Using Internet of Things for Monitoring Industrial Hazards

Project Report

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Internet of Things

(F2 + TF2)

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1 Abstract

Internet of Things (IoT) represents a general concept for the ability of network devices to sense and collect data from the world around us, and then share that data across the Internet where it can be processed and utilized for various practical purposes in different aspects of life.

The reach of IoT based systems in industrial areas is still limited, but it has huge potential. In this project, we create an IoT based hazard monitoring system specifically suited to requirements of mining, refining and manufacturing industries.

The system actively records, processes and analyzes the temperature of surroundings, which is a prime safety parameter in areas where molten metal is processed, manufacturing is done or welds are made. Also, it keeps track of high levels of dangerous gases present in the environment (LPG/Natural Gas).

If a parameter is violated, the system sends an immediate notification to a set of preset list of users on their smartphones, and continues logging and monitoring data for further analysis to suggest improvements in the safety regulations of the industry.

The sensors used in this prototype model can be modified with industry requirements (for example more robust temperature sensor may be required in very harsh conditions) whenever the need arises.

2 Literature Survey

IoT is a platform which has varied applications in day-to-day life ranging from domestic to industrial. The system we are going to implement aims to provide a low cost, low maintenance and robust architecture for analyzing hazardous situations in heavy industries. Various papers published in the field of IoT have touched different aspects of this project.

Remote Temperature Monitoring Using LM35 sensor and Intimate

Android user via C2DM Service presents a WSN prototype for remote room temperature monitoring, which can be used for fire safety operations, via an Android platform. The proposed system provides an Android user interface for registered user to access the current temperature and a flash/beep message in case of fire. This paper influenced our work in selecting the platform for alerting the user and connecting it with central controller.
`http://www.ijcsmc.com/docs/papers/June2013/V2I6201313.pdf`

Online Analysis And Fault Finding System For Distribution Transformers Using IOT is about design and implementation of embedded system to monitor and record key parameters of a distribution transformer like load currents, oil level, oil quality and ambient temperature. This paper provided insights about applications of IoT based systems in industrial environments, and how multiple sensors are unified together.
http://ijesc.org/upload/6194e52702ac6b1c3e6fe37b23226

Real Time Monitoring of CO2 Emissions in Vehicles Using Cognitive IOT aims to reduce the green house effect by real time monitoring and controlling of CO2 emission caused due to vehicles and industries using cognitive IOT. This paper gives insights about the domain of Cognitive IoT, which can be implemented as an extension of our project.
https://www.ijsr.net/archive/v5i3NOV161965.pdf

Review on Temperature and Humidity Sensing using IoT highlights some of the advantages of working with a Raspberry Pi, which helped us to implement a network, running scripts and graphical visualization of data.
https://www.ijarcsse.com/docs/papers

IoT based Data Logger System for weather monitoring using Wireless sensor networks deals with monitoring and controlling the environmental conditions like temperature and CO2 level with sensors and sends the information to the web page. This is similar to the web interface we have implemented in our project.

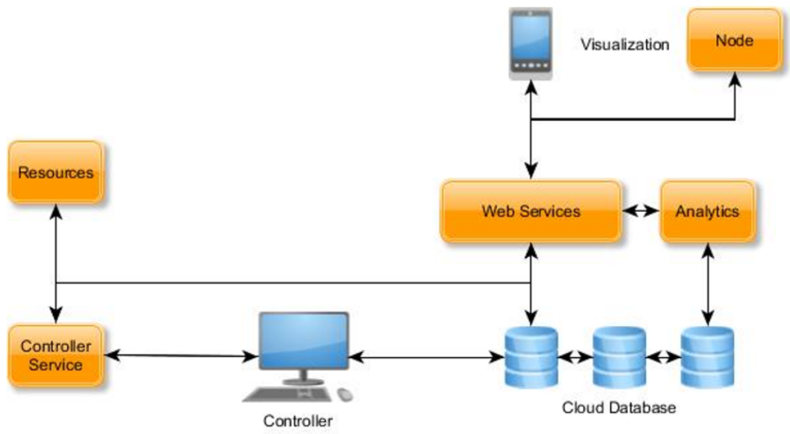
`http://www.ijettjournal.org/2016/volume-32/number-2/IJETT-V32P213.pdf`

Industrial Temperature Monitoring and Control System Through Ethernet LAN in which, temperature sensor measures the temperature and produce corresponding analog signal which is further processed by the central micro controller. The wired approach is less efficient in industrial areas, and thus we were motivated to implement a wireless system.

`http://www.ijecs.in/issue/v2-i6/39%20ijecs.pdf`

3 Proposed Architecture

The project architecture is based multiple monitoring nodes and making use of an embedded controlling device (Raspberry Pi), which gathers and processes the data generated by different sensors like temperature sensors and gas detectors. A cloud platform is used to visualize and analyze the data thus generated and also thereby enabling us to perform real time tracking and possibly implement a warning system, say notifications through the cloud or an audible alarm.



4 Required components and Services

- Raspberry Pi 3
- Temperature Sensor- DS18B20
- Gas Sensor- MQ 5/9
- Breadboard
- Raspbian OS (Running on Rpi-3)
- Simplepush API
- Thingspeak Cloud Platform

5 Innovative Ideas

5.1 Incredibly simple architecture

The system requires just 3 core hardware components to run, and runs with minimal space and resource requirements.

5.2 System crash protection

It is configured in such a way that it recovers and reconnects itself after a crash/power cut, and can resume working immediately.

5.3 High capacity system

It can serve alerts to more than a million unique users, and more new users can be added by just adding their API Key to the system.

5.4 Completely Secure

The system uses encrypted notifications for sensitive notifications and communication with cloud service is also based on unique API keys.

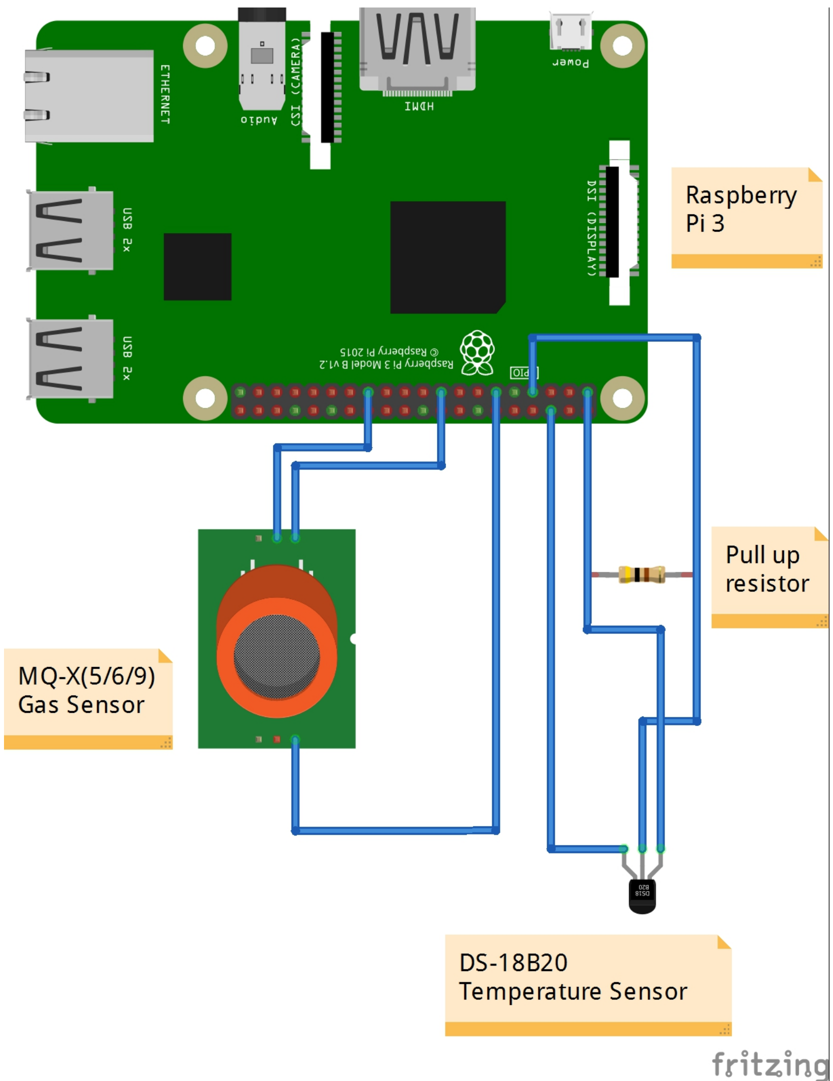
5.5 Versatile

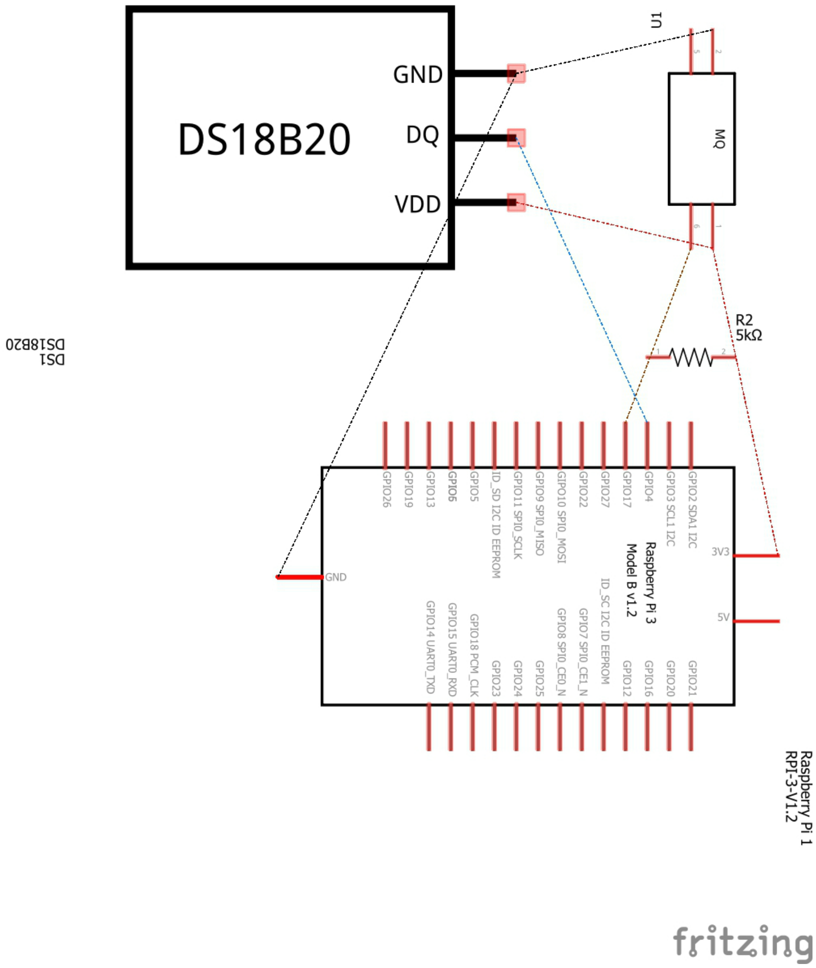
Notification parameters and user access control can be adjusted to suit your requirements.

5.6 Cost Effective

Cheaper to implement than other options and it cover a large area and user-base with low maintenance costs.

6 Circuit Diagram and Layout





7 Program Code

7.1 Temperature Analysis

```
#Temperature analysis using Raspberry-Pi and DS18B20 sensor - Ayush Dwivedi

import os
```

```
import requests
import glob
import time
import httplib
import urllib

key='5T1VDDGI9H83QY'

os.system('modprobe w1-gpio')
os.system('modprobe w1-therm')

base_dir = '/sys/bus/w1/devices/'
device_folder = glob.glob(base_dir + '28*')[0]
device_file = device_folder + '/w1_slave'

def read_temp_raw():
    f = open(device_file, 'r')
    lines = f.readlines()
    f.close()
    return lines

def read_temp():
    lines = read_temp_raw()
    while lines[0].strip()[-3:] != 'YES':
        time.sleep(0.2)
        lines = read_temp_raw()
    equals_pos = lines[1].find('t=')
    if equals_pos != -1:
        temp_string = lines[1][equals_pos+2:]
        temp_c = float(temp_string) / 1000.0
        if temp_c > 55:
```

```
                res = requests.get('https://api.simplepush.io/send/ji_4_d/
                High Temperature Alert/Temperature exceeded the safe value')

                #res2 = requests.get('https://api.thingspeak.com/update?
                api_key=XWG85OR8_0_HU&Temperature=temp_c')

        return temp_c

def temp_analysis():
    while True:
        temp = read_temp()
        params = urllib.urlencode({'field1': temp, 'key':key })
        headers = {"Content-typZZe": "application/x-www-form-urlencoded",
        "Accept": "text/plain"}
        conn = httplib.HTTPConnection("api.thingspeak.com:80")

 try:
            conn.request("POST", "/update", params, headers)
            response = conn.getresponse()
            print 'Current temperature is ', temp, '(deg. Celsius)'
            print 'Status:',response.status, ',',response.reason
            print('\n')
            data = response.read()
            conn.close()

        except:
            print ("Connection failed...")
        break

while True:
        temp_analysis()
```

```
        time.sleep(1)
```

7.2 Gas Leakage Analysis

```
import time, sys
import RPi.GPIO as GPIO

GPIO.setmode(GPIO.BOARD)
GPIO.setup(11, GPIO.IN, pull_up_down=GPIO.PUD_DOWN)

def action(pin):
    print 'Sensor detected high concentration of LPG/Natural gas!'
    return

GPIO.add_event_detect(11, GPIO.RISING)
GPIO.add_event_callback(11, action)

try:
    while True:
        print 'alive'
        time.sleep(0.5)
except KeyboardInterrupt:
    GPIO.cleanup()
    sys.exit()
```

7.3 MATLAB Analytics

```
% Temperature for the past hour is read from a ThingSpeak channel
% Maximum temperature is written to another ThingSpeak channel.

% Channel ID to read data from
readChannelID = 1297;
```

```
% Temperature Field ID
TemperatureFieldID = 4;

% Channel Read API Key
% If your channel is private, then enter the read API
% Key between the '' below:
readAPIKey = 'DTATWLOO4KQK6';

% To store the maximum temperature, write it to a
% channel other than
% the one used for reading data.

writeChannelID = [2554];
% TODO - Enter the Write API Key between the '' below:
writeAPIKey = 'Z9PAVIOERN3G1';


[tempF, timeStamp] = thingSpeakRead(readChannelID, 'Fields',
 TemperatureFieldID, 'numMinutes', 60, 'ReadKey', readAPIKey);

% Calculate the maximum temperature
[maxTempF, maxTempIndex] = max(tempF);

% Choose the timestamp at which the maximum temperature
% was measured
timeMaxTemp = timeStamp(maxTempIndex);

display(maxTempF, 'Maximum Temperature for the last hour is');

% Write the maximum temperature to another channel specified by
% 'writeChannelID' variable
```

```
display(['Note: To successfully write data to another
 channel, ',...
    'assign the write channel ID and API Key to
     ''writeChannelID'' and ',...
    '''writeAPIKey'' variables above. Also uncomment
    the line of code ',...
    'containing ''thingSpeakWrite'' (remove ''%'' sign
    at the beginning of the line.)'])


thingSpeakWrite(writeChannelID, maxTempF, 'timestamp',
 timeMaxTemp, 'Writekey', writeAPIKey);
```

8 Sample raw data recordings

The raw temperature values (in Celsius) as recorded by the Thingspeak cloud are-


```
{"channel":{"id":1297,"name":"Temperature Monitoring",
"description":"Reading DS18B20 data using Raspberry Pi
 3 Pi","latitude":"0.0","longitude":"0.0","field1":
"Temperature","created_at":"2017-04-17T16:46:59Z",
"updated_at":"2017-04-18T10:09:26Z","last_entry_id"
:48},"feeds":[{"created_at":"2017-04-17T17:11:13Z",
"entry_id":1,"field1":null},{"created_at":"2017-04-
17T17:11:29Z","entry_id":2,"field1":null},{"created
_at":"2017-04-17T17:14:21Z","entry_id":3,"field1":
null},{"created_at":"2017-04-17T17:15:31Z","entry
_id":4,"field1":null},{"created_at":"2017-04-17T17
```

:16:40Z","entry_id":5,"field1":null},{"created_at"
:"2017-04-17T17:16:58Z","entry_id":6,"field1":null}
,{"created_at":"2017-04-17T17:17:15Z","entry_id":7,
"field1":null},{"created_at":"2017-04-17T17:20:05Z"
,"entry_id":8,"field1":"33.75"},{"created_at":"2017
-04-17T17:20:20Z","entry_id":9,"field1":"33.75"},{
"created_at":"2017-04-17T17:20:38Z","entry_id":10,
"field1":"33.75"},{"created_at":"2017-04-17T17:24:
01Z","entry_id":11,"field1":"33.75"},{"created_at"
:"2017-04-17T17:24:18Z","entry_id":12,"field1":"
33.75"},{"created_at":"2017-04-17T17:24:34Z","entry
_id":13,"field1":"34.125"},{"created_at":"2017-04
-17T17:24:49Z","entry_id":14,"field1":"34.812"},{
"created_at":"2017-04-17T17:25:04Z","entry_id":15,
"field1":"34.75"},{"created_at":"2017-04-17T17:25:
21Z","entry_id":16,"field1":"34.687"},{"created_at
":"2017-04-17T17:25:37Z","entry_id":17,"field1":"
34.625"}]}

9 Output and Screenshots

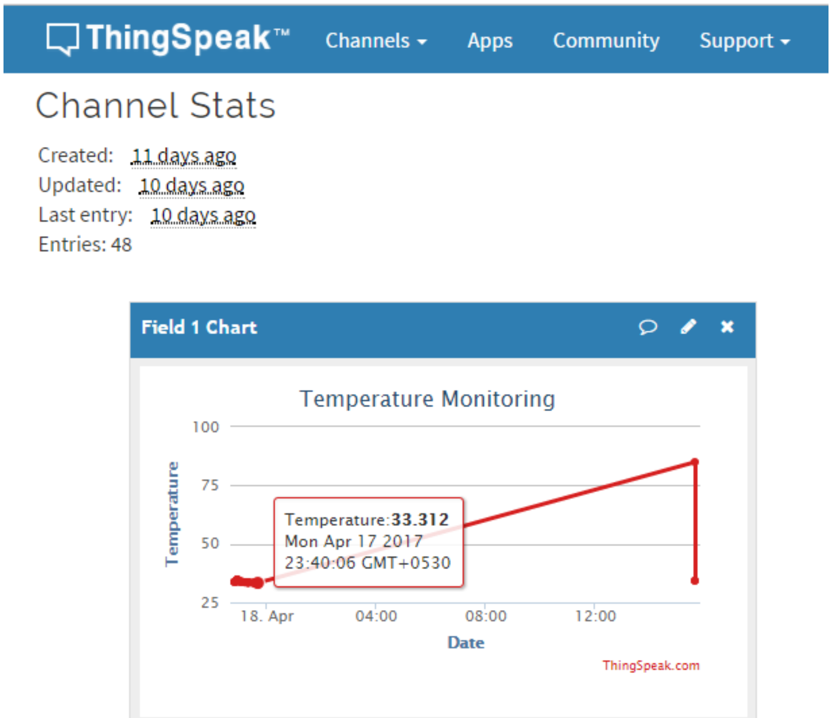


Figure 1: Temperature values sent to the cloud

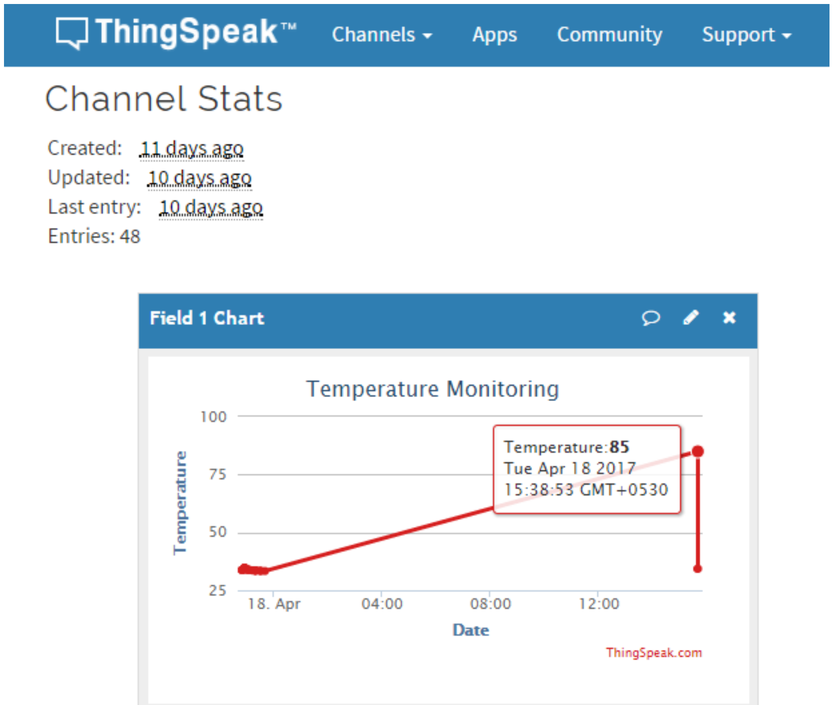


Figure 2: Temperature rising

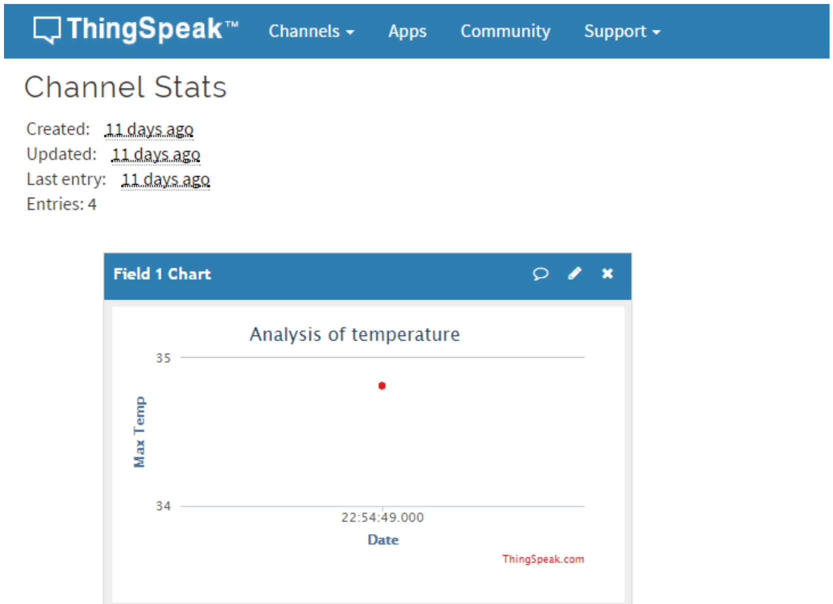


Figure 3: Analysis of last hour's temperature using MATLAB

Figure 4: Notification on Android

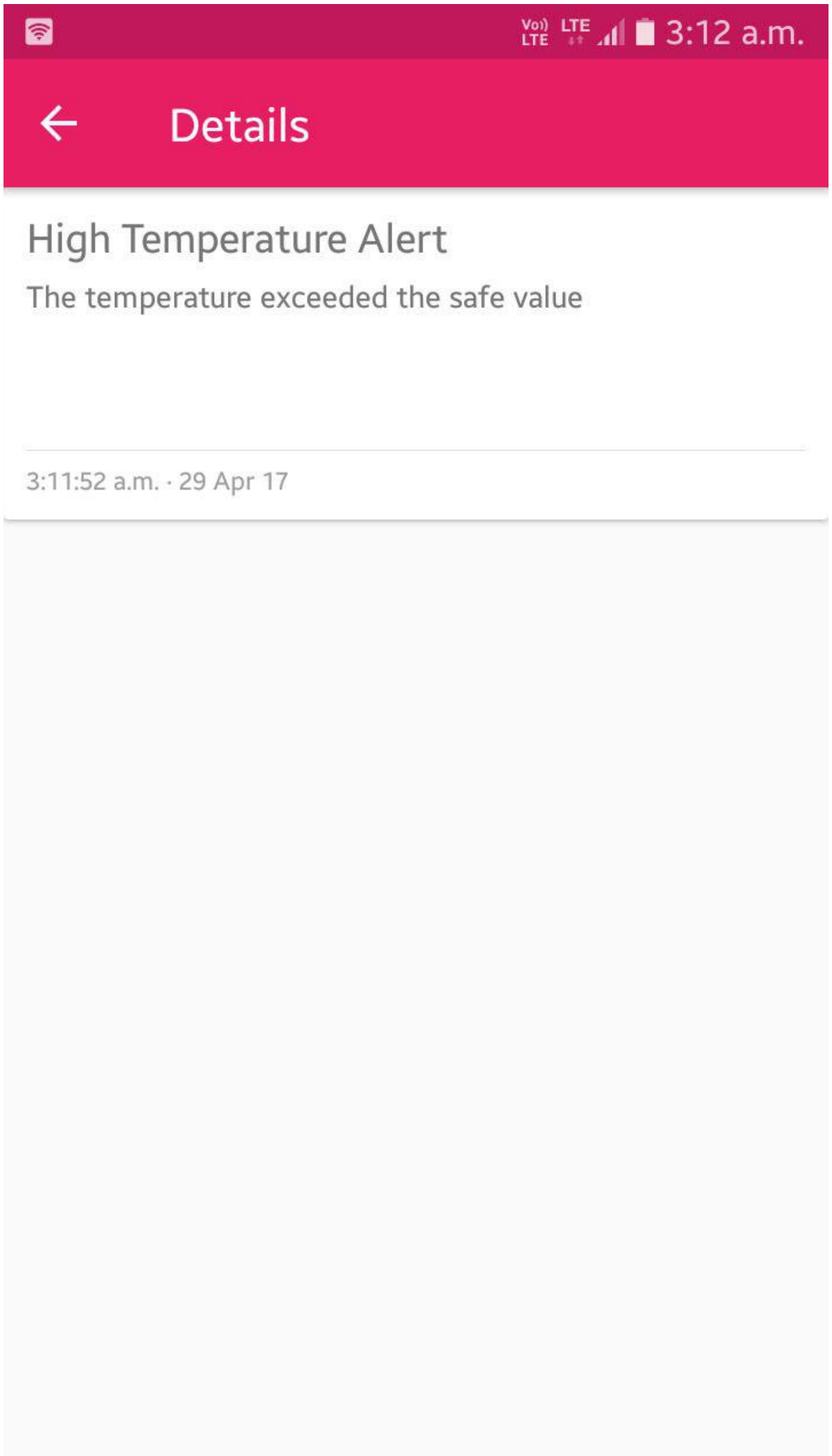


Figure 5: Notification on Android

Figure 6: Notification on Android

Figure 7: Notification on Android

10 Conclusion and future work

Currently, IoT is present and gaining more traction in a lot of fields, and one of the most important field is industrial applications. There are a huge number of ways in which industries can make use of IoT to improve working conditions, efficiency, cutting costs and improving the overall growth of the sector. However, hazard monitoring and mitigation is often overlooked in industrial areas.

Therefore, this project specifically aims to make use of IoT to actively monitor and analyse various factors in a typical heavy industrial zone like temperature and levels of gases in the environment. If the above parameters exceed the recommended safe values, the system can track the same and issue alerts. Also, the data generated in real time can provide important information about how smoothly the work is going on in different zones.

This system can be deployed in many industrial areas like mining, underground factories, metal refineries, automatic welding factories and even heavy parts production lines. It will help to provide a safe and efficient working environment in such areas, while also opening new paths to improve the safety parameters of these places.

11 References

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https://www.parallax.com/sites/default/files

http://www.haoyuelectronics.com/Attachment/MQ-9/MQ9.pdf