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Smart Mining Helmet Using Zigbee

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ABSTRACT: A smart helmet has been developed which includes various features such as the two way communication, detection of the hazardous gases, providing notification in the case of helmet removal, collision (miners are struck by an object), panic switch for emergency situations, continuous monitoring of the environmental conditions. Panic switch is provided for the safety of the miners and it is used to provide alert signal to the control room during any emergency situations. The information are sent to the control room through wireless network. The programming and troubleshooting were conducted on mainly two sections, Transmitter section and control room section.The main reason for death of miners is that, due to any reason miners falls down and loses consciousness also proper treatment is not provided them at that time. To overcome this problem the system provide emergency alert to the supervisor if person fall down by any reason. Some workers are not aware for safety and they are not wear helmet. A Limit switch was then used to successfully determine whether a miner has removed his helmet or not. The system uses Zigbee technology for transmission of data from underground mine to base station. There is alert switch at mines and base station for emergency purpose.

Keywords: Zihgbee, helmet

I.INTRODUCTION

Mining is the extraction of valuable minerals or other geological materials from the Earth, usually from an ore body, lode, vein, seam, reef, or placer deposit. Exploitation of these deposits for raw material is based on the economic viability of investing in the equipment, labour, and energy required to extract, refine and transport the materials found at the **mine** to manufacturers who can use material. Assuring miners safety in case of mining accidents that occurs due to increase in temperature, pressure, force. To help the coal miners inside the mines to communicate with the outside world. To monitor the conditions inside the mines and also to intimate the miners in case of emergency .Here in this Smart Mining Helmet we use different valuable sensors and softwares for the protection and monitoring of the miners whose work is not a bed of roses. We use IOT here for the monitoring and examining the miners in the tunnel via a webpage. We use Zigbee in this model , which is a wireless technology developed as an open global standard to address the unique needs of low-cost, low-power, wireless sensor networks. The system includes various sensors such as the temperature, pressure, force, IR sensor and gas sensor. Temperature and pressure sensor is used to monitor the surrounding environment.It is used in reduced the loss of death in mining area and increase the safety system for the workers. The mining industry presents unique challenges in the field of worker safety. Mine safety is achieved through the identification and minimization of hazards that include environmental and equipment-based factors. Today, miners rely on a combination of safety practices and equipment to improve caution, provide warning, and ensure protection from harm.

Safety is an essential component of any healthy workplace. Mines in particular are hazardous environments with a greater potential for large-scale environmental damage and loss of life than for many other workspaces, thus making mine safety an ever-present concern. As mines increase in size and depth and mining companies become larger operations that include more workers, safety becomes a new challenge that has been met by the development of specialized practices and equipment designed specifically to provide miners with the warning and protection they need to prevent or minimize accidents.Safer mines are created through a combination of safety rules and regulations, as well as technological equipment that reduces both hazards and risks. Mineral extraction and transport via automation and conveyor has reduced the incidence of worker injuries, while GPS location and proximity warning technology have lowered the rate of transport accidents. Personal safety equipment has increased in both efficacy and transportability, allowing miners to carry with them the protective gear needed at all times. Advancements in communication have improved worker and supervisor awareness to track movements and issue updates quickly to prevent accidents through miscommunication or misinformation. Regular audits provided by the Mine Safety and Health Administration ensure that mines are following federal safety regulations properly at all times.

Global mining areas and their density. Mining areas were mapped using a 50-cell radius around 62,381 pre-operational, operational, and closed mining properties. Mining areas with properties targeting materials critical for renewable energy technology and infrastructure are shown in blue, areas with properties targeting other materials are shown in

orange, and those targeting both commodity types are shown in pink. Color shading (light to dark) indicates the density of mining areas-i.e. the number of mining properties within a 50-cell radius of each 1 km cell.
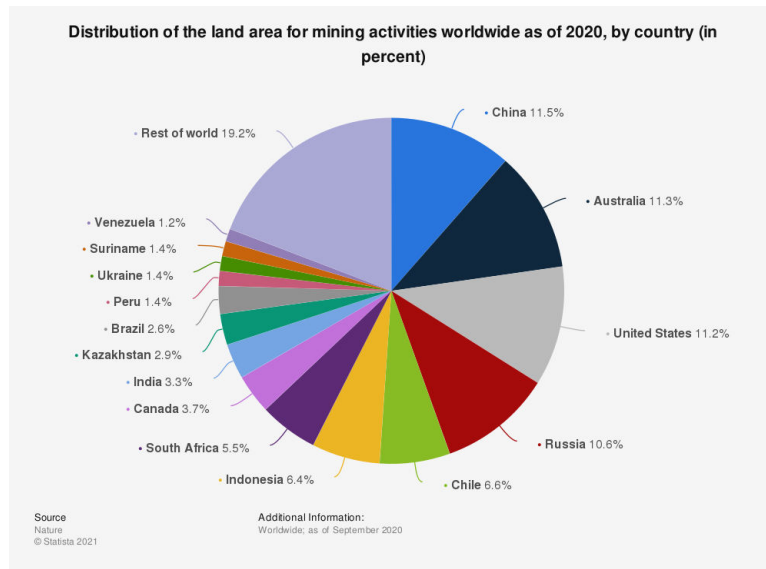

Fig 1. Distribution of Land areas for mining, by Country

2. System Architecture:

In this proposed method, Arduino UNO microcontroller is used to interface with the sensors and to the communication devices. The LCD is used to update the latest information in the LCD. Gas sensor used to detect toxic level in that working place. Temperature sensor is used to measure surrounding level of the temperature. The force sensor is used to detect workers are wearied helmet or not.Accelerometer is used to detect whether the workers face any accidents. The ZigBee system provides data communication to the end device. IOT is used to shows the updates in webpage. Buzzer is used to alert to the control system.
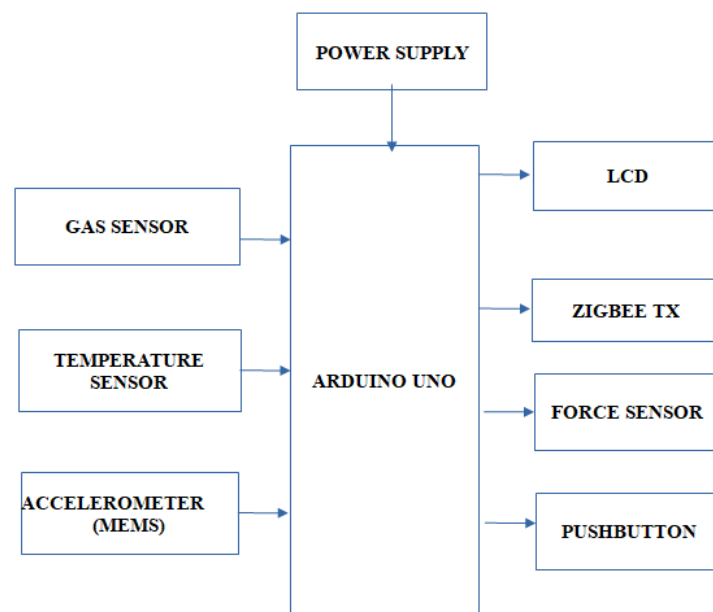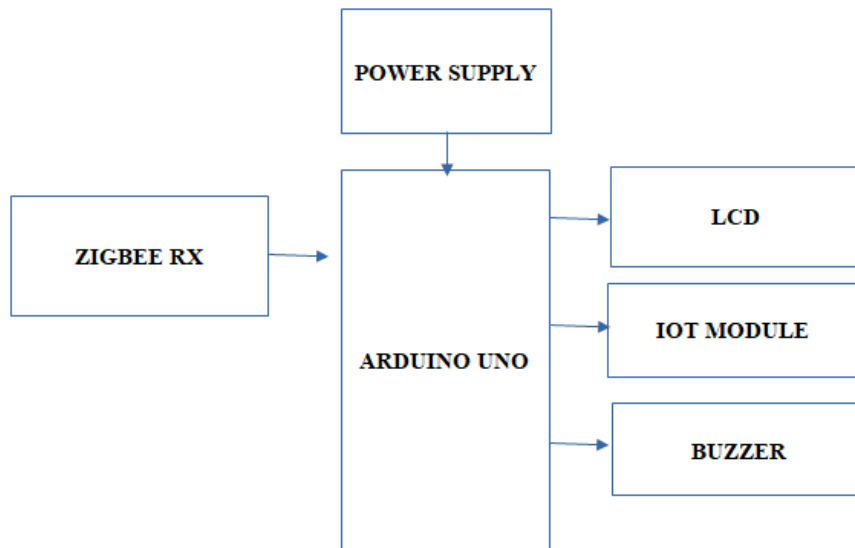
Block Diagram:

Fig 2. Transmitter Section of Proposed system

Fig 3. Receiver Section of Proposed System

3. Hardware Description:
ZigBee:
ZigBee Transmitter:
Zigbee digital transmitter in 2.4GHZ band is designed using Verilog for acknowledgement frame (or) architecture. There are two types of layers. (i) Physical layer and (ii) Medium Access Control (MAC) layer. Physical layer supports 3 frequency bands are 2.45 GHZ band with 16 channels, 915 MHZ band with 10 channels, 868 MHZ band with 1 channel. In these Zigbee transmitter we are using 2.4 GHZ band because it is a world wide band. In these scheme, we focus on 2.4 GHZ band application which has 16 channels with spacing of 5 MHZ and data rate is 250 Kbps. MAC layer defines two types of nodes they are Reduced Function Devices (RFDs) and Full Function Devices (FFDs).RFDs can only act as end device and are equipped with sensors or actuators like transducers, light, switches and lamps. They may only interact with a single FFDs. FFDs are equipped with a full set of MAC layer functions, which enables them to act as a network coordinator or a network end-device The beacon frame is used by a coordinator to transmit beacons. The function of beacons is to synchronize the clock of all the devices within the same network. The data frame is used to transmit data. Meanwhile, the acknowledgment frame is used to confirm successful frame reception. The MAC commands are transmitted using a MAC command frame.

Zigbee technology works with digital radios by allowing different devices to converse through one another. The devices used in this network are a router, coordinator as well as end devices. The main function of these devices is to deliver the instructions and messages from the coordinator to the single end devices such as a light bulb. In this network, the coordinator is the most essential device which is placed at the origin of the system. For each network, there is simply one coordinator, used to perform different tasks. They choose a suitable channel to scan a channel as well as to find the most appropriate one through the minimum of interference, allocate an exclusive ID as well as an address to every device within the network so that messages otherwise instructions can be transferred in the network. Routers are arranged among the coordinator as well as end devices which are accountable for messages routing among the various nodes. Routers get messages from the coordinator and stored them until their end devices are in a situation to get them. These can also permit other end devices as well as routers to connect the network. In this network, the small information can be controlled by end devices by communicating with the parent node like a router or the coordinator based on the Zigbee network type. End devices don't converse directly through each other. First, all traffic can be routed toward the parent node like the router, which holds this data until the device's receiving end is in a situation to get it through being aware. End devices are used to request any messages that are waiting from the parent.

Force Sensor:
Force Sensing Resistors (FSR) are a polymer thick film (PTF) device which exhibits a decrease in resistance with an increase in the force applied to the active surface. Its force sensitivity is optimized for use in human touch control of

electronic devices. FSRs are not a load cell or strain gauge, though they have similar properties. FSRs are not suitable for precision measurements.

Accelerometer:
The ADXL335 is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs. It can measure the static acceleration of gravity in tilt sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration. The user selects the bandwidth of the accelerometer using the \CX, CY, and CZ capacitors at the XOUT, YOUT, and ZOUT pins. Bandwidths can be selected to suit the application, with a range of 0.5 Hz to 1600 Hz for X and Y axes, and a range of 0.5 Hz to 550 Hz for the Z axis.

Temperature Sensor:
The LM35 series are precision integrated-circuit temperature devices with an output voltage linearly proportional to the Centigrade temperature. The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. The LM35 device does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full −55°C to 150°C temperature range.

Gas Sensor:
MQ2 is one of the commonly used gas sensors in MQ sensor series. It is a Metal Oxide Semiconductor (MOS) type Gas Sensor also known as Chemi-resistors as the detection is based upon change of resistance of the sensing material when the Gas comes in contact with the material. Using a simple voltage divider network, concentrations of gas can be detected.

LCD:
LCD screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters, animations and so on.

Buzzer:
A **buzzer** or **beeper** isan audio signaling device, which may be mechanical,electromechanical, or piezoelectric (piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke.

4. Software Requirements:
Arduino IDE:

The Arduino IDE is incredibly minimalistic, yet it provides a near-complete environment for most Arduino-based projects. The top menu bar has the standard options, including "File" (new, load save, etc.), "Edit" (font, copy, paste, etc.), "Sketch" (for compiling and programming), "Tools" (useful options for testing projects), and "Help". The middle section of the IDE is a simple text editor that where you can enter the program code. The bottom section of the IDE is dedicated to an output window that is used to see the status of the compilation, how much memory has been used, any errors that were found in the program, and various other useful messages.

Power Supply:
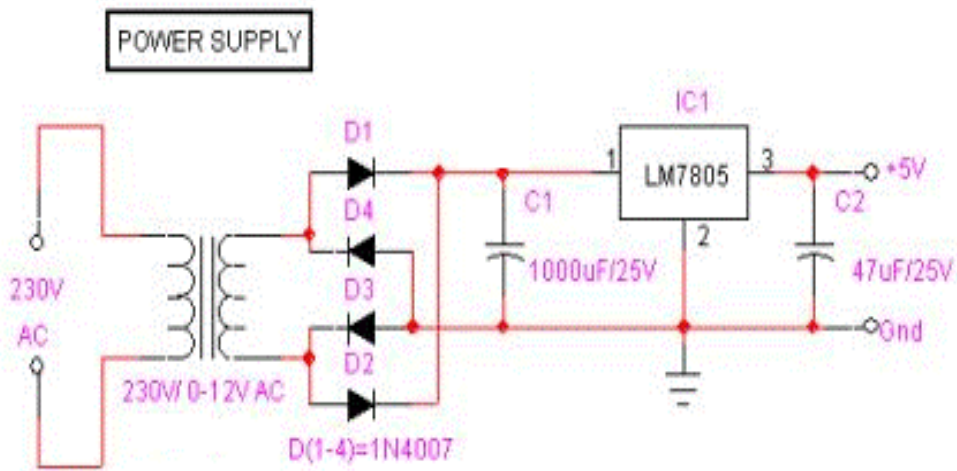This section describes how to generate +5V DC power supply

Fig 4. Power Supply Circuit

The power supply section is the important one. It should deliver constant output regulated the project. A 0-12V/1 mA transformer is used for power supply for successful working of this purpose. The primary of this transformer is connectedin to main supply through on/off switch& fuse for protecting from overload and short circuit protection. The secondary is connected to the diodes to convert 12V AC to 12V DC voltage. And filtered by the capacitors, which is further regulated to +5v, by using IC 7805.
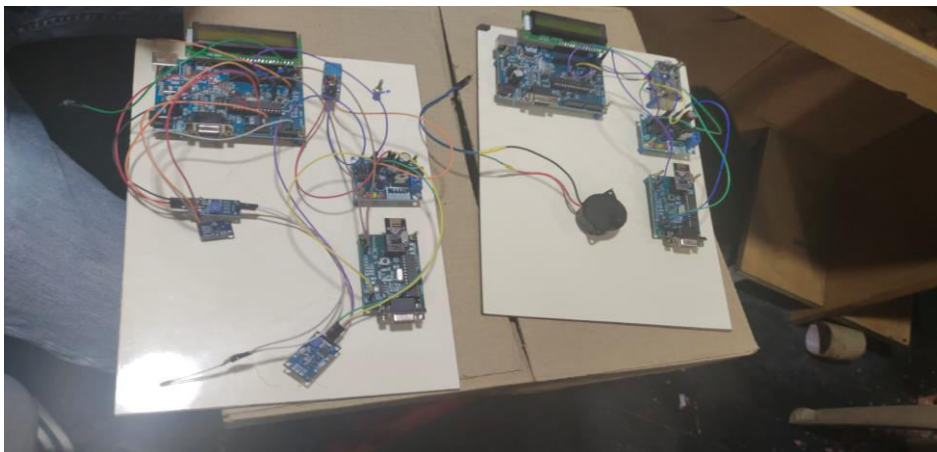
V. RESULTS

Fig 5. Real Circuit of the Smart Mining Helmet

Fig 6. Webpage showing Gas Concentration around the miner

Fig 7. Webpage showing Temperature around the miner

VI.CONCLUSION

In this work, we proposed a system which helps the miners from accident, toxic gases and from extreme temperature. This project also ensures the miners whether they are wearing the helmet or not. This Project gurantees safety of the miners and monitors them from the outside camp via zigbee connected by the IoT. Thus this Helmet gives the all-in-one setup for the miners to help them from any disastrous that happen around in the mines. As mining deaths are increasing Worldwide this prototype project may be useful in helping the miners.

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