IoT based Smart Helmet for Ensuring Safety in Industries

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Abstract:- **Industrial safety is one of the main aspects of industry . Working environment hazards include suffocation, gas poisoning and gas explosion. Hence air quality and hazardous event detection is very important factor in industry. In order to achieve those safety measures, the proposed system provides a wireless sensor network for monitoring real time situation of working environment from monitoring station. It provides real time monitoring of harmful gases like CO, CH4 and LPG and also temperature and humidity. To overcome those hazardous situation, this system provides emergency alert to the monitoring station . Some workers are not aware of safety and they did not wear helmet properly. For this purpose, a limit switch was used to successfully determine whether the workers had worn their helmet properly or not. The system uses Wi-Fi technology for transmission of data from working environment to the monitoring station. There is an alert switch at working environment for emergency purpose[1].**

Keywords: IoT, Arduino , Wi-Fi Technology, Sensors

1. INTRODUCTION:

The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifier and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. The IoT allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. IoT has evolved from the convergence of wireless technologies, micro-electromechanical systems(MEMS), microservices and the internet. The convergence has helped tear down the silo walls between operational technology and information technology, allowing unstructured machine-generated data to be analyzed for insights that will drive improvements [2].

In earlier days, LED helmets were deployed in Industries to inform the workers about the hazardous events. Later sensors were deployed to detect the events and the alert can be sent to the remote monitoring unit to avoid losses. several wireless sensor network has been used to detect and transfer datas. The most commonly used technology for wireless transfer is zigbee .One of the main disadvantage in using zigbee as a medium of transfer is the coverage area.The coverage area of zigbee is usually 10– 100 meters line-of-sight, depending on power output and environmental characteristics. Zigbee devices can transmit data over long distances by passing data through a mesh network of intermediate devices to reach more distant ones [3].

The proposed system uses Wi-Fi technology to transfer data from the working environment to the remote monitoring unit. The merit in using Wi-Fi as a medium of transfer is that it covers wider area and it is the latest modern technology that has been emerging worldwide for transferring data. In this system the transferred data is collected
,stored and analyzed using Thingspeak application. Thingspeak is one of the recently developed application in the field of IoT for analysing data transferred by wireless sensor networks.

2. RELATED WORKS:

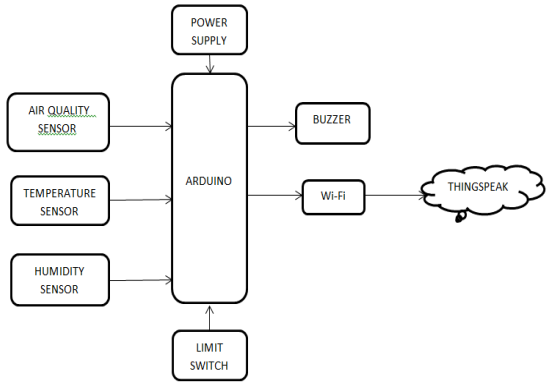
Yongping Wu and Guo Feng implemented helmets that uses the Bluetooth wireless transmission system for the monitoring the working environment. As a standard of unified global short-range wireless communication, Bluetooth technology is to establish a common lowpower, low-cost wireless air interface and controlling software opening system . At the same time, the system uses CAN bus technology maturely, has realized the combination of wired and wireless data transmission system. The main difficulty of this system is that the Bluetooth is short distance wireless technology and use of cabling is difficult. When a natural calamity occurs,the cabling will gets damaged. So the reliability and long life of conventional communication system is poor. Jingjiang Song, Yingli Zhu proposed automatic monitoring system for industrial safety based on wireless sensor network. The sensor groups of the system intensively monitor temperature, humidity in the working area.The parameters measured are sent to wireless communication module by the micro- controller. The collected information is sent to long-distance monitoring centre by cable. So the reliability and long life of conventional communication system is poor. The another problem is that the working condition of industries is very noisy and if the distance of the workers and system is long,workers will not get proper message. Pranjal Hazarika presents implementation of safety helmet for workers. This helmet is equipped with methane and carbon monoxide gas sensor. This sensor sense the gas and the data is transmitted to the control room wirelessly, through a wireless module called Zigbee connected with the helmet. This system does not working conditions of the workers and whether the

workers wear the helmet or not.The main difficulty of the system is the usage of zigbee technology.Zigbee technology has small area coverage and hence transferring to the monitoring agent is difficult to transfer data from the working area long distance monitoring unit [1].

3. PROPOSED WORK:

The system provides real time monitoring of industries from the monitoring station. The transmitter unit is placed on helmet of worker and receiver unit placed on the monitoring station. The Wi-Fi wireless technology is used for data transmission from the working environment to the base station. The Wi- Fi communication network provide way to monitor the working environment through thingspeak application from the monitoring station. The transmitter unit consists of air quality sensor, helmet removal sensor ,temperature and humidity sensor. The air quality sensors monitor the level of harmful gases like LPG, Methane, Carbon monoxide [1].

SYSTEM ARCHITECTURE



The MQ7 Air Quality Sensor is used to monitor the level of Methane, LPG, CO respectively LM35 is used for monitoring temperature. These are semiconductor type sensor. The sensor sense the particular level of gases and transmitted real time data to the microcontroller in the arduino , the controller receive the data, process it and transmit it to the monitoring station using Wi-Fi. At the same time if the sensor value increases above the threshold, alert sound and LED indication is provided to avoid losses .

The limit switch is used for detection of helmet removal condition. The limit switch placed inside the helmet. If helmet is worn properly, the switch is pressed and this data is transmitted to the thingspeak app using Wi-Fi. If helmet is removed, the switch is not pressed and then buzzer is ON, at the same time this data is transmitted to the monitoring station and can be viewed through Thingspeak app.

All real time data are received from helmet to the monitoring station through Wi-Fi and can be visualized on the Thingspeak application in the form of graphical charts . At the receiver side buzzer is used for abnormal condition. The buzzer is ON when gas sensor exceeds above threshold or miner removed her helmet or working environment is in abnormal condition. This system provides an alert button at base station so that control room can directly convey the emergency message to the workers [1] .

4. HARDWARE AND SOFTWARE DESCRIPTION:

HELMET SECTION:

The Helmet section of the system comprises of:

1) AIR QUALITY SENSOR:

Air Quality Sensor is used to sense and detect the emission of gases like LPG, Methane, carbon monoxide that causes several health hazards to the workers of the industries. The threshold value for Air Quality Sensor used in this system is 600 ppm. temperature sensor used in this system is 35 degree Celsius.

3) HUMIDITY SENSOR:

The Air Quality Sensor , MQ7 is a low power heat conduction gas sensor. The working principle is its resistance value fluctuate when gas concentration changes, the relationship is almost a linear one. MQ7 is a high precision, low-power unit with heating circuit, the voltage is Vc: 5.0V±0.1V VH: 5.0V±0.1V, load resistance is 51 Ω, preheating time is Over 48 hours static power consumption is less than 900mW, and working temperature range is -40℃ ~ +70℃ [4].

Sensor Type			Semiconductor
Standard Encapsulation			Bakelite (Black Bakelite)
Detection Gas			Natural gas/ Methane
Concentration			300-10000ppm (Natural gas / Methane)
Circuit	Loop Voltage	V_c	≤24V DC
	Heater Voltage	V_H	5.0V±0.2V ACorDC
	Load Resistance	R_L	Adjustable
Character	Heater Resistance	R_H	31Ω±3Ω (Room Tem.)
	Heater consumption	P_H	<900mW
	Sensing Resistance	R_s	2KΩ-20KΩ(in 5000ppm CH_4)
	Sensitivity	S	Rs(in air)/Rs(5000ppm CH_4)≥5
	Slope	α	≤0.6($R_{300ppm}/R_{5000ppm}$ CH_4)
Condition	Tem. Humidity		20℃±2℃; 65%±5%RH
	Standard test circuit		Vc:5.0V±0.1V; V_H: 5.0V±0.1V
	Preheat time		Over 48 hours

Fig 1 Specification of MQ7 Sensor[4]

2) TEMPERATURE SENSOR:

The temperature sensor is used to sense the temperature of the working environment. The Threshold condition for The humidity sensor is used to sense the humidity in the work area. The threshold condition for humidity sensor used in this system is 80.

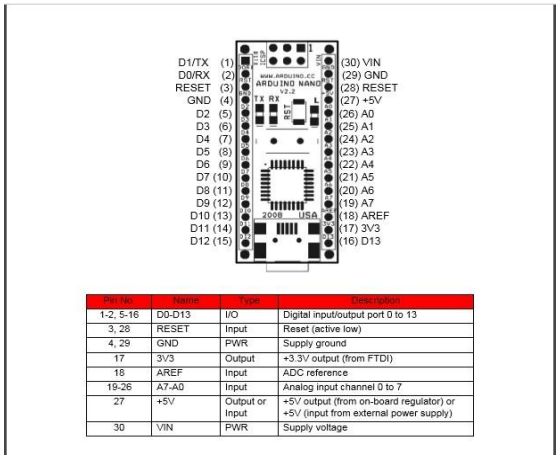
4) LIMIT SWITCH:

The Limit Switch is used to detect whether the worker properly wears the helmet or not. If the helmet is not worn properly an alert signal is generated to the monitoring unit and they alerts the worker by giving necessary instructions.

5) ARDUINO :

A pre-assembled Arduino board includes a microcontroller, which is programmed using Arduino programming language and the Arduino development environment. In essence, this platform provides a way to build and program electronic components. Arduino programming language is a simplified from of C/C++ programming language based on what Arduino calls "sketches," which use basic programming structures, variables and functions. These are then converted into a C++ program. Other open-source electronics prototyping projects, such as Wiring and Processing, provide the underpinnings for Arduino technology[5].

This system uses Arduino NANO that uses AVR Microcontroller (Atmega328). Atmega is subfamily of AVR Microcontroller. AVR microcontroller is selected because their fast responses speed. AVR reach 20MIPS at 20MHz clock where PIC16FS only reach 5MIPS at 20 MHz due to 4 clock instruction architecture. AVR is better in terms because of processing power.
The Atmega328 chip has an inbuilt ADC. It convert analog signal to digital value, with Vref value being a reference for which digital values are low or high. Atmega328 has 28 pins. It has 14 digital I/O pins, of which 6 can be used as PWM output, 6 analog input pins and 2 for crystal oscillator [1].



Pin No	Name	Type	Description
1-2, 5-16	D0-D13	I/O	Digital input/output port 0 to 13
3, 28	RESET	Input	Reset (active low)
4, 29	GND	PWR	Supply ground
17	3V3	Output	+3.3V output (from FTDI)
18	AREF	Input	ADC reference
19-26	A7-A0	Input	Analog input channel 0 to 7
27	+5V	Output or Input	+5V output (from on-board regulator) or +5V (input from external power supply)
30	VIN	PWR	Supply voltage

Fig 2 Arduino Nano Specification[4] ALERT SECTION:

The alert section is used to alert whenever the value of the sensors exceeds the threshold Conditions.
For the purpose of alerting , this system uses LED Lights and a Buzzer.

1) Green LED Lights
Green LED Lights are switched on when the readings of the sensors lies within the threshold conditions.

2) Red LED Lights
Red LED Lights are switched on when the readings of the sensors raises above the threshold conditions

3) Buzzer
Buzzer which is connected to the arduino emits an alert signal whenever the sensor readings rises above the threshold conditions.

COMMUNICATION SECTION:

The communication section is used to transfer the data from the working environment to the monitoring unit. For this purpose, this system uses Wi-Fi technology which covers wider area transfer. At whatever point the sensor information surpasses the predetermined limit (preset) esteem, the wi-fi module at remote observing site transmits ready flag to nearby site by blowing signal ceaselessly.
1) Wi-Fi Module

For wireless transmission purpose, this system uses a kit namely Nodemcu . NodeMCU is a LUA based interactive firmware for Expressif ESP8622 Wi-Fi SoC, as well as an open source hardware board that contrary to the ESP8266 Wi-Fi modules includes a CP2102 TTL to USB chip for programming and debugging, is breadboard-friendly, and can simply be powered via its microUSB port[7].
NodeMCU Features [8]: Developer: ESP8266 Opensource Community

Type :Single-Board Microcontroller OS
:XTOS
CPU :ESP8266(LX106)

Memory :128Kbytes Storage :4Mbytes Power
:USB

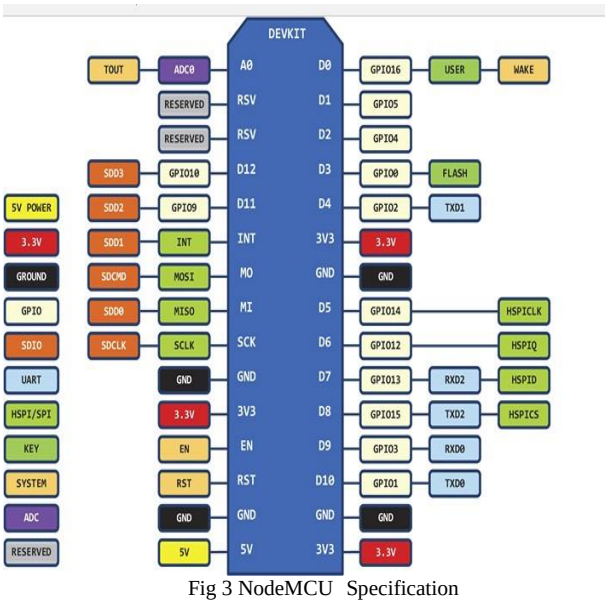


Fig 3 NodeMCU Specification

MONITORING SECTION:

The Monitoring section of the system comprises of:

1) THINGSPEAK APPLICATION:

ThingSpeak is an open source Internet of Things (IoT) application and API to store and retrieve data from things using the HTTP protocol over the Internet or via a Local Area Network. ThingSpeak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates [9].

Thingspeak is a cross platform application written in Ruby language. ThingSpeak has integrated support from the numerical computing software MATLAB from MathWorks, allowing ThingSpeak users to analyze and visualize uploaded data using Matlab without requiring the purchase of a Matlab license from Mathworks. ThingSpeak has a close relationship with Mathworks, Inc. In fact, all of the ThingSpeak documentation is incorporated into the Mathworks' Matlab documentation site and even enabling registered Mathworks user accounts as valid login credentials on the ThingSpeak website. The terms of service and privacy policy of ThingSpeak.com are between the agreeing user and Mathworks[9].

5. RESULT ANALYSIS:

The result analysis of our project includes 1) sensing the gas emission , temperature and humidity 2)Transmission of data using Wi-Fi 3) Storing and monitoring data using Thingspeak application.

6. CONCLUSION:

Through this study, we developed a smart helmet which was designed to help workers to get rid of hazardous events in industries. The paper has been successfully presented and tested with integrated features of each hardware component for its development. Significance of each block has been resonated out and placed carefully, thus contributing to the best working of the unit. Hence the system is reliable with simple and easily available components, making it light weight and portable [4]. This product can be enhanced by adding additional features in the near future.

7. REFERENCES:

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