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Vita Track: A Wearable Device For Continuous Health Monitoring And Early Warning System

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Abstract:
Vita Track is a wearable health monitoring device designed to enhance worker safety in high-risk environments. It continuously tracks heart rate (BPM), oxygen saturation (SpO2), and body temperature, providing real-time alerts to detect early signs of health risks such as fatigue, dehydration, and respiratory distress.
The system integrates GPS tracking and Wi-Fi connectivity for remote monitoring, allowing supervisors to track worker health and location in real time. An OLED display provides instant feedback, while a rechargeable battery system ensures continuous operation, even in remote areas. By offering proactive health insights, early intervention, and enhanced workplace safety, Vita Track serves as a reliable, life-saving solution for industries like construction, law enforcement, and firefighting

Key Word: *Wearable Health Monitoring, Real-Time Tracking, Biomedical Sensors, GPS Tracking, Remote Monitoring.*

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I. Introduction

Workers in high-risk jobs, such as construction, law enforcement, and firefighting, often face health risks like fatigue, dehydration, and breathing problems due to tough working conditions. Traditional health monitoring depends on manual supervision and self-reporting, which can cause delays in emergency response. To solve this issue, Vita Track is designed as a wearable health device that continuously tracks heart rate (BPM), oxygen levels (SpO2), and body temperature, providing real-time alerts to detect health risks early. The system includes sensors, GPS tracking, and Wi-Fi connectivity, allowing remote monitoring of worker health and location. An OLED display gives instant feedback, while cloud-based data sharing helps supervisors respond quickly in emergencies. A rechargeable battery powers the device, making it useful in areas without electricity. By offering real-time health tracking and early warnings, Vita Track helps improve workplace safety and quick emergency response, protecting workers in dangerous environments.

II. Literature Review

Title: IoT-Based Health Monitoring System for Workers' Safety
Authors: M. Rahman, T. Ahmed, R. S. Kumar, and L. Zhang
Publication: IEEE Sensors Journal, 2018

Description:

This study explores the application of wearable IoT devices for real-time health monitoring in high-risk workplaces. The researchers developed a system that integrates biomedical sensors to track heart rate, body temperature, and oxygen levels, transmitting data to a centralized platform for continuous monitoring. The study highlights that early detection of fatigue and stress through IoT technology can help reduce workplace accidents and improve worker well-being. The research concludes that IoT-based health monitoring is a cost-effective and efficient method for ensuring worker safety in hazardous environments.

Title: GPS and Geofencing for Worker Safety in Construction
Authors: M. Barua, S. Hossain, and D. Lee
Publication: IEEE Transactions on Industrial Informatics, 2019

Description:

This study investigates the use of GPS tracking and geofencing to enhance worker safety in large construction sites where supervision is difficult. The proposed system equips workers with GPS-enabled wearable devices that provide real-time location tracking. Geofencing technology is used to set safe zones, triggering alerts if a worker enters a restricted or hazardous area. The findings indicate that geofencing improves emergency response times and prevents unauthorized access to dangerous locations. The study concludes that integrating GPS tracking into worker safety protocols significantly reduces the risk of workplace accidents.

III. Proposed System

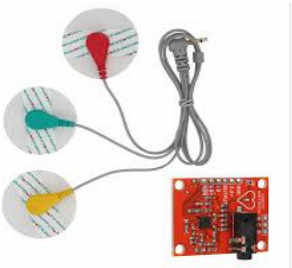
1.ESP32 Microcontroller

The ESP32 microcontroller serves as the central processing unit in Vita Track, collecting data from sensors (MAX30100, DS18B20, and NEO-6M GPS) and transmitting it via WiFi to a web-based dashboard. It enables real-time data processing, wireless communication, and low-power operation, ensuring continuous health monitoring. Additionally, it supports sensor integration, remote monitoring, and real-time alert generation for worker safety.

2.MAX30100 Sensor

The MAX30100 sensor is a key component in Vita Track, responsible for measuring heart rate (BPM) and blood oxygen saturation (SpO2) using photoplethysmography (PPG)**.** It emits infrared and red light to detect blood flow variations, allowing real-time health monitoring. This sensor helps identify early signs of fatigue, respiratory distress, or cardiovascular strain**,** ensuring proactive worker safety management.

3.AD8232 ECG sensor



The AD8232 captures heart signals from electrodes and amplifies them. It sends an analog ECG signal to the ESP32 for processing. The ESP32 transmits this data via WiFi to the web dashboard. Users can monitor real-time heart activity in Vita Track.

4.DS18B20 sensor

The DS18B20 sensor is integrated into Vita Track to track body temperature with precision, ensuring continuous health monitoring. It uses a 1-Wire communication protocol, which simplifies data transfer while maintaining low power consumption. This sensor plays a crucial role in detecting heat-related stress, abnormal temperature variations, and potential health risks,

5.GPS module

GPS module in Vita Track enables real-time location tracking to ensure worker safety in hazardous environments. It continuously records latitude and longitude coordinates, allowing supervisors to monitor worker movements remotely. Additionally, it supports geofencing alerts, notifying authorities if a worker enters a restricted or dangerous area, improving emergency response and accident prevention.

6.OLED Display

The OLED display in Vita Track provides real-time health feedback by showing heart rate (BPM), SpO2, and body temperature directly on the wearable device. Its high contrast and low power consumption ensure clear visibility in various lighting conditions. This feature allows workers to monitor their health instantly, enabling timely action to prevent potential health risks.

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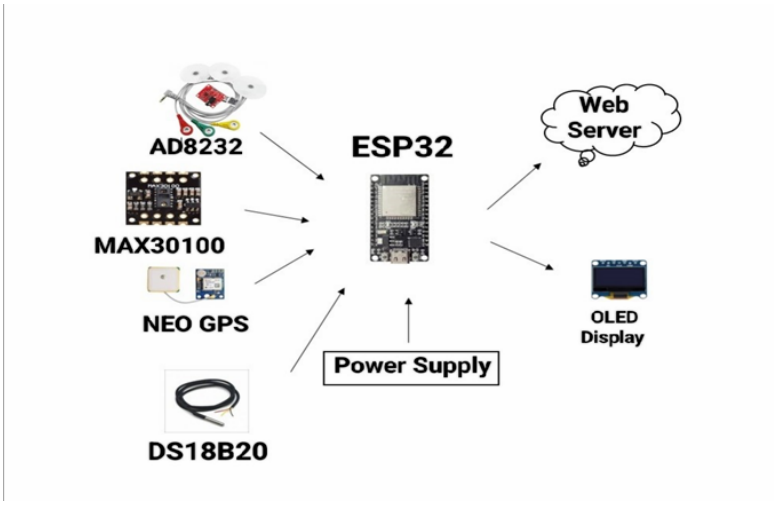
IV. System Block Diagram



V. Methodology

The Vita Track health monitoring system is designed to provide real-time tracking of vital health parameters and worker location using IoT-based sensors and wireless communication. The system follows a structured workflow, including data collection, processing, transmission, and analysis to ensure continuous health monitoring and early warning alerts.

The first step involves data acquisition using biomedical sensors. The MAX30100 sensor continuously measures heart rate (BPM) and blood oxygen saturation (SpO2), while the DS18B20 temperature sensor tracks body temperature. These readings help in detecting conditions such as fatigue, respiratory distress, or heat-related stress. Meanwhile, the NEO-6M GPS module provides real-time location tracking, ensuring that workers remain within designated safe zones. The GPS module also enables geofencing, triggering alerts if a worker moves into a restricted or hazardous area.

The collected data is processed by the ESP32 microcontroller, which serves as the central unit of the system. The ESP32 efficiently handles multiple sensors inputs, processes the readings, and transmits the data via Wi-Fi to a web-based dashboard. The OLED display on the wearable device provides immediate feedback, allowing workers to check their vitals instantly.

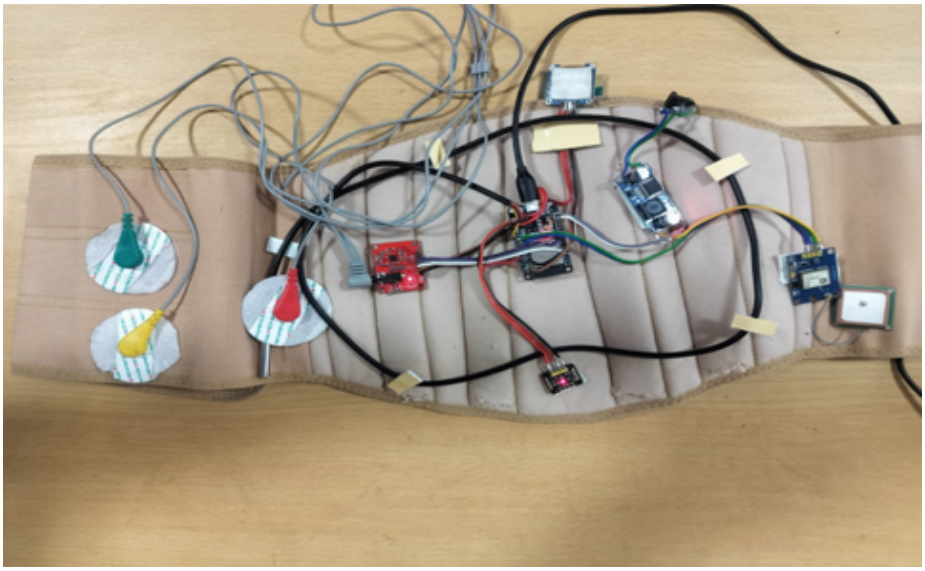
A web-based monitoring dashboard is used for remote supervision, enabling supervisors to track multiple workers simultaneously. The dashboard displays real-time health metrics and location data, ensuring proactive decision-making. In case of abnormal health readings, real-time alerts are triggered, notifying both the worker and the supervisor. These alerts ensure that necessary interventions can be made promptly, preventing health complications or accidents.

Future improvements of the system will integrate AI-based predictive analytics, allowing for pattern recognition in health trends. By analyzing historical and real-time data, AI models can predict potential health risks before they become critical. Additionally, advanced connectivity options such as 5G can be incorporated to enhance real-time data transmission, improving system efficiency and reliability. The integration of energy-efficient technologies, such as solar or kinetic energy harvesting, can further enhance battery life, making the system more sustainable for long-term use.

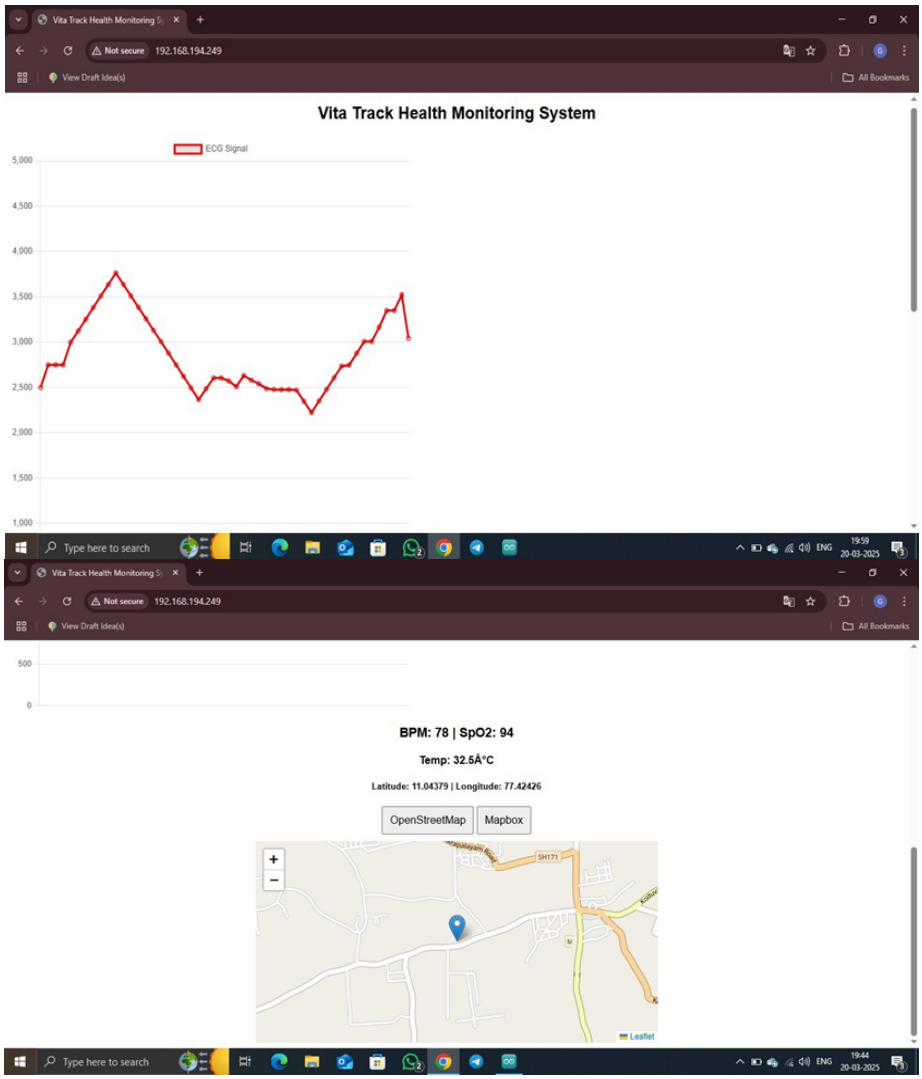
By combining IoT, real-time data processing, and AI-driven insights, Vita Track offers a comprehensive health and safety monitoring solution, reducing workplace health risks and improving emergency response times.

VI. Result

The automatic machine significantly reduced the manual labor, which made farming more efficient. The variable parameters enabled effective adjustment to changing working conditions. The wireless monitoring enabled working from a distance, reducing the need for manual adjustment as well as enhancing the ease of use



(i)Prototype



(ii)Web server

VII. Discussion

The Vita Track wearable health monitoring system enhances occupational safety by providing real-time tracking of worker health and location in hazardous environments. Traditional health monitoring methods rely on manual checkups, which often fail to detect early signs of fatigue, heat stress, or respiratory issues. Vita Track addresses these gaps with real-time alerts, data visualization, and predictive analytics, ensuring proactive intervention.

A key strength of the system is its high-precision sensors, including the MAX30100 for heart rate and SpO2 monitoring and the DS18B20 for body temperature tracking. These sensors provide continuous health data, accessible via a Wi-Fi-enabled web dashboard. The NEO-6M GPS module ensures real-time location tracking and geofencing to prevent exposure to hazardous areas. The OLED display further enhances usability by providing instant health feedback to workers. The ESP32 microcontroller efficiently handles sensor data processing and wireless transmission, ensuring seamless cloud connectivity. Future enhancements could integrate AI-based predictive analytics to detect health risks before escalation. Instant alerts improve emergency response, allowing supervisors to take immediate action.

Despite its advantages, the system has some limitations. Continuous sensor operation and Wi-Fi transmission increase power consumption, requiring optimization for extended battery life. GPS tracking may face disruptions in enclosed spaces. Future improvements may include low-power modes, energy harvesting, and AI-driven insights to enhance efficiency and reliability.

VIII. Conclusion

The Vita Track health monitoring system enhances worker safety by providing real-time tracking of vital signs and location in hazardous environments. Its integration of biomedical sensors, GPS, and WiFi connectivity ensures continuous monitoring and proactive health management. Instant alerts and remote supervision help prevent medical emergencies and workplace accidents. Future advancements in AI, energy efficiency, and predictive analytics will further improve its reliability and effectiveness.

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