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A SMART HELMET FOR IMPROVING SAFETY IN MINING INDUSTRY

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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 such as temperature and pressure in the mining industry and GPS is provided to track the location of the miner. Once the poisonous gas is detected the helmet opening gets closed and the oxygen supply is provided within the helmet for the miners by the opening of solenoid valve of the oxygen cylinder. 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 .Temperature and Pressure sensors are used for the continuous monitoring of environmental conditions .The information are sent to the control room through wireless network. The layout of the visualization was completed and displayed in the control room with the help of a Lab VIEW software .This paper presents the undertaken design detailing solutions to issues raised in previous research.**

Keywords-*mining, environmental condition, collision, hazardous gases.*

I. INTRODUCTION

Mining is a multifaceted industry which includes complicated operations carried within the tunnels, underground etc. This involves various risk factors which affects the health of miners. The Chasnala mining disaster that took place near Dhanbad in the Indian state of Jharkhand almost killed 372 miners. This was considered as one of the worst disasters in the mining industry. Miners may not be aware of the external conditions such as rise or fall of temperature, pressure etc. Sometimes Miners collide with the heavy objects like mining objects, hard rock which risks their life. Another factor that affects the miners is the inhalation of hazardous gases that provokes them in danger. In this situation miners are not able to communicate with the outside world. In this case, the smart helmet system becomes an essential and helpful measure to protect the miners from various accidents. This project aims at designing a smart helmet for hazardous event detection, monitoring the surrounding environmental conditions and updating information like GPS location and sensor data to the central console for easy tracking and providing oxygen supplements to avoid the inhalation of poisonous gases. This secures the life of miners in mining industries.

From the Survey, various information are gathered One death every third day in India's most dangerous job is Mining. According to the International Labour Organization (ILO), while mining employs around 1% of the global labour force, it generates 8% of the fatal accidents China has the largest mining industry producing up to three billion tons of coal each year. Though China accounts for 40% global coal output, it is responsible for 80% of mining deaths around the world each year. This survey clearly shows that the requirement for safety measure must be extended to save the life of miners. This survey motivated us for initializing this project.

II. SYSTEM OVERVIEW

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. Whenever the miners collide with the heavy objects Force sensor is used. An IR sensor intimates central console whenever the miner remove their helmet off their head. Gas sensor is used to detect the presence of poisonous gases in the atmosphere. GPS is used to track the position of miners in case of any abnormalities. Panic switch is manually operated by the miner to seek help from the central console in highly emergency conditions. Oxygen supplement is provided within the helmet to avoid the inhalation of poisonous gases by the opening of solenoid valve. These informations are sent to the central console through wireless transmission in critical situations.

III. EXISISTING SYSTEM

In the existing system mining helmet ensures to protect the miners head from several injuries. Being aware of the environmental condition becomes a challenging part of the existing system. Since the helmet is too heavy, uncomfortable to work with the miners tend to remove the helmet off their head. In case of its removal miners are prone to unsafe conditions.There is no existing smart helmet that can study the environment and make decisions to sustain worker protection. Oxygen supply is not provided for the miners in case of poisonous gas leakage. Establishing a hurdle free communication environment is the biggest challenge the mining organizations face.

IV. REASONS FOR PROPOSAL

- Assuring miners safety in case of mining accidents that occurs due to increase in temperature, pressure, force.

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- To help the coal miners inside the mines to communicate with the outside world.
- To monitor the conditions inside the mines and intimate the miners in case of emergency.
- GPS is used to track the position of miners.
- Detection of the poisonous gases.
- Alerting the miners whenever the helmet is removed.

V. PROPOSED SYSTEM

We have implemented an ultimate protective helmet that comes with many sensors for various detection and analysis. Firstly, the hazardous gases are detected using gas sensors. Whenever the poisonous gas is detected the solenoid valve gets opened for providing oxygen supplements. The second hazardous event was classified as a miner removing the mining helmet off their head. An IR sensor was developed successfully to determine when the helmet is off the miner's head. The third hazardous event is defined as an event where miners are struck by an object against the head with a force exceeding a certain level by using force sensor which is used for detection. The unpredicted hazardous conditions such as temperature and pressure are sent to the control station via wireless transmitters for continuous monitoring.GPS is also provided for easy tracking of miner's position. Panic switch is manually operated by the miner to seek help from the central console in highly emergency conditions.

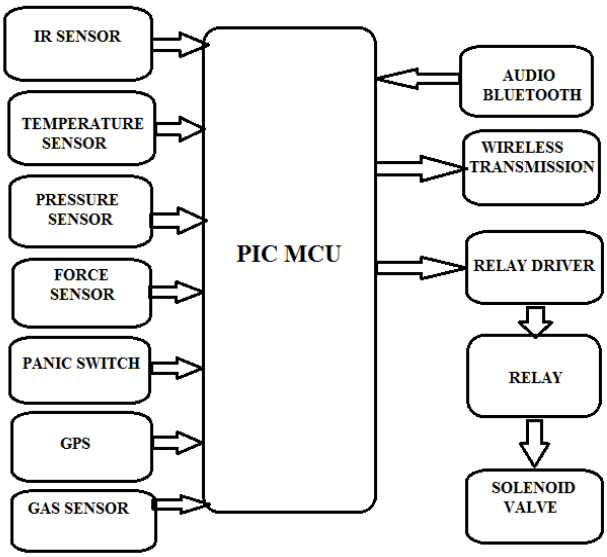

Fig:1 block diagram of transmitter section.

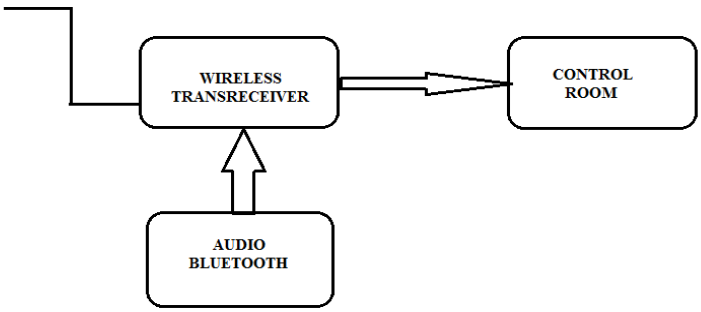

Fig:2 block diagram of receiver section.

VI. WORKING

A. Transmitter Section

STEP1**:** Data corresponding to the sensor modules are collected.

STEP2: Data obtained using the sensor modules are present in the analog form.
STEP3: It is sent to the PIC16F8778 for further processing.
STEP4: The values are then digitalized using the ADC present in the PIC which is programmed using the MP Lab software.
STEP5: PIC also contains a UART which relays these values to the wireless transceiver.

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STEP6: Now, the data is sent across the wireless transceiver to the central console.

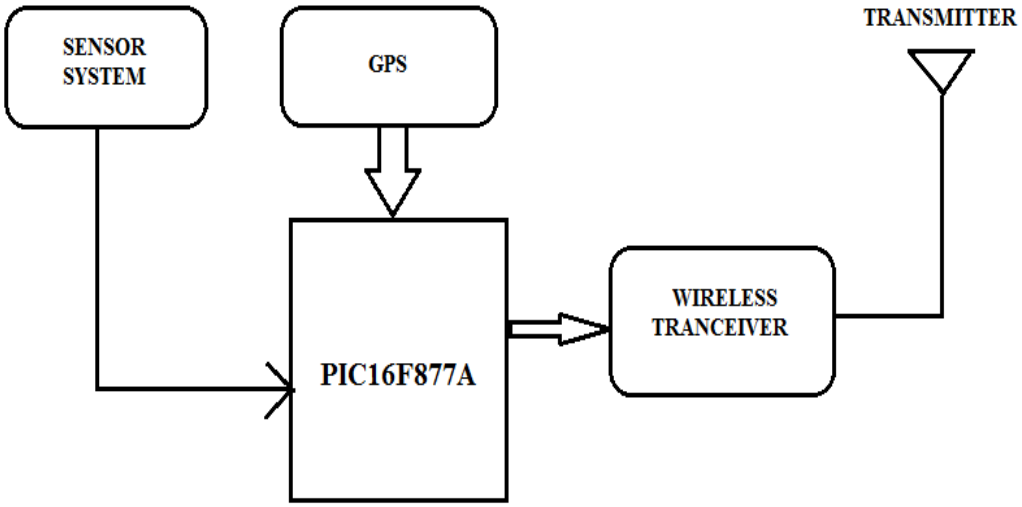

fig:3 functional block diagram of transmitter section

STEP2: Data is displayed on the control room's screen.
STEP3: The abnormalities are identified and alert signal is provided.
STEP4: Accordingly, help is provided for the miners.
STEP5: In case of emergency the system tracks the position of miners using GPS

B. Receiver Section

STEP1**:** The wireless transceiver at the receiver end captures the transmitted data.

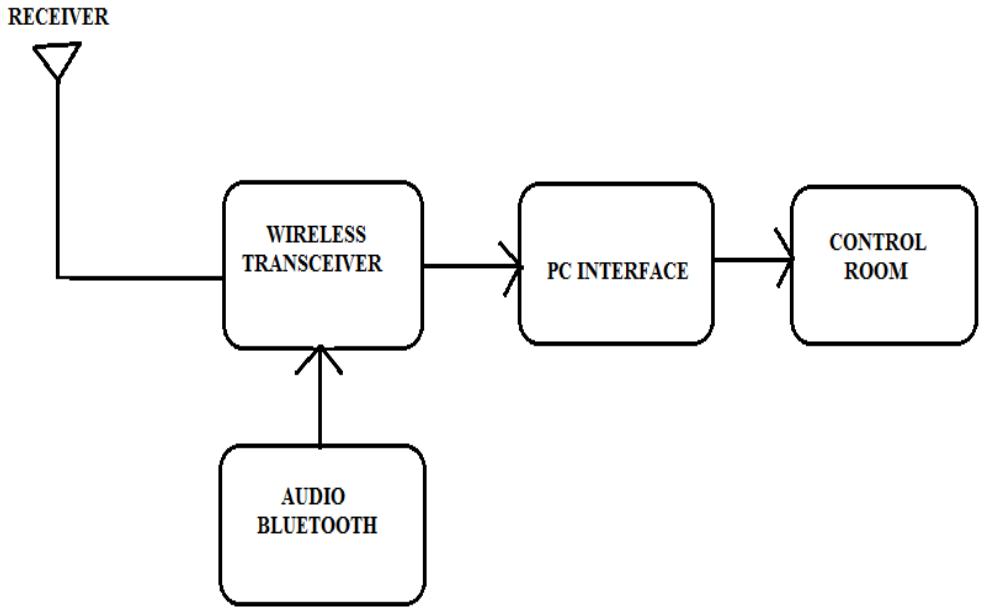

fig:4 functional block diagram of receiver section

VII. PROCESS FLOW DIAGRAM

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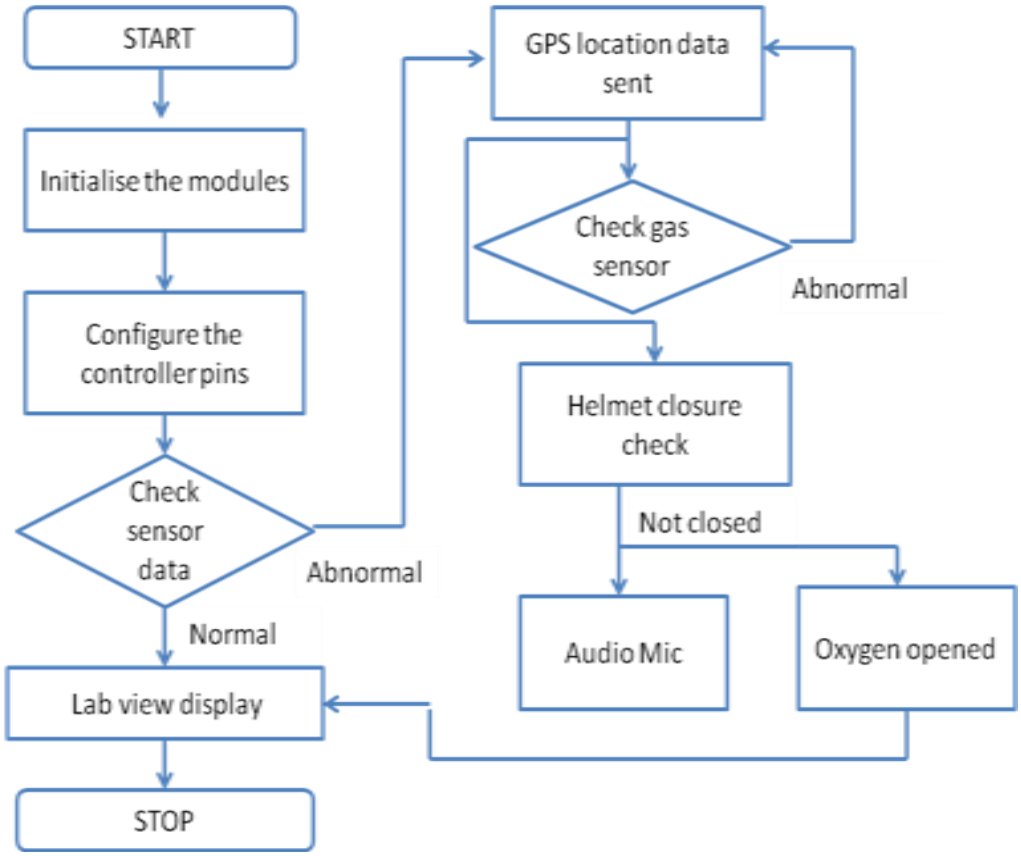

fig:5 flow chart

VIII. HARDWARE DESCRIPTION

A.PIC16F877A Microcontroller

PIC16F877A microcontroller uses Harvard architecture. It features all the components which modern microcontroller normally has. For its low price, wide range of application, high quality and easy availability, it is an ideal solution in application such as: the control device, measurement of different values etc. It has 40 pins and its Operating speed is DC -20MHz clock input, DC-200 ns instruction cycle. The Operating voltage is 5v.

fig:6 PIC16F877A microcontroller

B. LM35 Temperature Sensor

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ˚ Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4˚C at room temperature and ±3⁄4˚Cover a full −55 to +150˚C temperature range.

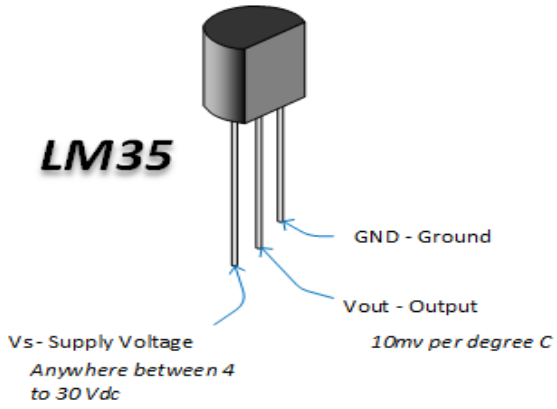

fig:7 LM35 Temperature sensor

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C. Pressure Sensor

Electronic pressure sensor usually measures the change in pressure through the deformation of a diaphragm. Pressure is an expression of the force required to stop a gas or fluid from expanding, and is usually stated in terms of force per unit area. A pressure sensor generates a signal related to the pressure imposed.

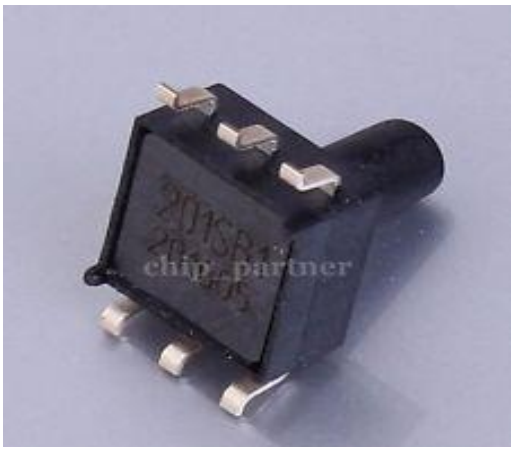

fig:8 pressure sensor

D. Force Sensor

Interlink Electronics FSRTM 400 series is part of the single zone Force Sensing Resistor TM family. Force Sensing Resistors, or FSRs, are robust polymer thick film (PTF) devices that exhibit a decrease in resistance with increase in force applied to the surface of the sensor. This force sensitivity is optimized for use in human touch control of electronic devices such as automotive electronics, medical systems, and in industrial and robotics applications.

fig: 9 Force sensor.

E. Gas Sensor

A gas sensor is a device that detects the presence of gases in an area, often as part of a safety system. This type of equipment is used to detect a gas leak or other emissions and can interface with a control system so a process can be automatically shut down. Gas sensor is a subclass of chemical sensors. Gas sensor measures the concentration of gas in its vicinity. Gas sensor interacts with a gas to measure its concentration.

fig :10 Gas sensor

F.IR Sensor

An infrared sensor circuit is one of the basic and popular sensor modules in an electronic device. This sensor is analogous to human's visionary senses, which can be used to detect obstacles and it is one of the common applications in real time An IR sensor can measure the heat of an object as well as detects the motion. Usually in the infrared spectrum, all the objects radiate some form of thermal radiations.

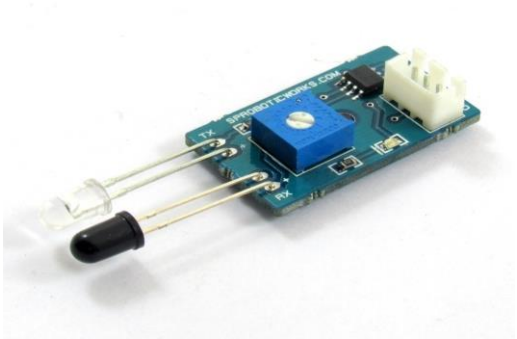

fig:11 IR sensor

G. Solenoid Valve

The term "solenoid" does not refer to the valve itself, but to the operator and coil mounted on the movable valve, also known as "pilot" or "magnetic actuator". The coil consists of capillary copper wire wound on a support reel. When electric current is fed into the coil, magnetic flow lines are generated, which are strongest in the centre of the coil. This magnetic flow raises the moveable plunger in the coil until it brings it into contact with the pole piece.

fig:12 solenoid valve

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IX. SOFTWARE IMPLEMENTATION

A. Embedded C Programming

Embedded c is a set of language extension for the C Programming language by the C Standards committee to address commonality issues that exist between C extensions for different embedded systems. Historically embedded C programming requires nonstandard extensions to the C language in order to support exotic features such as fixed-point arithmetic, multiple distinct memory banks, and basic I/O operations.

B. Labview Software

Lab VIEW is an integrated development environment design specifically for engineers and scientist. Native to lab VIEW is a graphical programming language that uses a data flow model instead of sequential lines of text code, empowering us to write functional code using visual layout that resembles our thought process.

X. EXPIREMENTAL RESULTS

The proposed system is thus developed successfully as shown in the fig:14 and it helps in alerting the central console in case of critical conditions. GPS helps to track the miners location during abnormalities in the sensor information.

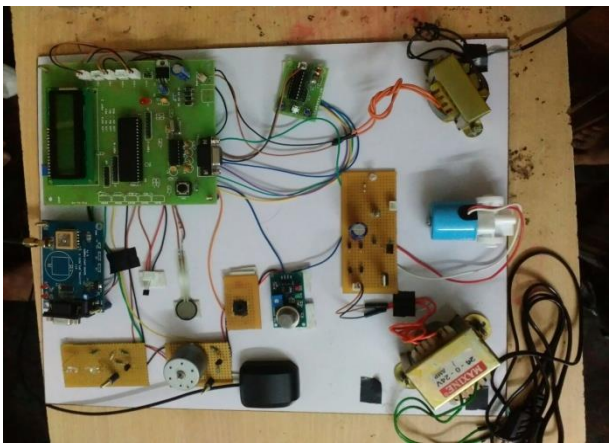

fig:13 Transmitter section

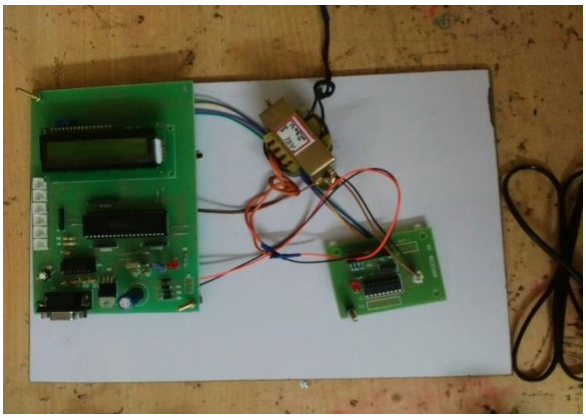

fig:14 Receiver section

The helmet unit which collects the temperature, pressure, force and hazardous gas data has been designed to alert the control room in case of abnormal condition. The voice transmission system has been implemented to have direct contact with miners in case of emergency situations. The visualization is made by using lab view software at the central console. The information's are carried to the central console through wireless transmission.

fig:15 initial condition

fig:16 pressure abnormalities

fig17: force abnormalities

XI. CONCLUSION AND FUTURE SCOPE

Thus a smart helmet for hazardous event detection, monitoring the surrounding environmental conditions and updating information like GPS location and sensor data to the central console for easy tracking and providing oxygen supplements to avoid the inhalation of poisonous gases is designed. The system can also be further developed with the implementation of Internet Of Things (IOT).The database can be created that monitors the sensor modules continuously.

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