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Development of Real Time Monitoring System to Detect Dust Pollution in Open cast Mines

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Abstract: Air quality in the mining sector is a serious environmental concern and associated with many health issues. Air quality management in mining regions has been facing many challenges due to lack of understanding of atmospheric factors and physical removal mechanisms. A modeling approach called the Real time monitoring of Dust pollution is developed to predict dust particulate concentration in the mining region. Different sensors detected data were utilized to compute dust generation due to different mining activities at different locations. Work zone air quality, ambient air quality are described revealing high pollution potential due to suspended particulate matter and consequent impact on human health. As we know Opencast mining dominates major portion in India. So for this a continuous air monitoring is required for environmental protection and geological mining it is required for the mineral mining plant to protect its surroundings from the effects of mining operations.

Keywords: Dust pollution, Particulate, ambient

I. INTRODUCTION:

Dust is used to describe fine particles suspended in the air. The size of dust particles vary from few nm to 100µm and the concentration of dust vary from few micrograms to hundreds of micrograms per cubic meter of air. Various factors such as dust lifted by weather, volcanic eruptions, pollutions, mining activity, construction activity etc. contribute to the formation of dust. The formation of dust can be attributed to the fine particles which become entrained in the atmosphere due to turbulent disturbances produced by wind; it is also formed fromechanical disturbances and through release of particulate rich gaseous emissions. Dust includes wide range of particles varying from 1mm to less than 1µm. But the size range normally varies from 1-20µm. because particles above 20µm are usually quick to settle and particles below 1µm don't form in abundance.

Particles greater than 10µm: These particles settle according to the law of gravity. In still air, they settle with increasing velocity. 2. Particles between 0.1µm to 10µm: These particles settle with a constant velocity obeying Stoke's law. The velocity depends upon density and size of particles, acceleration due to gravity and viscosity of the medium. 3. Particles between 0.01µm to 0.1µm: These particles don't settle in air rather remains in colloidal state.

The device system which we are going to make will monitor the presence of Dust pollution in particulate size and temperature of the surrounding area and also shares live data. This can be used for outdoor environments. Although this device detects types of dust pollution which are specialized in certain aspects, the majority focuses on components: particulate matter and temperature.

The sensors which we were used are very expensive in the past, but with technological advancements these sensors are becoming more affordable and more widespread throughout the population. These sensors can help serve many purposes and help bring attention to environmental issues beyond the scope of the human eye.

These sensors can then in turn, help measure the spatiotemporal coverage and variety of chemical

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species, and empower individuals and communities to better understand their exposure environments and risks from dust pollution.

II. OBJECTIVE OF THE PROJECT

To develop real time monitoring system for detection of dust generating from mining operations in opencast mines.

III. LITERATUREREVIEW

"Dust monitoring systems" Mokhloss I. Khadem Valentin Sgarciu(2011) This paper proposes a dust monitoring system which is designed by a distributed network of nodes , which consists of smart sensors that detect dust. Through microcontrollers embedded in each node, each sensor can upload measurements directly to a server within a network. All nodes shall transmit information trough the network to the main server to process and record into a database. based on the configured dust acceptance levels on server, an alarm can be triggered from server and sent back to the corresponding devices through server.

"Prediction of dust dispersion during drilling operation in open cast coal mines: A multi regression model" KV Nagesha, VR Sastry, Ram KR Chanda (2016)

Dust pollution is one of the major concerns in mining operations. The workers and nearby human habitats prone to various respiratory diseases due to dust pollution. Prediction of dust dispersion is required to determine the pollution level of the ambient air and also to implement various control measures to reduce their concentration. Though there are various tools available for dust prediction, mathematical models are commonly used to predict the dust concentration, for its easy use. In the absence of specific mathematical models to predict the dust produced from drilling operations for Indian meteorological and geo-mining conditions, dust dispersion models were developed using multiple regression analysis method. Field investigations were carried out in two large opencast coal mines in India. First mine data was used to develop the models and the second mine data was used for validation of the models. It was found that the predicted dust concentration values of the developed models are more close to the field monitored values compared to the USEPA model predicted values. These models can be used for predicting the dust concentration level of PM10 in atmosphere in coal mines

"IoT based mine safety system using wireless sensor network" ,Roopashree K, Srujana B K, Suma P, Suma G, Chaithanya S, (2017)

In this paper Mine Detection Robot can be substituted or partial substituted for emergency workers to enter the mine shaft disaster site and detect hazardous gas do some environmental exploration and surveying task .Safety measures taken to address this problems is to implement current sensor technologies and IoT based wireless communication system which uses cloud computing for transmission and storage of parameters obtained from wireless module with zigbee interface. Wireless sensor technology used in recently developed mine safety monitoring system is highlighted and compared with traditional wired monitoring system.

"Fine dust monitoring system based on Internet of Things" Wonseokchoi ,Dokyunghwang, Jongpilkim ,Jangmyung lee (2018)

In this paper, The propose to measure and monitor the fine dust (PM2.5) indoor. Also, using the app of the smart phone which is the monitoring device users are not constrained to time and place, IoT (Internet of Things) technology, which is one of the 4th industrial technologies is used to measure indoor and airborne fine dusts. And IoT devices (Fine dust sensors) and microcontroller, which is an embedded system are configured in hardware to precisely measure and collect data on fine dusts, A wireless transceiver device such as Wi-fi was used to transmit the collected fine dust data to the smartphone. In addition, IoT requires low-power, lightweight and accurate message delivery important and a more advanced message protocol is needed. Therefore, the protocols mainly used for IoT are MQTT (Message Queue Telemetry Transport) and CoAP (Constrained

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Application Protocol). The data transmission methods of these two protocols are TCP (Transmission Control Protocol) and UDP (User Datagram Protocol), The MQTT protocol which is superior in reliability was applied to the monitoring technology in this study.

" Development of a Dust Measurement System" ,T. Ewetumo, A. O. Oke, and J. C. Ehiabhili (October 2018)

Dust particle are particulate matter that can become suspended in the atmosphere and deposited. Dust is present in the atmosphere has significant effect climate, health of human, and strong influence on the solar energy during dry season. The dust monitoring device developed consists of sharp dust sensor module that has capacity of measuring particle size about PM2.5 and above, microcontroller (arduino mega 2560), micro secure data (MicroSD) shield card, with intelligent liquid crystal display unit (LCD) and all are link together to form the complete unit. The dust measuring system compare with available dust device has the correlation of 0.999980 and maximum value of 0.541 mg/m3. Also the sensitivity, resolution and error are 5V/0.1 mg/m3, 0.001 mg/m3and ±0.005% respectively, at 67% relative humidity and temperature of 32oC. The total power consumption of the dust monitoring system is 1.06 W**.**

"A data-driven approach to control fugitive dust in mine operations" Muhammet Mustafa Kahraman, Mustafa Erkayaoglu (2021)

Particulate matter (PM) is one of the main actors related to air pollution caused by surface mining. Fugitive dust, considered as particulate matter that cannot be collected by conventional measures, is classified by the particle size. The Environmental Protection Agency (EPA) categorizes PM as coarse and fine particles based on the particle size being less than 10 μm (PM 10) and less than 2.5 μm (PM 2.5). Basic operations of surface mining such as drilling and blasting, loading, haulage, and processing are processes that can potentially generate fugitive dust. Regulations and legislations enforce the mining industry to use environmental monitoring systems, fugitive dust level measured by PM 10 level as part of this. Air quality monitors are positioned at different locations around surface coal mines and track air quality levels during production.

IV. IMPLEMENTATION

The method adopted to make this device is by using different forms of sensors to detect particulate size .

- Along with sensors we use **Arduino Microcontroller board**, power supply by **lithium ion batteries** of 1200MAH , analog and digital ports to function the device.
- The arduino microcontroller chip that is responsible for all function of our proposed project.
- It functions as the brain of this system. It controls the hardware and the interface with the transmitter part.
- The particulate size of dust is detected by the **LED Particle Sensor PM1006K** ,it adopts the principle of optical sensing method to detect the variation trend of particle (size between 0.3μm~10μm) concentration in the air. An infrared light emitting diode and an optoelectronic sensor are optically arranged inside. And the sensor can directly output particle mass concentration (μg/m³) with built-in MCU.
- Series of codes written in software BLYNK SERVER as logic requires i.e., when particulate size of dust is detected by the LED Particle Sensor PM1006K , the device will display data continuously on BLYNK app .

All the components are assembled in the form like arduino microcontroller, Dust sensor, temperature sensor, Battery connected to voltage regulator, LCD Display, Transceiver

- Each node is installed with a dust sensor , temperature sensor and a zigbee transceiver.
- The data from these sensors is transmitted to the centralized system via zigbee protocol.
- Each node is powered by two lithium ion batteries to give a backup of 10 to 12 hours on every charge.

Such 'n' number of nodes can be connected to a single central system with each node having an unique ID

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- The centralized system receives the information from the node via zigbee protocol and displays it along with their ID's on to an LCD screen.
- Some data is also sent to internet using wifi to be accessed on to a mobile phone from any location.
- If any abnormal condition arrives the buzzer gives an alert and the problem is displayed on the LCD.
- The system since is on the surface is powered by AC 220 V.
- Hence the device which we are going to make is portable, this device is capable to detect particulate size from 2 to 3 different locations at a time ,by making a 2to 3 nodes which are connected to main microcontroller, data transformed through zigbee or wifi protocol.

Arduino

Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board.

Arduino UNO

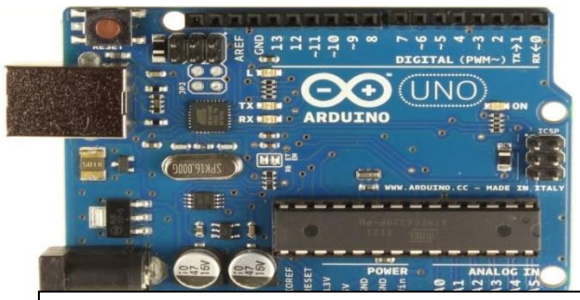
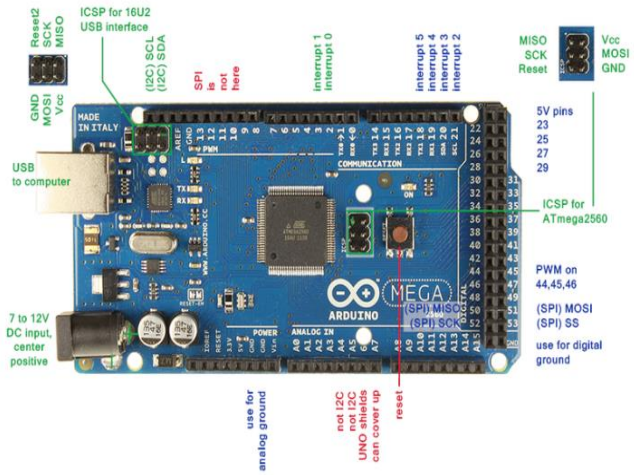


Fig: shows Arduino UNO Microcontroller

The Arduino Uno is a AVR microcontroller board based on the ATmega328 . It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Arduino Mega



The Arduino Mega is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila.

The Mega 2560 R3 also adds SDA and SCL pins next to the AREF. In addition, there are two new pins placed near the RESET pin. One is the IOREF that allow the shields to adapt to the voltage provided from the board. The other is a not connected and is reserved for future purposes. The Mega 2560 R3 works with all existing shields but can adapt to new shields which use these additional pins

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DS18B20 – Temperature sensor

The DS18B20 digital thermometer provides 9-bit to 12-bit Celsius temperature measurements and has an alarm function with nonvolatile user-programmable upper and lower trigger points. The DS18B20 communicates over a 1-Wire bus that by definition requires only one data line (and ground) for communication with a center microprocessor. In addition, the DS18B20 can derive power directly from the data line eliminating the need for an external power supply. Each DS18B20 has a unique 64-bitserialcode,which allows multiple DS18B20s to function on the same 1-Wire bus. Thus, it is simple to use one microprocessor to control many DS18B20s distributed over a large area.

LCD

Description: A Liquid Crystal Display (LCD) is a low cost, low-power device capable of displaying text and images. LCDs are extremely common in embedded systems, since such systems often do not have video monitors like those that come standard with desktop systems. It can be found in numerous common devices like watches, fax and copy, machines and calculators.

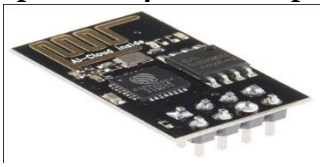
LCD Initialization

The LCD must be initialized before displaying any characters on LCD, the initialization
Procedure for LCD driver is:
1. Function set - set 8-bit long data interface
2. Display on - set display on, cursor on, and blink on.
3. Entry mode set - set entry mode to increment the cursor after a character is displayed.
4. Display Clear - clear the LCD display.

LED Particle Sensor PM1006K

PM1006K adopts the principle of optical sensing method to detect the variation trend of particle (size between 0.3μm~10μm) concentration in the air. An infrared light emitting diode and an optoelectronic sensor are optically arranged inside. And the sensor can directly output particle mass concentration (μg/m³) with built-in MCU.

Esp8266 Wifi Microchip



The **ESP8266** is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability produced by Shanghai-based Chinese manufacturer, **Espressif Systems**. The chip first came to the attention of western makers in August 2014 with the **ESP-01** module, made by a third-party manufacturer, Ai-Thinker. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections.

Buzzer

The above figure shows a buzzer. A buzzer or a beeper is an audio signalling device, which may be mechanical, electro-mechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke.

BLYNK

Blynk is designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data, visualize it and do many other cool things. There are three major components in the platform:

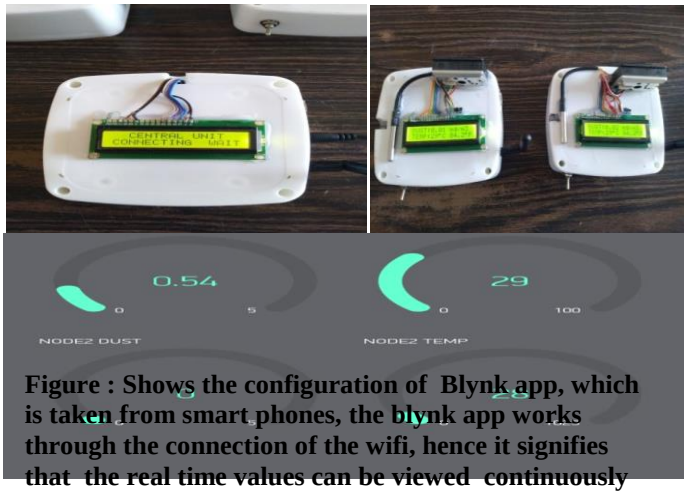


Figure : Shows the configuration of Blynk app, which is taken from smart phones, the blynk app works through the connection of the wifi, hence it signifies that the real time values can be viewed continuously through smart phones whenever at any point

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- **Blynk App** - allows to you create amazing interfaces for your projects using various widgets we provide.
- **Blynk Server** - responsible for all the communications between the smartphone and hardware. You can use our Blynk Cloud or run your private Blynk server locally. It's open-source, could easily handle thousands of devices and can even be launched on a Raspberry Pi.
- **Blynk Libraries** - for all the popular hardware platforms - enable communication with the server and process all the incoming and outcoming commands.

Now imagine: every time you press a Button in the Blynk app, the message travels to the Blynk Cloud, where it magically finds its way to your hardware. It works the same in the opposite direction and everything happens in a blynk of an eye.

V. RESULTS

The device was able to detect the value of the dust particulates at the real time effectively, which was able to display on LCD screen continuously on both nodes and central system. It was also able to display the data on real time continuously in BLYNK app through our android phones effectively.

VI. CONCLUSION

A device which is used for REAL TIME MONITORING of dust particles in opencast mines and displays continuous values in LCD in graphical or analytical format, This device displays the values continuously to the required locations . The buzzer gets actuated when the values of the dust exceeds the threshold limit. So that the dust can be suppressed by water spraying or any other measures can be taken. This device is portable in nature as it can be used at various locations through nodes in opencast mines at a specified distance from the central system.

By using a this sensor network we can monitor and measure the dust in any environment: Mining or industrial. The area coverage of a dust monitoring network can be expanded depending on the needs, without any adverse impact to the overall network cost. Each dust sensing device can focus on a specific area and by managed as a single entity or in turn it can be used as only one point of presence in an area, contributing to the overall accuracy of the measurement.

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