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

DESIGN AND DEVELOPMENT OF SAFETY CIVIL BELT USING IoT

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Abstract**—** The Safety Civil Belt, utilizing Arduino and IoT technology, integrates SpO2, altitude, temperature, and pressure sensors, alongside GPS and an SOS button for distress signaling. Coordinated by an Arduino microcontroller, it enables predefined emergency responses and real-time GSM transmission of sensor data as SMS alerts. This holistic approach ensures continuous health and environmental monitoring for enhanced personal safety in various civil contexts. Future enhancements may include cloud integration for expanded functionality and scalability, making it a significant advancement in wearable safety devices with potential for widespread adoption and innovation.

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I. INTRODUCTION

The IoT-enabled safety civil belt signifies a substantial stride in safeguarding workers in perilous environments. This innovative belt integrates advanced features for real-time monitoring of the wearer's health and safety status, offering a proactive approach to accident prevention and emergency management. Its key components include an SPO2 sensor for blood oxygen monitoring, a BMP-280 sensor for altitude and pressure measurement, and a GPS-6mv2 sensor for precise location tracking. By amalgamating these sensors, the belt continuously monitors vital signs and environmental conditions, enabling early hazard and timely intervention. Integration of a GSM 800C module ensures seamless communication, facilitating alerts to supervisors or emergency services during crises, thereby enhancing response efficiency. The Arduino acts as the control hub, managing belt functions and processing sensor data for actionable insights. Auxiliary tools like a buzzer and SOS push button empower wearers to seek immediate help intuitively in hazardous scenarios, fortifying safety features. Overall, this IoT-enabled belt exemplifies a leap forward in workplace safety, leveraging advanced technology to shield workers and bolster emergency response in high-risk settings, demonstrating a commitment to worker well-being.

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II. OBJECTIVES

- Design and implement a Safety Civil Belt leveraging IoT technology, particularly Arduino, to enhance monitoring and emergency communication capabilities.
- Integrate sensors for SpO2, altitude, temperature, and pressure, alongside GPS functionality and an SOS button, ensuring comprehensive wearer safety.
- Enable real-time data collection and transmission via GSM for swift response to emergencies.

- Demonstrate the continuous monitoring of wearer health and environmental conditions to enhance personal safety across various civil applications.
- Provide a comprehensive solution for personal safety by combining sensor data collection and GPS functionality for precise location tracking.

III. LITERATURE SURVEY

The literature surrounding safety harnesses and wearable safety technology is rich and diverse, reflecting the multifaceted nature of ensuring worker safety in various industries. Wu et al.[1] introduced a cutting-edge deep learning framework tailored for detecting safety harnesses in high-altitude operations, offering a promising avenue for automating safety monitoring in challenging environments. Complementing this, Baszczyński[2] delved into the nuanced effects of full-body harness design on fall arrest performance, underscoring the importance of ergonomic considerations in harness development. Advancements in real-time monitoring have been explored by Fang et al.[3], who investigated the use of advanced technologies like YOLOv5 and OpenPose for detecting safety harnesses in real-time, paving the way for enhanced safety protocols in industrial settings. Meanwhile, Nadhim et al.[4] provided a critical review of falls from height in the construction industry, emphasizing the pivotal role of safety measures such as harnesses in mitigating workplace accidents. Turner et al.[5] contributed valuable insights into suspension tolerance in full-body safety harnesses, informing improvements in harness design to enhance wearer comfort and safety. Additionally, Gibbons and Hecke[6] proposed a participatory approach to ergonomic risk reduction, highlighting the importance of involving workers in safety protocol development. The integration of GPS and GSM technologies for safety applications was explored by Hlaing[7] and Win et al. [8], demonstrating the potential of these technologies in tracking and communication for emergency response. Furthermore, Gunawan et al.[9] and Fua and Liu [10] focused on sensor-based health monitoring, showcasing the utility of sensors like MAX30102 in wearable devices for monitoring vital signs.

In summary, these studies collectively contribute to advancing the understanding of safety harnesses, wearable safety technology, and sensor-based monitoring systems. Their findings provide a solid foundation for further research and development aimed at enhancing worker safety across various industries.

IV. METHODOLOGY

The IoT-enabled safety civil belt revolutionizes worker safety in hazardous environments by integrating advanced features like an SPO2 sensor for blood oxygen monitoring, BMP-280 for altitude and pressure tracking, and GPS-6mv2 for precise location. Complemented by the GSM 800C module, it ensures seamless communication for alerting supervisors or emergency services, enhancing situational awareness and response efficiency. Coordinated by an Arduino control center,it manages functionalities effectively Auxiliary tools like a buzzer and SOS push button provide immediate assistance, emphasizing the belt's pivotal role in workplace safety. Through this fusion of technology and design, it sets a precedent for future advancements in mitigating risks and safeguarding worker well-being.

A. Block Diagram

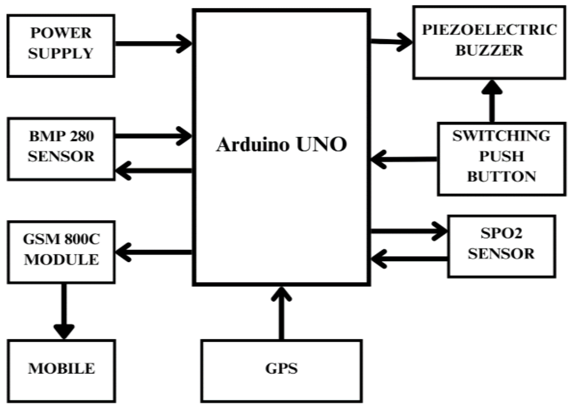

Figure 1: Block Diagram

The IoT-enabled safety civil belt is a groundbreaking advancement in ensuring worker safety in hazardous environments. It integrates an extensive array of cutting-edge features meticulously crafted to enhance monitoring and response capabilities. At its core, the belt incorporates state-of-the-art sensors, including an SPO2 sensor for real-time blood oxygen level monitoring, a BMP-280 sensor to track altitude and environmental pressure, and a GPS-6mv2 sensor ensuring precise location tracking. These sensors synergistically converge to continuously assess the wearer's health and safety, enabling swift detection and response to potential accidents. Augmenting its functionality, the inclusion of the GSM 800C module facilitates seamless communication, empowering the belt to transmit vital messages and notifications to supervisors or emergency services. This bolsters overall situational awareness and response efficiency, ensuring swift assistance in critical situations. Orchestrating these capabilities is the Arduino control center, which seamlessly integrates and manages the belt's functionalities. It ensures optimal performance and reliability in the face of dynamic workplace challenges, providing a robust backbone for the safety system. Furthermore, auxiliary tools such as a buzzer and an SOS push button serve as invaluable lifelines for wearers, enabling them to summon assistance promptly and intuitively during emergencies. This underscores the belt's pivotal role in workplace safety, providing workers with a sense of security and confidence while operating in hazardous environments. Through the meticulous fusion of advanced technology and ergonomic design, the IoT-enabled safety civil belt sets a precedent for future advancements in mitigating risks and safeguarding the well-being of workers.

It heralds a new era of safety innovation, where proactive monitoring and rapid response capabilities redefine workplace safety standards, ultimately ensuring the protection and welfare of workers across various hazardous environments.

B. HARDWARE COMPONENTS

ARDUINO UNO: The Arduino Uno microcontroller board, powered by the ATmega328P 8-bit AVR microcontroller, is a versatile platform with 14 digital I/O pins, 6 analog input pins, and various essential components. With 32KB flash memory, 2KB SRAM, and 1KB EEPROM, it drives code execution and interaction with sensors and devices. The Uno facilitates user-friendly hardware projects with features like USB connection, power jack, ICSP header, and reset button.

Figure 2: Arduino Uno

SAFETY CIVIL BELT: A safety civil belt is a protective gear worn in construction or civil engineering to prevent falls and injuries. It connects to secure anchor points, mandated by safety regulations to mitigate risks in hazardous work environments. These belts ensure worker safety at heights or in potentially dangerous conditions.

Figure 3: Safety Civil Belt

GPS NEO 6M SENSOR: The GPS NEO-6M sensor is a compact, high-sensitivity module used for precise positioning and location tracking. Operating on 1 Hz update rate, it interfaces via UART and requires minimal power, making it ideal for various navigation and tracking applications in diverse environments.

Figure 4: GPS Neo 6M Sensor

SPO2 SENSOR (MAX30102): The SPO2 sensor, such as the MAX30102, measures blood oxygen levels using photoplethysmography. It emits light into the skin and measures the reflected light to determine oxygen saturation. This compact sensor is widely used in healthcare devices for non-invasive monitoring of oxygen levels in the blood

Figure 5: SPO2 Sensor (MAX30102)

GSM 800C MODULE: The GSM 800C module is a communication device enabling GSM connectivity for data and voice communication. It operates within GSM 850/900/1800/1900 MHz bands and interfaces with microcontrollers via UART. With a SIM card slot, it accesses cellular networks for transmitting messages and facilitating communication in various applications, from IoT devices to remote monitoring systems.

Figure 6: GSM 800C Module

BMP 280 SENSOR: The BMP280 sensor is a versatile device used for measuring barometric pressure, temperature, and altitude. Operating via I2C or SPI interface, it provides accurate readings for various environmental monitoring applications. Its compact size and low power consumption make it suitable for integration into portable devices and weather stations.

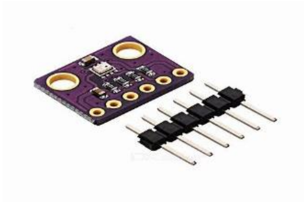

Figure 7: BMP 280 Sensor

PIEZOELECTRIC BUZZER: The piezoelectric buzzer is an electronic component that emits sound when an alternating voltage is applied. It is commonly used in electronic devices for generating audible alerts or tones due to its compact size, low power consumption, and reliable performance.

Figure 8: Piezoelectric Buzzer

PUSH BUTTON: The A push button is a simple mechanical switch used to control electrical circuits. When pressed, it completes the circuit, allowing current to flow. Commonly found in electronic devices and control systems, push buttons provide a user-friendly interface for initiating actions or commands with a single touch.

Figure 9: Push Button

V. RESULTS AND DISCUSSION

The Safety Civil Belt, a comprehensive wearable safety solution leveraging IoT technology, was successfully developed, implemented, and validated through meticulous research, design, and integration of various sensors and components. Rigorous testing ensured its effectiveness in continuously monitoring wearer health and environmental parameters. The project yielded valuable insights for applications in emergency response, industrial safety, and healthcare. Detailed documentation includes test results and recommendations, affirming its significance in wearable safety technology. This achievement demonstrates the feasibility of integrating IoT into wearable devices, addressing critical safety needs. The project's outcomes lay a foundation for future research and development in similar safety solutions, aiming to mitigate risks and ensure individual well-being across diverse environments.

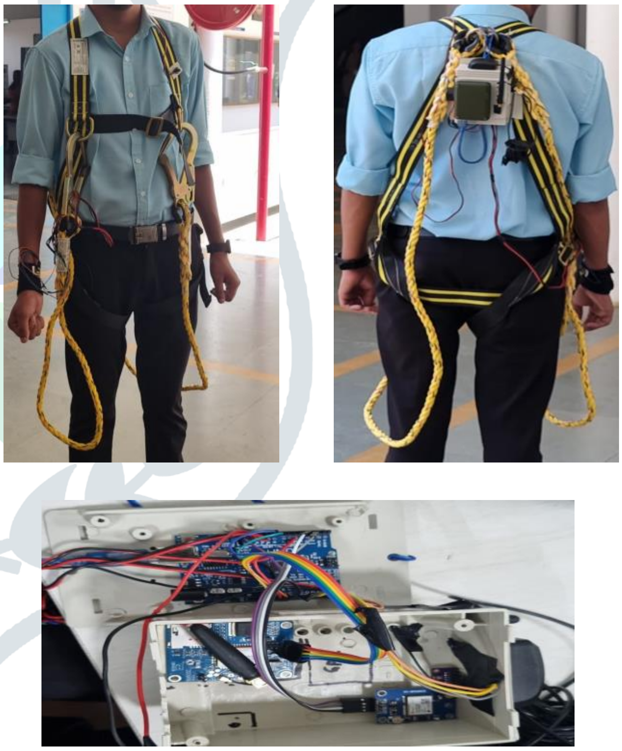

Figure 10: Prototype Model of Design and Development of Safety Civil Belt

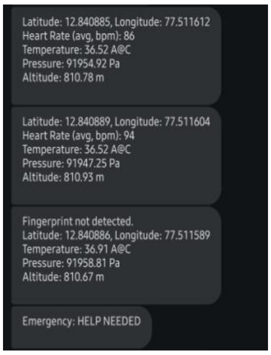

Figure 12: continuous monitoring of data is sent through SMS

VI. CONCLUSION

The Safety Civil Belt combines MAX30102 for health monitoring, GPS for location tracking, BMP280 for environmental pressure, and an SOS button for emergencies, ensuring employee safety in hazardous areas. This integration enables vital sign monitoring, location tracking, and environmental assessment. A GSM module enhances communication for alerts, with a manual SOS button for emergencies. Utilizing IoT, it enhances workplace safety and facilitates emergency response, ensuring better worker safety and effective handling of emergencies in dangerous environments. The comprehensive sensor integration and communication features make it a valuable tool for proactive monitoring and rapid response, thereby mitigating risks and enhancing safety in various industrial settings.

VII. FUTURE SCOPE

The project's future scope involves advancing sensor technologies for enhanced accuracy, integrating machine learning for predictive analysis, and developing a mobile app for remote monitoring. Collaboration with emergency responders for real-time integration is also planned, expanding its reach and impact. Additionally, exploring energy-efficient solutions to extend battery life, enhancing user comfort through ergonomic design improvements, and conducting field trials to validate performance in various scenarios are part of the envisioned roadmap to further improve the Safety Civil Belt's efficacy and usability.

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