propane or a natural gas line), and activating a fire suppression system.There are different types of flame detection methods. Some of them are: Ultraviolet detector, near IR array detector, infrared (IR) detector, Infrared thermal cameras, UV/IR detector etc.When fire burns it emits a small amount of Infra-red light, this light will be received by the Photodiode (IR receiver) on the sensor module. Then we use an Op-Amp to check for change in voltage across the IR Receiver, so that if a fire is detected the output pin (DO) will give 0V(LOW) and if the is no fire the output pin will be 5V(HIGH).

TECHNICAL SPECIFICATIONS :

a. LM393 comparator chip
b. Detection Range: 760 nm to 1100 nm
c. Operating Voltage: 3.3 V to 5 V
d. Maximum Output Current: 15 mA
e. Digital Outputs: 0 and 1
f. Detection Angle: about 60 degrees
g. Adjustable sensitivity via potentiometer
h. LED lights indicators: power (red) and digital switching output (green)
i. Fixed bolt holes for easy installation
j. PCB Size: 32 x 14 mm

Fig.7. Flame Sensor Module

7. Gas Sensor MQ2 module : The Grove – Gas Sensor(MQ2) module is useful for gas leakage detection (home and industry). It is suitable for detecting H2, LPG, CH4, CO, Alcohol, Smoke or Propane. Due to its high sensitivity and fast response time, measurement can be taken as soon as possible. The sensitivity of the sensor can be adjusted by potentiometer.

TECHNICAL SPECIFICATIONS :

a. Operating Voltage is +5V
b. Can be used to Measure or detect LPG, Alcohol, Propane, Hydrogen, CO and even methane
c. Analog output voltage: 0V to 5V
d. Digital Output Voltage: 0V or 5V (TTL Logic)
e. Preheat duration 20 seconds
f. Can be used as a Digital or analog sensor
g. The Sensitivity of Digital pin can be varied using the potentiometer

Fig.8. Gas Sensor Module

8. LM-35 Temperature Sensor Module : LM35 is a temperature measuring device having an analog output voltage proportional to the temperature.It provides output voltage in Centigrade (Celsius). It does not require any external calibration circuitry.The sensitivity of LM35 is 10 mV/degree Celsius. As temperature increases, output voltage also increases. For example, 250 mV means 25°C.It is a 3-terminal sensor used to measure surrounding temperature ranging from -55 °C to 150 °C.LM35 gives temperature output which is more precise than thermistor output.

TECHNICAL SPECIFICATIONS :

a. Calibrated directly in Degree Celsius
b. Linear + 10.0 mV/˚C scale factor
c. 0.5˚C accuracy guarantee-able (at +25˚C)
d. Rated for full −55˚ to +150˚C range
e. Operates from 4 to 30 volts
f. Less than 60 µA current drain
g. Low self-heating, 0.08˚C in still air

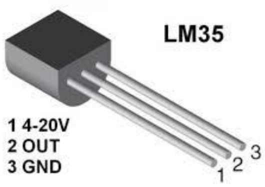

Fig.9. Temperature Sensor Module

9. CFL Lamp : A compact fluorescent lamp (CFL), also called compact fluorescent light, energy-saving light, and compact fluorescent tube, is a fluorescent lamp designed to replace an incandescent light bulb; some types fit into light fixtures designed for incandescent bulbs. The lamps use a tube which is curved or folded to fit into the space of an incandescent bulb, and a compact electronic ballast in the base of the lamp.

TECHNICAL SPECIFICATIONS :

WORKING VOLTAGE	240 VAC
RATED POWER	15 W
OPERATING FREQUENCY	50 Hz
POWER FACTOR	0.85
TEMPERATURE	65000 K

Table.3. CFL Lamp Technical Specification

Fig.10. CFL Lamp

Software Components

1. ArduinoSoftware : The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software. This software can be used with any Arduino board.

Fig.11. Arduino Logo

2. Blynk Mobile Application :Projects can be linked to one's CW01 CHIP, in order to receive real-time data on theBlynk app on phone. This is simply the data that would be displayed on a connected OLED display (OD01) and is refreshed the same way and not saved on one's device. The data is still uploaded to the dashboard. This is a convenient method of checking the status of the sensors as well as being more mobile than a laptop or desktop viewing the data on the dashboard.

Fig.12. Blynk Logo

VI. WORKING AND METHODOLOGY

The sensors namely, flame sensor, gas sensor, light dependent resistor and temperature sensor are connected to the Arduino UNO R3 board through the analog pins. These sensors receive data, which serves as an input to the Arduino UNO R3 board. The data obtained, is displayed on the 20x4 LCD module connected with the board. This data is a real-time data and is immediately transmitted into the user's phone through the wifi module connected with the arduino through the RX-TX pin (Receiving and Transmitting pin). The wifi module and the Arduino board requires a separate power supply in order to function. The system in turn, is connected to a relay attached with a light source (CFL lamp, in this case) which is programmed to switch ON/OFF according to convenience, i.e. If a lower than desired value of light intensity is sensed by the LDR, the relay will turn off, thus providing an additional light source and if desired value of light intensity or more than desired value is detected, then the relay will automatically turn on, thus switching off the additional light source. The circuit is constructed on a breadboard as per the given circuit diagram in Fig.13.

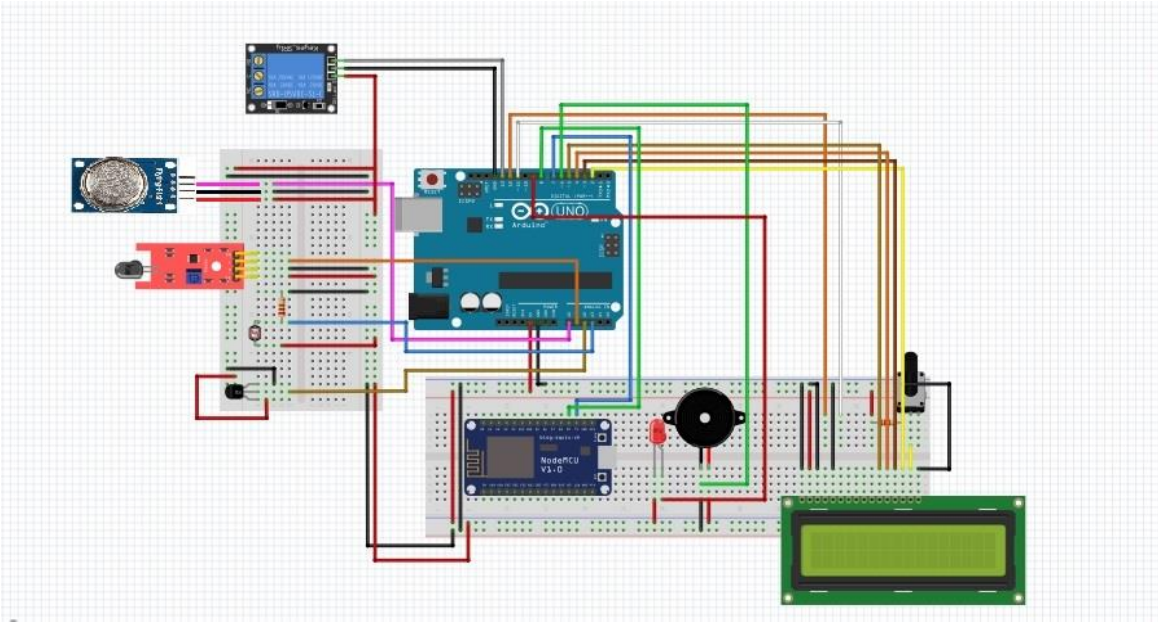

Fig.13. Circuit Diagram

Once all the connections are made according to the circuit diagram, in order to make the circuit work, it must beprogrammed according the user's requirements. The Arduino UNO R3 board is programmed with the help of arduino software which is very much easy to program and has a very friendly user interface. First, the program is written in a computer using the arduino software and after compilation, it is uploaded into the Arduino microcontroller memory which makes all the components connected with the arduino board work accordingly.

With the help of the program, the users are able to obtain the real-time data derived from all the sensors on the 20x4 LCD display connected to the board. But in order to send the values into the phone of the user within a desired range, the values must be transferred through wifi from the wifi module with which the phone of the user is connected via wifi. This functionality is achieved using the Blynk android application. The wifi module is programmed to upload the data into the Blynk application, which can be accessed from the smartphone of desired user. The program required for the NodeMCUwifi module to run and upload data into the Blynk application is written in computer using the arduino software and then uploaded into the wifi module which in turn, is connected with the arduino board.

VII. EXPERIMENTATION AND RESULTS

Implementation

This system is implemented by constructing the circuit using breadboards and banana wires. A rough model is built in order to implement the proposed system. The system developed is at a highly evolving phase, as numerous upgradations and changes can be implemented with more availability of resources and advancement of technology. The circuit is powered at first, by connecting the Arduino UNO R3 board and the wifi module to a power supply. In order to make the system work, the working software of the arduino board and the wifi module are uploaded into the respective devices by connecting them to the computer through the USB cable. Once the arduino board starts working according to the program, all the sensors immediately starts sending data into the arduino microcontroller which is shown in the LCD connected with the board.

Drawbacks

The major drawback faced in the implementation of this particular system is the fact that, Arduino UNO R3 board delivers a maximum output voltage of 5V, which is used up by the necessary components connected with the board itself, hence leaving no space for upgradation of the system by addition of other components or devices which could have served to make the system a more smart, efficient and capable one. Hence, all the possibilities of upgradation which could have been implemented is kept as a future scope.

Results

In order to test the functionality of the sensors and the circuit components, various experiments were performed. At first the light sensor(LDR) was tested by varying the light intensity. When exposed to light of higher than or same as required intensity, the relay module remains ON thus keeping the additional light switched OFF; but when it senses a decrease in intensity, the relay module turns OFF thus putting ON the additional light source. The gas sensor (MQ2 module) reads the amount of gas present in the industrial environment air and on sensing an abrupt rise in gas density (i.e. more than desired value) in the air, it raises an alarm and switches on a LED light for notification. The temperature sensor (LM 35 module) in case of an abrupt rise in temperature (i.e. more than desired value) in the industrial environment and the fire sensor (RKI 3100) on detection of fire, performs the same functionality as that of the gas sensor. The circuit is designed in a way such that in either or all of the three cases of fire, increase in gas density and rise in temperature an alarm would be raised and the notification LED will glow such that even if one of the sensors are not working, the workers will get notified about the danger because of the fact that the cause of these type of accidents are interrelated. All the sensors connected provide analog inputs and the real-time data is obtained on the LCD connected to the arduino board. The light intensity sensed by LDR is and the gas density sensed by MQ2 module are displayed in percentage form and in turn, the temperature sensed by the temperature sensor LM 35 is displayed in Fahrenheit on the LCD. The detection or non-detection of fire is indicated by a display message.

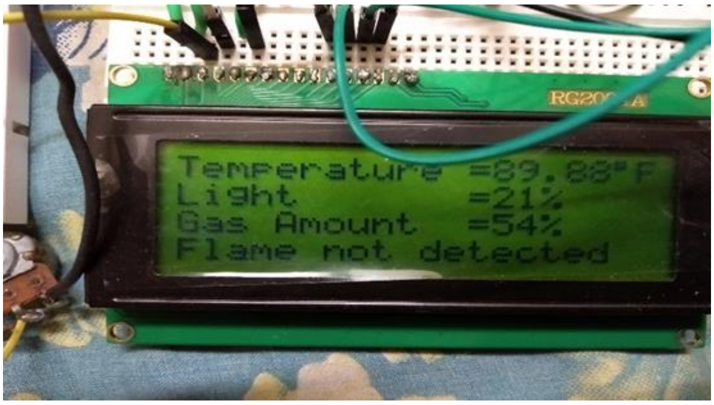

Fig.14. Display of output on 20x4 LCD

This same accurate data is sent into the phone of desired user, through the NodeMcuwifi module via Blynk application. All the units of display are same as that on the LCD screen except for the message generated due to the fire sensor. In Blynk application no message is generated, in this case the fire sensor indicates 0 on sensing a fire else it indicates 1.

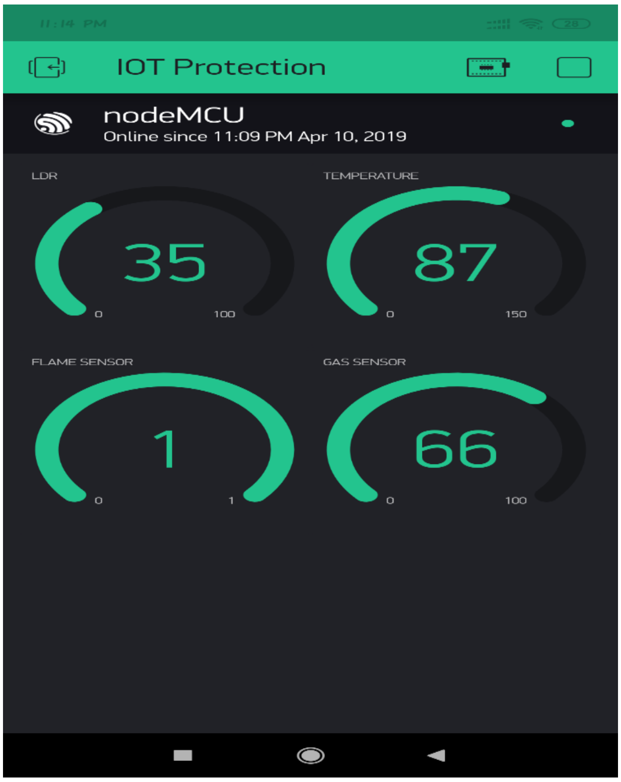

Fig.15. Display of output in Blynk application on phone

VIII. CONCLUSION AND FUTURE SCOPE

Conclusion

This project describes an IOT based Industrial Security System which is developed with the help of Arduino. The system is able to collect sensor data and respond intelligently as per given situations. It was designed based on application of wireless communication. It is very suitable for real-time and effective requirements of the high-speed data acquisition system in IOT environment.The application of ARDUINO UNO greatly simplifies the design of peripheral circuit, and makes the whole system more flexible and extensible. Different types of sensors can be used as long as they are connected to the system. Main design method of the reconfigurable smart sensor interface device is described in this dissertation. Finally, by taking industrial safety parameters monitoring in IOT environment as an example, we verified that the system achieved good effects in practical application. Nevertheless, many interesting directions are remaining for further researches in this domain.

Future Scope

The proposed system does the reconfiguration of the sensor's threshold values. There is a lot of scope for development of an environment which can be automatically controlled based on the alerts from the monitoring system which could not be achieved in this project due to insufficient output voltage given out by the arduino(UNO R3) board. This system can be associated with a GSM module which will notify the user about the emergency through a text message as a precautionary measure in case the Blynk application is closed or not working. This system can also be designed to take smart precautionary actions that will prevent the industry from incurring losses, such as turning on the ventilator fan in cases of gas leakage detection or turning on the fire-fighting system of the industry on detection of a huge flame on the basis of the readings of both the temperature and the flame sensor.

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REFERENCES

[1] S.P. Lalwani, MKKhurana , S.J. Khandare, O.U.R. Ansari , Dr. S.B. Pokle, “IOTBased Industrial Parameters Monitoring and Alarming System using Arduino - A Novel Approach,” *International Journal of Engineering Science and Computing,* vol. 8, no. 4, pp.17305-17308,April. 2018

[2] P.S. Teja, V.M. Krishna, Dr.Ch. Raja, “Industry Supervising System By Using Arduino& IOT,” *International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)*, vol. 6, no. 3, pp.93-95, March. 2017

[3] S.R. Khan Professor Dr .M.S.Bhat, “GUI based Industrial Monitoring and control system,” *IEEE Power and Energy Systems Conference: Towards Sustainable Energy*, pp. 1-4, March. 2014

[4] A. Sleman and R. Moeller, “Integration of wireless sensor network services into other home and industrial networks using device profile for web services (DPWS),” *Proc. 3rd Int. Conf. Information and Communication Technologies: From Theory to Applications, Damascus, Syria*, pp. 1–5, April. 2008

[5] R. Piyare and S.R. Lee” Smart home control and monitoring system using smart phone,” *ICCA 2013 ASTL© SERSC 2013*, vol.24, pp.83-86, 2013

[6] B.K. Uttam, G.A. Baspusaheb, Jadhav P. Shivaji, Prof. Pisal.R.S. “ Industrial Automation using IoT,” *International Research Journal of Engineering and Technology (IRJET)*, vol. 4, no. 6, pp.205-208, June.2017

[7] https://nevonprojects.com/iot-industry-protection-system-arduino/

[8] Mrs. L.G. Murali, Dr. M.M. Vijayalakshmi “Fire Accidents in Buildings – Case Studies,” *International Journal of Engineering Trends and Technology (IJETT)*, vol. 11, no. 4, pp.178-184, May. 2014

[9] A. Sharma, S. Pal, V. Jain : “IoT Based Smart Security System for Prevention of Industrial Hazards,” *International Research Journal of Engineering and Technology (IRJET)*, vol. 5, no. 3, pp.886-891, Mar-2018

[10] https://components101.com/microcontrollers/arduino-uno

[11] https://www.fecegypt.com/uploads/dataSheet/1522335719_relay%20module.pdf

[12] https://components101.com/5v-relay-pinout-working-datasheet

[13] https://en.wikipedia.org/wiki/NodeMCU

[14] http://www.resistorguide.com/photoresistor/

[15] https://components101.com/mq2-gas-sensor

[16] http://wiki.seeedstudio.com/Grove-Gas_Sensor-MQ2/

[17] https://www.electronicwings.com/sensors-modules/lm35-temperature-sensor

[18] https://www.robotics.org.za/LM35-MOD-B

[19] https://wiki.xinabox.cc/Blynk_functionality

[20] https://www.arduino.cc/en/main/software

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