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Research Article

IOT based advanced Industrial Safety device

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Abstract

Most of the industrial hazards are due to malfunctioning of the machines. Malfunctioning caused by gas leaks, increase in pressure, temperature, and humidity.High noise in the industrial environmentcauses damage to the human life, equipment and the environment. At present only onsite alarms are used to warn the people in the industry. So, we introduce IOT based advanced industrial safety device where the different sensors interact in a working environment through a digital platform for managing different types of hazardsExample: safety of machines as well as workers. These hazards can be controlled and prevented by implementing pressure, air quality, sound, temperature, and humidity sensors in the industrial equipment and environment. These sensors are interfaced to the microcontroller ESP8266 Node MCU Wi-fi module. Wireless sensor networks(WSN) need for recording and monitoring physical conditions of the industrial equipment and environment. If any problem arises, Node MCU generates an alarm to alert the workers and if it reaches the saturation level, the machine automatically turns off. The data collected by the sensors requires an extension and some amount of processing to choose and store the required information on a cloud- based storage to the internet via Wi- fi router so that it can be viewed by users through an Android Application from anywhere

Keywords: Industrialhazards, Safety device, Sensors, Node MCU

Introduction

IOT is influenced by Wireless sensor networks. The applications of WSN are healthcare, army, environment safety, agriculture development, industrial safety, transportation systems and security.

The status of the equipment and environment is monitored using industrial sensors which is connected to the control board using wired or wireless techniques. Benefits of wireless technology in industries includes low installation cost, highly scalable and flexible, intelligent processing capability, high mobility and easy to develop compared to wired technology.Explosion is mainly due to gas leak. There are different types of gases some of them are Liquified Petroleum Gas, ammonia (NH3), carbon-monoxide (CO), methane (CH4) gas and so on. Some of these gases are used for humans. For example, LPG is used for cooking whereas ammonia used for plants to protect against pest. However, there are various hazardous gases which are harmful to users or humans if not handled properly or because of the device failure that causes gas leakage. Gas leakage can possiblylead to fire and the person who is highly exposed to gas suffers from gas poisonous.

Similarly, issues with pressure, vibration, humidity, and temperature can also be very strong indicators of things that can go wrong. Current systems focus on emergency evacuation, fire-fighting, and smoke detection. However, very few systems combat the catastrophe before it is caused. Though the emergency response is vital, preventing the emergency from occurring in the first place can save lives and capital. So, this project focuses on the prevention of hazards.

In this section, the existing works of various researchers are studied and the key takeaways are summarized. Many valid points and assumptions can be taken as inspiration from these studies.Liquefied Petroleum Gas leakage detection and monitoring system on site with LCD display is used to measure the how much LPGis used on a constant interval and alarm to notify in case of leakage so, explosion is avoided this was proposed in 2019 by Linxi Dong et al. [1]. It also says the quantity of LPG presentwith that instant action can be taken.

In 2019, NafizeIshtiaque Hossain et al [2] proposed a framework for any leakage monitoring continuously. If leakage detected it alerts the user via a buzzer and by using an Android application.

In 2018, Ravi Kishore kodali et al.

[3] proposed and developed a gas leakage monitoring system via Cloud using ZigBee, Arduino, MQ-2 gas sensor and Cloud. The data is fed on cloud using Wamp server and an SMS is sent to alert on the gas leakage to the mobile of home owner and fire brigade with model number, location, date and time. Arijit Banik et al. [4] utilized MQ-2 gas sensors that connect to ARM microcontrollers with ESP8266 Wi- Fi to connect to ThingSpeak.com network.

In 2018, Rossi Passarella et al. [5] proposed detection of a gas leakage from a pipeline by using gas flow pattern is a neural network-based method. Each segment of the pipe is modeled by taking into consideration of both input and output pressure of the gas flow. All the required informationis gathered using IoT for gas monitoring and used neural network on attained data frompipeline gas flow [6-9]. This work is useful in predicting the location of gas leakage using gas flow patterns without using any external sensor unlike previous methods. Although there are a few existing works proposed and

developed using IoT, there are no works that implement the dashboard display and cloud event management provided at IoT Cloud for management of gas leakage detection systems[10-15].

Limitations: In above proposed papers they have only focused on detection and control of gas leakage system that held in houses which alerts the users or workers by warning call through GSM and alarm buzzer and send the message to the owner in case of gas leakage, but these are only applicable for household users not for industries.

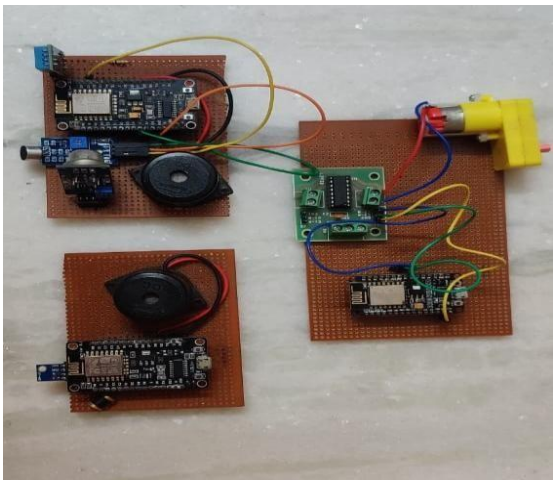
In some papers [16-20] they detected and monitored the gas levels in the industries but not focusing on temperature, pressure, humidity levels. If these levels reach the saturation point without detecting then the industrial equipment will be damaged and that may affect on workers' health and environment.

Existing System

In existing system, smoke detector, fire alarm, and fire extinguisher are used to detect the fire. Smoke detector senses smoke which gives signal to indicate the fire[21-22]. Fire alarm is a device which gives signal to alert the people if there is any fire or smoke. Fire extinguisher helps to put-off the fire during fire breakouts. It is a metal device which contains mater or chemicals.Gas drip is sensed by gas leakage sensor. But what about the indicating factors like temperature, pressure, humidity, air quality, and sound so we are going to sense all these parameters[23-25].

Proposed System

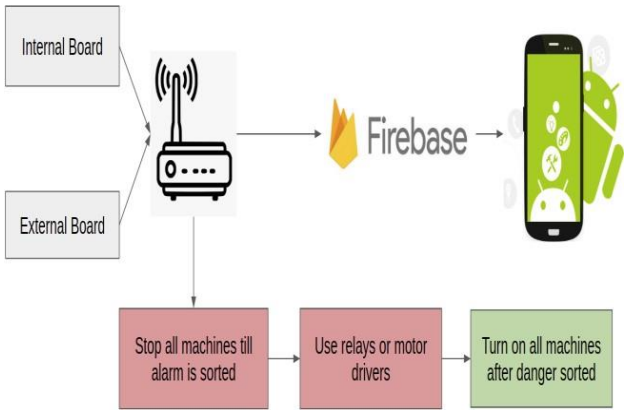
In Proposed system, Hardware part of the system contains external and internalboard which consists of sensors that detects chemical leak, smoke, temperature, pressure level rise, and moisture content in the industrial equipment and environment. The Sensors are interfaced to the microcontroller ESP8266 NodeMCU Wi-fi module. If any problem arises, alarm buzzer will alert the workers. If the values read by the sensor reaches the saturation level, the machine automatically turns off and remains in the state until the problem rectified. In the software part, the microcontroller is attached to the Internet via a Wi-fi router. So, NodeMCU is able to update values to the Firebase cloud storage. The Android App is interfaced with Firebase, so the values updated by the NodeMCU can be viewed in the app.The values are read by the sensors and if the sensor readings are abnormal, it is reflected in the app. The user can monitor current status and real time value of sensors with internet from anywhere in the world.



Experimental Setup

Block Diagram:

The block diagram below describes how the internal and external board are interlinked with the Android app.



Block Diagram of Proposed System

The hardware design has two major parts - the internal and external boards. The internal board is to be placed inside the machine wherever it can be used effectively. It can be placed in a furnace or a storage unit or any other place where monitoring is essential. The external board consists of important parameters like temperature, humidity, etc., that can indicate a warning sign. So, both these boards are vital to have a completely safe environment. There is also a separate board to demonstrate the working of this system. It consists of a buzzer and a motor (machine) to show how the system stops working when there is an emergency and restarts after the danger is averted.

Methodology

Node MCU (ESP8266):NodeMCU

is an IOT platform that can be accessed by everyone.The microcontroller used here is ESP 8266 because it has an inbuilt Wi-Fi module that can connect to any router as it is being programmed. So, it is connected to the Internet at all times. It has a set of registers that function as a general-purpose RAM. It requires 5v power supply and has a clock speed of 16 MHZ.

DHT-11 Temperature and Humidity Sensor: The DHT11 is one of the digital humidity and temperature sensor that is available at low cost. The power supply of DHT11 is 3V to 5V. It can withstand up to 20-80% humidity with 5% accuracy. It is good for 0-50°C temperature readings with ±2°C accuracy.

Air Quality Sensor:MQ-135 sensor is an air quality sensor for

encountering different types of gases which are existing in the air. It detects harmful gases such as beneze, sulphides and ammonia. The gas sensor is operated in the range from 2.5V to 5.0V.

Piezoelectric vibration sensor:It is dynamically sensitive which means it is good at computing minute changes in pressure nevertheless in a high-pressure environment. A robust piezoelectric sensor is used and it has a wide range of industrial applications.

Pressure sensor:BMP180 is a high precision sensor that senses pressure and delivers the output information in digital format. It can detect pressure ranging from 300 to 1100hPa. The relative accuracy of BMP180 sensor is ±0.12hPa and it consumes very low power at only 3uA.

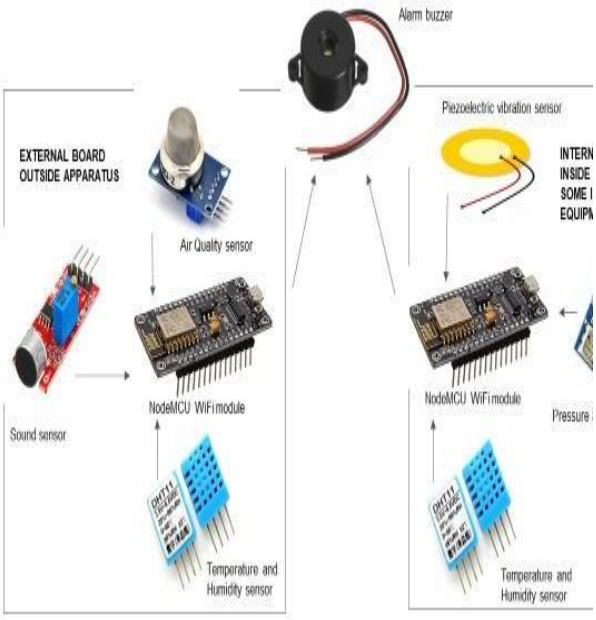
Sound sensor:The KY-038 sound sensor is a sound level indicator which is also referred as an electric condenser microphone. The potentiometer is adjusted to control the sensitivity. It has 2 outputs i.e., Analog and digital output.

Motor driver L293D: Motor is driven by L293D. The set of two DC motors simultaneously controlled by a 16-pin IC L293D. The task is built easierby using L293D Motor Driver IC.

Arduino IDE:It is used for programming the Wi-fi module by installing additional libraries. It is an application that written in function from C and C++. It is a derivative of processing IDE as a version of 2.0.

Firebase:To create mobile and web applications google developed a platform called Firebase. This platform contemporizes data application over iOS, Android, and Web devices. The information collected from these applications are stored in firebase's cloud.

MIT App Inventor:To integrate and develop web application, MIT app invented by Google. To develop an application which runs on anandroid device, for this it uses GUI (graphical user interface).



Implementation of sensors in External & Internal board

Conclusion

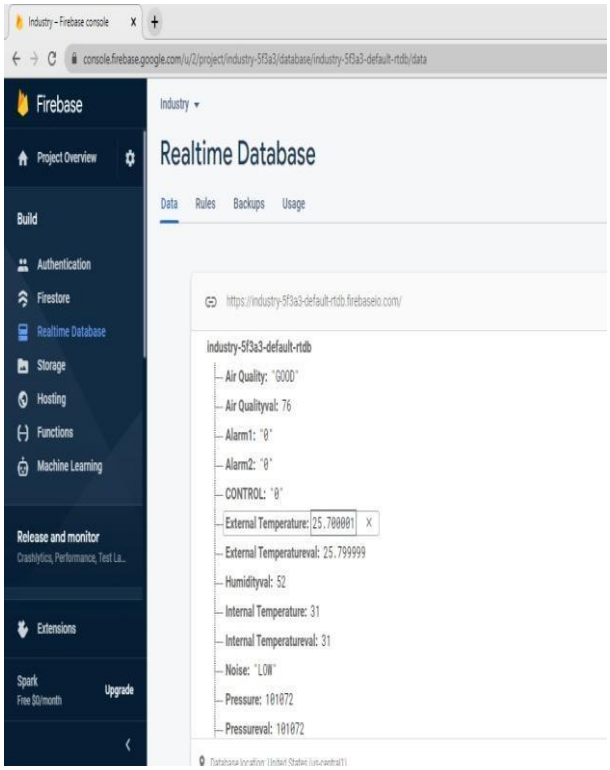
The project as well as application of the proposed solution is demonstrated successfully. The fully developed system has been tested to demonstrate its feasibility and effectiveness. The industrial safety system contains the necessary low- cost hardware as well as secure software operations. The hardware implementation involves the use of multiple sensors, processing units, Wireless Microcontroller nodes, and the software implementation involves uploading values to the cloud-based storage and retrieving those values on an Android App.

Result

Thissection provides the consolidation of the achieved goals in this project. The section considers both hardwareand software implementation. In the hardware side, the working model of the project is presented and pictures are added to support. The softwaresection consists of screenshots explaining the working of the mobile app and firebase cloud storage.

Screenshot of Android app

Screenshots of the back end, i.e., the cloud storage on fire base is also displayed. The real time database has the sensor values stored as shown in the figure below:



Database

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