Retraction

Retraction: A Smart Helmet for the Mining Industry using LoRaWAN (J. Phys.: Conf. Ser. 1916 012089)

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IOP Publishing regrets that our usual quality checks did not identify these issues before publication, and have since put additional measures in place to try to prevent these issues from reoccurring. IOP Publishing wishes to credit anonymous whistleblowers and the Problematic Paper Screener [1] for bringing some of the above issues to our attention, prompting us to investigate further.

[1] Cabanac G, Labbé C and Magazinov A 2021 arXiv:2107.06751v1
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A Smart Helmet for the Mining Industry using LoRaWAN

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Abstract. Air Quality becomes an important factor in mining areas where the health condition of the workers is prominently considered. The composition of many toxic gases under the mining area causes many fatalities that keep on increasing day by day. The Total Volatile Organic Compounds (TVOC) and Carbon-di-oxide creating a significant role in the health system of the workers. The unstable levels of these TVOC's cause many health issues like nausea, emesis, fatigue, episitis and dyspnoea. Exceeding the standard levels of these toxic compounds in the air causes many problems like severe breathing trouble and headache. In this proposed work, Smart Helmet has been developed for mining workers using LoRaWAN to overcome the above mentioned problems. This device helps to alert user on the air quality. When the air quality changes, the device inform the user, so that they can take necessary actions. The effectiveness and performance of this smart helmet using LoRaWAN can be analyzed with the help of experimental results.

Keywords: Air Quality, Total Volatile Organic Compound, CO2, Toxic Compounds, Health Issues, Smart Helmet, LoRaWAN.

1. Introduction
Air quality management becomes a serious factor in coal and ore mining industry, particularly on emission of harmful gases. This is mainly due to air hazards during constructional work and working in the mining area has hazardous solid and liquid particles like PM10 and PM2.5 and gaseous emissions like Carbon Monoxide, Carbon-di-oxide, Sulphur-di-oxide and Nitrous oxides which are harmful and causes health issues to the people who are working in that area. These harmful gases usually released during shipping, drilling and managing waste from the site or accommodate inside the pit. However, some metals like arsenic, lead and mercury, which are one of the parts of ore causes air pollution which results in serious health issues in downwind area. In both industry and population density areas, the airborne particles are harmfuly affect the health of the people by health issues like affect the respiratory tract, damage the lungs and also causing skin diseases by absorbing the harmful particles into the skin.
Normally, mining industry needs the cumulative air quality management into a single system, that can be integrated with the air quality management plan that really addresses all the procedures and responsibilities of the performance assessment methods. This performance assessment produces the detailed analysis like at what time and under what kind of conditions and at what stage the mine’s lifecycle can operate from their planning. The objective of this proposed model is to provide the mining industry to manage the air quality by doing the assessment and prediction method on this model.

2 Literature Survey
Zigbee technology is implemented for providing safety for the people working in mining industry and also change their way of working system which controls the numerous changes in the mining area environment [1]. For detecting three types of hazardous such as gases, helmet removal and collision or impact [2]. Gas, MEMS and IR sensors are capable of monitoring and reporting the conditions prevailing in the mining area. Is there any hazardous situation, then it detects using the smart helmet and pass the message to control room which was monitored frequently via zigbee transmitter, once message received then control station will immediately alert the people working in that area by zigbee receiver, which rings the alarm [3]. Helmet detect hazardous event, monitor environmental conditions and information will be updating such as GPS location and sensor data to the central for tracking purpose [4]. The parameters will be displaying on the current start on personal computer and if any harmful gases like CO₂ exceed their limit then the corresponding person fall detection & alert to remove the helmet for the mining industry workers [5]. The real time data where the sensors sense the environmental conditions in the mining area is displayed on the Light Emitting Diode, which is also to be updated on the respective website server with the aid of Thing Speak using IoT [6]. It provides reliable communication between mining workers using zigbee module [7]. To recognize unsafe situations in the mining area such as carbon monoxide gas accumulation, removal of helmet and detection of crash [8]. To provide flexible and complete solution for building private LoRa network, design and implementation using hardware and software were done [9].

The aim of this study about the most recent research papers analysis using LoRa technology [10]. The literature survey includes the propagation models performance, energy efficiency, MAC layer and channel access challenges of LoRaWAN [11]. LoRaWAN is compared with other wireless communication devices such as Bluetooth, Wi-fi, zigbee and it has huge scope for implementation in smart city applications [12]. The energy consumption of LoRaWAN end device transmitting data have been modelled [13]. The required power of LoRaWAN in class A and C type devices were investigated which have the high efficiency [14]. LoRaWAN is an open standard development to prevent consumption and moderate the network effectively. This new technology is able to concentrate on network management, optimization of high dense, etc. [15-16].

3 Proposed System
This proposed work is to check the quality of the air in the mining industry using smart helmet. In the underground CO₂ will be trapped, in addition to CO₂, Total Volatile Organic Compound (TVOC) such as H₂, N₂, etc. will be present. The air quality sensor (SGP30) is interfaced with a SAMD21(ARM Cortex M0+) for collecting the data of CO₂ and Total Volatile Organic Compound. The collected data is processed and then it will be transmitted to base station by LoRaWAN module. The base station receives the air quality data along with the employee ID. When the Air Quality worsens, certain steps/measures can be taken by the management figure 1.
3.1. Hardware Components

Air Quality Sensor(SGP 30)

SparkFun SEN-16531 Air quality sensor SGP 30 (Qwiic) provides information on air quality by monitoring volatile organic compounds. This kind of air quality sensors are used to measure the Carbon-di-oxide and VOC’s, but few of them requires 48 hours and a 20 minute as a start up time for the sensor. The SGP30 gas sensor provides resistant to contamination from other gases which will provide low drift and long-time stability of the sensor. The SGP30 gas sensor output measurements of total Volatile Organic Compounds(TVOC) in ppb has been read and Carbon-di-oxide is equivalent in ppm figure 2.

Adafruit LoRa feather

Figure 2. Air Quality Sensor

Figure 3. Adafruit LoRa feather
Adafruit LoRa feather board has inbuilt SAMD21 (ARM M0 controller) with LoRa RFM69 module (transcommunication). This is used for transferring and receiving the data. It is a low power wide area network modulation technique. It is a wireless communication module. It uses license-free sub-gigahertz radio frequency and different countries have certain bands to operate LoRaWAN such as Europe has 868 MHz, Australia & North America has 915 MHz, India has 865 to 867 MHz, Asia has 923 MHz figure 3.

SAMD21

Microchip technology SAMD21 Arm cortex M0+ microcontroller (MCUs) are low power MCUs that range from 32 to 64 pins with upto 256KB flash and 32KB of SRAM. The SAMD21 MCUs have a maximum 48MHz frequency and reaches around 2.46 Coremark/MHz. These type of devices are mainly design for simple and intuitive migration together with identical peripheral modules. Features include hex compatible code, identical linear address map and pin compatible travelling paths between all devices in the product series figure 4.

4. RFM69(LoRa)

The RFM69 radios have a range of approximately 500 meters line of sight with tuned unidirectional antennas. Depending on obstructions, frequency, antenna and power output, will get lower ranges especially not at line of sight. It provides the transmission over long range with less power consumption. MAC layer protocol can be used for this RFM69 LoRa figure 5.

5 Result and Discussion

The Total Volatile Organic Compound (TVOC) and CO2 value are measured in parts per billion (ppb) and parts per million (ppm) respectively. The particular range of ppb and ppm values are taken in corresponding scale for easy monitoring of the workers in the mining area. The below figure indicates the TVOC and CO2 Scale figure 6.
The display of detailed report about the TVOC and CO2 scale along with the employee ID in the mining area are monitored in the base station figure 7 and figure 8.

Figure 6. a) CO2 scale

Figure 6. b) TVOC Scale

Figure 7. Hardware Setup
6 Conclusion
In this proposed work, smart helmet had for mining industry using LoRaWAN had developed, which comprises a quality device that keeps the user alert on his/her air quality. When the air quality changes, the device is capable of informing its user with the appropriate data and by that they can take some preventive measures to avoid those hazards. The obtained results figure out that the proposed system performs good for the people working in mining industry.

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