JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Real Time Risk Assessment for Mountain Climbers Using IoT & Smart App Technology

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Abstract: Mountain climbing is an adventurous yet high-risk activity that requires continuous monitoring of environmental conditions. This project, Real-time Risk Assessment for Mountain Climbers Using IoT and Smart App Technology, aims to enhance climber safety by integrating Internet of Things (IoT) sensors with a smart application. The system utilizes sensors to track real-time data such as temperature, Humidity and Hazard Gases (Co2 & CH4). This data is transmitted to an app, and also the system will give the buzzer sound to other climbers who are having near by the RF communication, The smart app provides climbers with instant alerts, and guidance to mitigate risks. Additionally, the system allows remote monitoring by rescue teams, ensuring timely intervention in case of emergencies through the Blynk IoT Application. By leveraging IoT and, this project significantly improves climbers' safety, making mountaineering a more secure and data-driven experience.

Index Terms **- Arduino Uno, Tx-Rx Module, NodeMCU, Blink IoT, MQ-135 Sensor, MQ-4 Sensor**

I. INTRODUCTION

Mountain climbing is one of the most adventurous and physically demanding activities, attracting enthusiasts worldwide who seek the thrill of conquering great heights. However, it is also one of the riskiest outdoor activities, often exposing climbers to extreme weather conditions, avalanches, altitude sickness, equipment failures, and unexpected injuries. These hazards can result in life-threatening situations if not detected and managed in real time. Therefore, it is crucial to have a reliable risk assessment system that can continuously monitor the climbers' health conditions and environmental factors, providing timely alerts and safety recommendations.

With rapid advancements in Internet of Things (IoT) and smart app technologies, it is now possible to develop an intelligent risk assessment system that offers real-time monitoring, data analysis, and emergency response solutions for climbers. This project aims to create a real-time risk assessment system for mountain climbers using IoT and smart app technology to ensure their safety and minimize risks.

Despite improvements in climbing equipment and navigation technology, mountaineering accidents and fatalities continue to occur due to unpredictable environmental conditions and climbers' physical limitations.

II. LITERATURE SURVEY

IoT-Based Risk Assessment in Adventure Sports

- **D. J. Cook & S. K. Das (2020)** explored IoT-based smart environments and their applications in remote monitoring. Their study emphasized how wearable sensors and IoT networks can be used to detect real-time environmental hazards and health risks, making them highly suitable for mountain climbing applications.
- **G. Fortino et al. (2018)** discussed the integration of wireless body sensor networks (WBSN) with IoT, which can help in continuous health monitoring of individuals engaged in extreme activities.
- **S. Patel et al. (2019)** highlighted the role of smart textiles and flexible sensors in monitoring heart rate, oxygen saturation (SpO2), and body temperature, which are crucial parameters for climbers.

Wearable Health Monitoring Systems for Climbers

- **L. Wang et al. (2021)** reviewed the accuracy and efficiency of wearable health monitoring devices, particularly focusing on their role in extreme environments such as high-altitude mountaineering. The study found that optical heart rate sensors and SpO2 monitoring were effective in assessing oxygen deficiency and cardiovascular strain.

- **Y. Zhu et al. (2020)** presented a machine learning-based health risk prediction model that processes real-time data from wearable IoT sensors to predict potential medical emergencies during extreme sports.
- **P. Chatterjee et al. (2019)** explored smart wristbands and biosensors for detecting early signs of hypothermia, dehydration, and muscle fatigue in high-altitude environments. Their research highlighted the importance of continuous monitoring for injury prevention.

Smart App Integration for Real-Time Monitoring and Emergency Response:

- **B. Kumar et al. (2021)** designed a mobile application that integrates GPS tracking, health monitoring, and weather forecasting to provide real-time risk assessment for climbers.
- **S. Gupta et al. (2020)** developed an IoT-connected emergency response system that allows automatic SOS messaging and live location tracking in case of medical emergencies.
- **N. Rodriguez et al. (2022)** examined the usability of wearable-device-connected smart apps in adventure sports, emphasizing that intuitive user interfaces and real-time push notifications significantly enhance climbers' safety.

III. EXISTING METHOLOGY

The existing proposal very few have been implemented and tested in the real world, identifying the existence of gap between theory and real-world application at scientifically accepted level.

IV. DISADVANTAGES OFEXISTING METHOLOGY

There are some disadvantages of Zigbee which are given below,

- It is so highly risky to be used for official private information.
- The Zigbee has low transmission rate.
- Replacement with Zigbee compliant appliances can be costly.

V. PROPOSED METHODOLOGY

In recent days Mountain Climbing has been a very dangerous activity that can result in a number of adverse effects on the environment for example during climbing methane, carbon dioxide gases are more on the top of the Mountains.

Here, we propose a safety system for Mountain Climbers using microcontroller-based circuit for the climbers. The system makes use of AT mega microcontroller-based RF based circuitry to receive the data transmitted from the Climbers. In order to achieve safety measures, the proposed system provides a wireless sensor network for monitoring real time situation of working environment from monitoring station. It provides real time monitoring of harmful gases like NH3, NOx, alcohol, Benzene, smoke, CO2, CH4 and also temperature and humidity. Thus, the system ensures mountain climbing safety using IOT.

The improved safety features in our system significantly enhance the safety and survival rate of mountain climbers by providing real-time alerts about potential hazards. Our system is designed to continuously monitor both physiological and environmental conditions, ensuring climbers are well-informed and prepared for risks such as altitude extreme weather conditions, and instability.

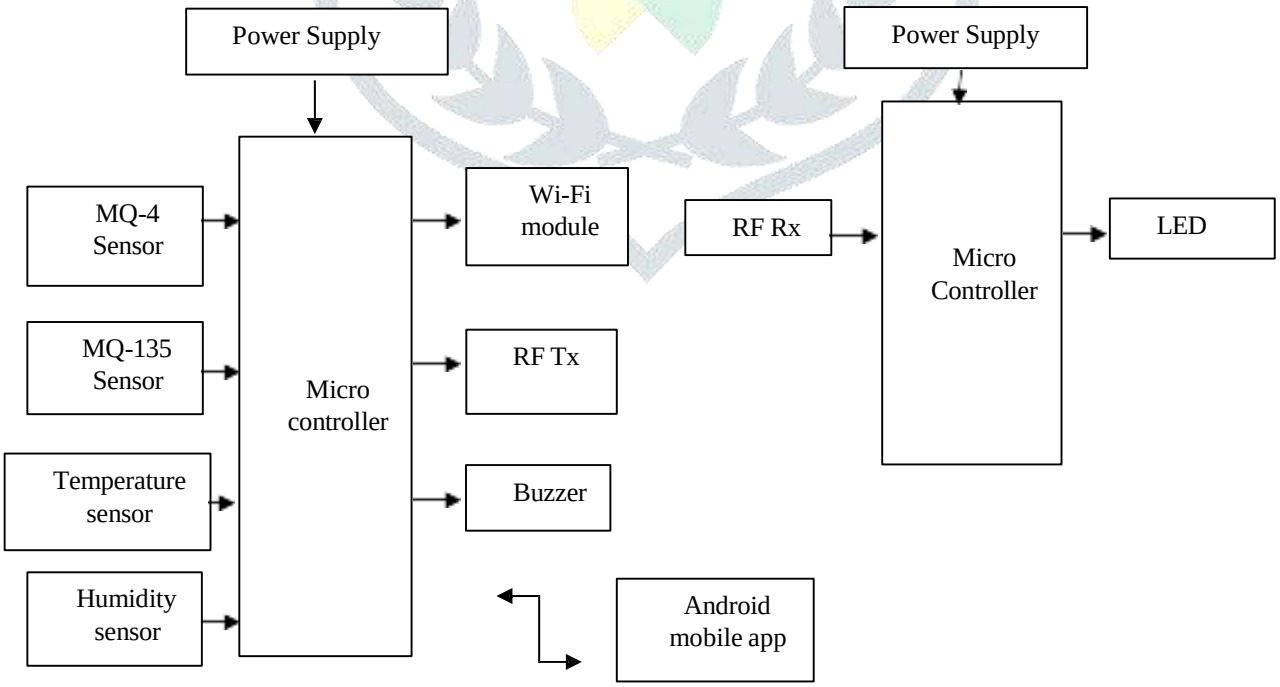

Fig 1.1: Block diagram of the Proposed System

Implementation Method:

In order to explain the proposed system, there are six units. Air quality sensor, which is used to detect air pollution from coal mines. It is mainly due to emissions of particulate matter and gases include carbon monoxide (CO), Carbon dioxide (CO2). MQ-4 Sensor is used to detect the methane gas. Data processing unit is the Arduino Uno microcontroller, which is used to get all the data from the above all sensors and concludes whether need any intimation to wireless unit or the user carrying it. Wireless transmission and alerting unit are used to transfer the data obtained from the processing unit.

Wireless transmission is achieved through NodeMCU module with cloud IOT technology through this the information regarding the gas levels are uploaded in to a server and the server store the data, the stored data is displayed in a server login channel through this we can see previous recorded gases level and can decide work place is safe or not and to take different protection methods will be made easy. Alerting unit is used to give the alarm sound to the climber using buzzer when any harmful gas is detected.

VI. RESULTS AND DISCUSSION

Here the Master Device has the sensors of MQ-135 and MQ-4, those can be detecting the Hazard gases such as Methan and Carbon Dioxide then it transmits the message to the Slave Device which can be shown in Fig 2. Abd also the master device can send the information of the parameter values such as temperature and Humidity and gases values to the Blynk IoT app.

Fig:1 Master Device

Fig 2: Slave Device

Fig 3: Blynk IoT app

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