Safety and Maintenance Management System in Industries Based on IoT

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Abstract— Safety of employees, in any industry, especially at the factory level is one of the most important aspects to be considered by businesses. Factories where working conditions are harsh and employees need to take great caution while going about their work; it is common for mishaps to occur. With numbers going as high as into the thousands it is important that there is measure of safety for the employees from any possible hazardous situations. As a solution to this problem, we propose a monitoring system to be installed in factories. With this system, we will be able to monitor critical safety parameters of the working environment in these factories so that we are well-aware of the safety situation and the possibility of occurrence of any mishap. For the design of this system, we use an ESP8266 Wi-Fi chip enabled microcontroller Node MCU. Three sensors are connected one to monitor temperature and humidity (DHT sensor), an ultrasonic sensor (HC-04) and a smoke sensor (MQ2 sensor). These sensors continually monitor the environment in the workplace and upload the data onto the Losant IoT Platform, which is one of the most powerful cloud platforms which help monitor data by different visualizations and further provision.

Keywords: Temperature Sensor, Ultrasonic Sensor, Smoke Sensor and IoT

I. INTRODUCTION

With rapid industrial development, there have been a drastically increased number of factories all over India in all sectors. With this development, the spurious outburst of factories have unfortunately not been accompanied by the required and regulated safety standards set by the National Policy on Safety, Health and Environment at Workplace [1]. There are plenty of problems that plague the workers working in factories with hazardous environments.

The main problems that affect the workers in a typical factory are the environmental conditions, namely, temperature and humidity, the presence of potentially harming and dangerous equipment used in the factory, and the possibility of a fire outbreak itself in the factory [2]-[4]. So for a more employee-friendly and safe atmosphere to prevent accidents there is the need for a system which can continually monitor the situation in the factory and send the data in an understandable way to the concerned authorities so that they can monitor it and accordingly act when there is any mishap to avoid escalation of the problem or when there is the possibility of an accident and alert the concerned people to prevent it [5]-[8].

The Internet of Things is what comes to the rescue here with us being able to monitor the environment with several sensors and upload the data so that it can be monitored. Temperature and humidity are two of the most basic aspects to be considered and maintained at specific levels so that employees do not feel uncomfortable and be prone to health risks. Most people feel comfortable in the temperature range of 20 to 27◦C and a humidity range of 35-60%. Typically extreme levels of temperature and humidity cause workers to suffocate and prevent them from putting in their maximum effort. Some of the problems caused include muscle cramps, fatigue, irritation and headache. So there is a need to constantly monitor these parameters [9]-[10].

Another main cause for factory accidents is the fact that employees tend to walk into areas where there are automated machinery. This leads to accidents where the workers stray into the range of the machine and are hit by it while it is working. Implementing sensors to detect if someone is approaching a possibly hazardous machine and warning him or her in advance would save the life of the employee and prevent these kinds of accidents. Most factories operate with the help of heavy machinery and high power electricity to operate. This gives cause for a possible fire to break out with any deviation from normal working conditions. So we need to continuously monitor the factory for signs of a fire breaking out [11]-[13]. This is done by smoke sensors which sense the presence of smoke when there is a fire.

As a solution to these problems, this project implements the Node MCU based on ESP8266 and monitors the various parameters for signs of possible accidents or mishaps in the factory and aggregates all this data for further evaluation and processing to reach intelligent decisions. The data is uploaded on one of the most powerful and most popular IoT platform, Losant for aggregation and can be displayed in a user-friendly and easy-to-understand pattern, using their Dashboard option [14]-[15]. Communication is done using the MQTT protocol which is lightweight in memory and consequently power consumption so that the system can be widely implemented at low costs on a large scale.

II. MODULE OF THE PROPOSED WORK

A. Node MCU

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. It is quite compact and also affordable, making it one of the most popular choices for many people working on IoT applications. With a RAM of 128kB and a storage space of 4MB, it is quite light on memory and power consumption. It has one analog and eight digital GPIOs, thus making it quite convenient to run a variety of different applications integrating sensors and actuators with it. It is very comfortable to work with, as it is a quite versatile device

B. DHT Sensor

The DHT11 sensor is a low-cost and low-power sensor to measure the temperature and humidity in the atmosphere. It is very inexpensive but on the downside the sensor is very

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basic and slow to work, often involving a delay of around two seconds. The DHT sensor is made up of two parts, the capacitive humidity sensor and a thermistor. These are the two components mainly responsible for sensing humidity and temperature respectively.

C. Ultrasonic sensor

In this paper, the HC SR-04, an ultrasonic sensor is used to measure the distance of any person approaching. The modules involved in this operation include ultrasonic transmitter, a receiver and the requisite control circuit. The module automatically sends ultrasonic waves which, if there is an obstacle, get reflected back from the obstacle and reach back to the receiver module of the sensor. If a signal is received back, the time taken between the transmission and reception is calculated and the distance is accordingly calculated from the speed of the waves and the time.

D. Gas Sensor

The MQ2 is a sensor we use to detect the presence of combustible gas and smoke. This sensor uses a small heater inside with an electrochemical sensor. It is sensitive to a range of gases and is used indoors at room temperature.

E. Losant IoT Platform

The Losant IOT Platform is one of the most popular and powerful cloud platforms that help users effortlessly integrate their solutions with their cloud services to store potentially massive amounts of raw data and process them to make sense out of them. It supports communication from billions of devices and uses the lightweight MQTT protocol for communication. It provides robust data collection, aggregation and different ways to visualize our accumulated data in an easily understandable way. The protocol used, MQTT, is a lightweight application-layer communication protocol that uses the concept of publish-subscribe method for messaging. Our device, as a client, publishes data which can be collected and stored on our Losant accounts by subscribing to the topics the data has been published in. Losant provides an MQTT broker whose services we can use to bridge the gap between publisher and subscriber.

III. HARDWARE IMPLEMENTATION

The hardware setup consists of the main microcontroller, the NodeMCU, to which all the devices are connected. The DHT sensor has a single digital output which can be connected to any digital GPIO of the NodeMCU. With this we can read the values of temperature and humidity directly in the factory without any calibration needed, due to the presence of onboard processing availability on the DHT sensor. The ultrasonic sensor has two pins, the trigger pin (Trig) and the echo pin (Echo) which need to be connected to two digital GPIOs of the NodeMCU. The trigger pin is used to trigger a pulse of a predefined type which will be sent out, and if reflected back and received, will be done so by the echo pin. Here, again, there is onboard processing to calculate the time between the trigger and echo reception, to calculate the distance the obstacle is from the sensor. This will help us detect if a person is straying into a dangerous zone which is off-limits for safety purposes.

The smoke sensor is an analog sensor and will output an analog value which can be read by the analog pin on the NodeMCU. It can be used to continually monitor for presence of smoke in the factory. If the sensor detects a certain amount of smoke, then it will accordingly change its value, which we can use to further trigger safety procedures to prevent any mishaps. This completes the hardware connections to be made for the project. The NodeMCU can be powered up by a power source like a power brick, or from a 5V power supply circuit.

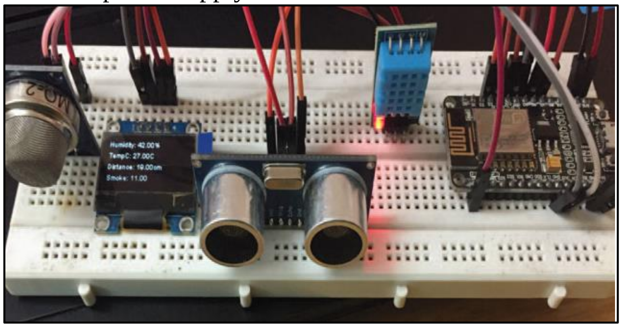

Fig. 1: Hardware Setup of the Proposed Work

IV. SOFTWAREIMPLEMENTATION

The software coding has been done in the Arduino software, v1.8.3. Arduino is open-source software which is very popular for writing codes for various microcontrollers and their applications. It is well-documented and has many forums and a lot of online support. In the code, we first connect the NodeMCU to the Internet through a Wi-Fi network. This is done by using the ESP8266 Wi-Fi module located on the NodeMCU. Then the connection to Losant is established and topics are described for publishing using MQTT protocol.

Now the sensor data from all the afore-mentioned sensors will be taken in by the NodeMCU and this data will be pushed on to the Losant IoT Platform. On Losant, we create an account and set up the necessary credentials to be able to subscribe to the topics published by the device NodeMCU. We can add a new Application and then set the attributes which are nothing but the sensor data being collected by the device through the various sensors connected to it. Then we create a new Dashboard on the platform under the Application and customize it to suit our data collection requirements. This Dashboard is a perfect place to continuously monitor all the data from different sources on one single platform. The program is uploaded in NodeMCU and log in to data will be pushed on to the Losant IoT Platform. All the sensor data is monitoring and controlling in losant IoT platform.

Fig. 2: Sensor Analysis of the Proposed Work

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V. CONCLUSION

The integrating IoT with solutions to empower worker safety and a safe workplace for them is visible and can be done on a large scale with the help of the powerful tools mentioned in this paper. With this development, it can be said that in the years to come there will be a massive improvement in the safety standards in hazardous factories so that employees can work peacefully without the risk of loss of life hanging over their heads.

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