International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 03 Issue: 10 October 2025
Page No: 3973-3977
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2025.0580

SAATHI: Warfield Buddy for Soldiers

Merin K M[1], Sabin Biju[2], Sanjith Shajahan[3], Dr. Rakesh S[4]
[1,2,3]UG Scholar, Dept. of ECE, Albertian Institute of Science and Technology, Kochi, Kerala, India
[4]Associate Professor, Dept. of ECE, Albertian Institute of Science and Technology, Kochi, Kerala, India
Emails: *merink060@gmail.com[1], sabinbiju719@gmail.com[2], sanjithsanju444@gmail.com3, rakesh_s@aisat.ac.in[4]*

Abstract
SAATHI is an advanced wearable technology designed exclusively for soldiers, aimed at enhancing battlefield safety, situational awareness, and operational efficiency. It is a combination of a protective vest and a helmet. The protective vest monitors heart rate, body temperature, saturation level etc., and provides metal detection capability and temperature management. The helmet for soldiers is equipped with air quality sensor, a high-resolution camera, GPS and a communication module. The helmet allows real-time video streaming and live transmission of battlefield visuals to command centres, enabling improved decision-making and tactical planning. SAATHI provided a solution to the evolving challenges of modern warfare by combining personal protection with enhanced communication, health monitoring, and situational awareness, offering soldiers a critical advantage on the battlefield.

Keywords: *Air Quality Sensor, Arduino, BPM Sensor, Helmet, Gas Sensor, Peltier Module, Temperature Sensor, Smart Vest.*

1. Introduction
In modern warfare, the safety and situational awareness of soldiers on the battlefield are paramount. The development of smart wearable technology is revolutionizing personal protection for military personnel and also improving communication, monitoring, and decision-making in combat scenarios. SAATHI, an advanced wearable technology-based system combines cutting-edge sensors, real-time data transmission, and protective gear into a single integrated platform. The protective vest integrates embedded sensors that monitor vital signs such as heart rate, body temperature, saturation level, toxic gas levels etc., and manages temperature. These real-time health indicators are crucial for medics and commanders to assess a soldier's physical condition, providing the ability to detect fatigue, stress, or injury. In the event of injury, the system can alert nearby medics with the soldier's exact location and medical data, allowing for faster and more effective medical intervention. A wearable display band on the hand provides soldiers with crucial health monitoring information. The protective gear also includes a helmet which holds a camera for capturing the real time visuals. It also supports mission recording for post-operation analysis. A communication module helps in two-way voice communication between the soldier and the command centre. These features enhance both immediate operational effectiveness and long-term strategic planning.

2. Literature Review
2.1. Health Monitoring Capabilities
Smart vests are equipped with sensors that track vital signs such as heart rate and body temperature, ensuring soldiers' health is continuously monitored during operations [1-2]. Advanced biometric authentication systems enhance data security, allowing only authorized personnel access to sensitive health information [2].

2.2. Environmental and Position Tracking
Integrated gas sensors and accelerometers provide environmental threat detection and motion tracking, respectively, improving situational awareness [1,3]. GPS tracking capabilities enable real-time location monitoring, facilitating rapid response in emergencies [3].

2.3. Communication Innovations
Gesture-based communication systems allow

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 03 Issue: 10 October 2025
Page No: 3973-3977
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2025.0580

soldiers to exchange information silently, crucial in noisy or radio-restricted environments [1]. The integration of IoT technologies ensures secure data transmission, enhancing operational coordination [2,4].

2.4. Technological Integration

Smart vests leverage the Internet of Things (IoT) and Artificial Intelligence (AI) to collect and analyze data, enhancing the functionality of traditional military gear [5]. This framework integrates physiological monitoring, emotional assessment, fatigue tracking, and environmental conditions into a single device, allowing soldiers to maintain situational awareness and resilience [6].

2.5. Safety and Surveillance

Unlike traditional bulletproof jackets, smart vests provide comprehensive surveillance capabilities, addressing the limitations of existing protective gear [6]. The integration of sensors allows for continuous monitoring of a soldier's health and environment, facilitating timely interventions in critical situations [5].

3. Proposed System

The proposed system consists of a combination of a smart protective vest and a smart helmet. The smart protective vest integrates several sensors for monitoring the health condition of the soldier, temperature management, metal detection etc. and the smart helmet integrates several communication modules, air quality monitoring sensor and camera module. Figure 1 and 2 displays the block diagram and circuit diagram representation of the proposed SAATHI respectively.

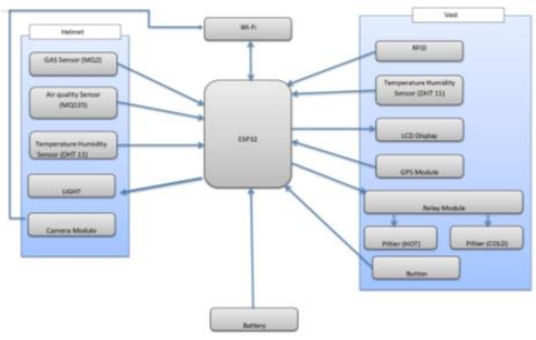

Figure 1 Block Diagram Representation of the Proposed SAATHI

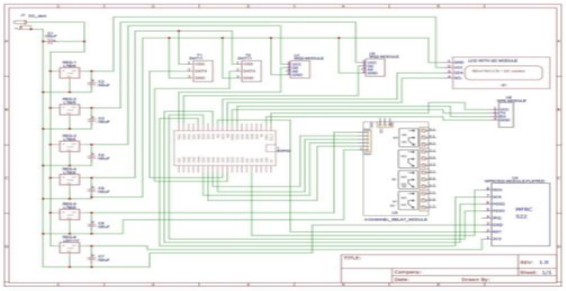

Figure 2 Circuit Diagram Representation of the Proposed SAATHI

3.1. Hardware Components

3.1.1. ESP32

The ESP 32 microcontroller manufactured by Express if Systems is a good choice for SAATHI in view of the processing speed, energy efficiency and wireless connectivity offered. Figure 3 shows the picture of an ESP 32 board.

Figure 3 ESP 32 Board

3.1.2. DHT11 Sensor

Temperature and Humidity Sensor (dht 11): This sensor monitors environmental conditions, particularly temperature and humidity levels around the soldier. It can help in tracking weather changes and the physical comfort or stress level of the soldier. Figure 4 shows the picture of a DHT11 sensor.

Figure 4 DHT11 Sensor

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 03 Issue: 10 October 2025
Page No: 3973-3977
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2025.0580

3.1.3. BPM Sensor

The BPM sensor shown in Figure 5 monitors the soldier's heart rate and provides critical health data in real time. This sensor helps detect signs of stress or exhaustion allowing for immediate intervention when necessary.

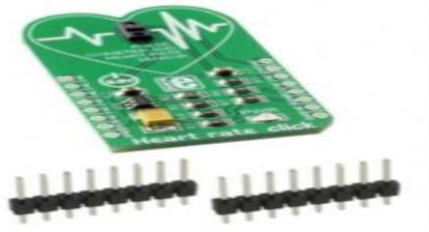

Figure 5 BPM Sensor

3.1.4. Peltier Module

A Peltier module as shown in Figure 6 is a thermoelectric device that transfers heat from one face to the other when electric current is passed through the module, enabling cooling or heating depending on current direction.

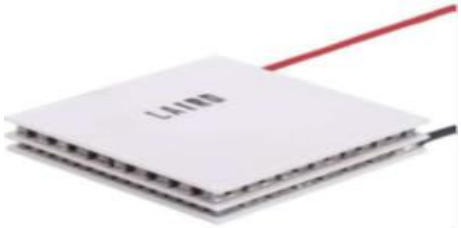

Figure 6 Peltier Module

3.1.5. Metal Detector

The metal detector, embedded in the vest, helps the soldier detect metallic objects, such as landmines or hidden weapons. It is a critical component for detecting explosive materials or dangerous equipment in hostile environments.

3.1.6. OLED Display

Figure 7 OLED Display

The OLED display on the vest shows real-time data such as GPS location, heart rate, temperature, humidity, gas levels, and more, providing soldiers with critical information directly on their vest. Figure 7 shows the picture of an OLED display.

3.1.7. Air Quality Sensor

The MQ135 sensor as shown in Figure 8 detects a variety of gases, including ammonia, carbon dioxide, benzene, and smoke. It's used for monitoring air quality, ensuring safety in environments with potential airborne toxins or pollutants.

Figure 8 MQ135 Sensor

3.1.8. Gas Sensor

The MQ-2 is a gas sensor that detects gases like methane, propane, smoke, and alcohol. It has a high sensitivity, providing analog output, ideal for air quality monitoring and detection systems. Figure 9 shows the picture of an MQ2 sensor.

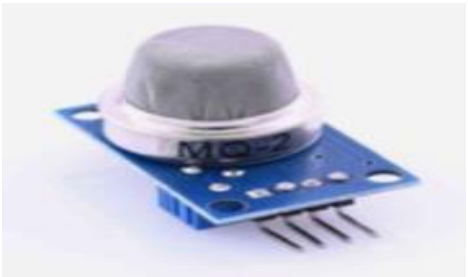

Figure 9 MQ2 Sensor

3.1.9. GPS Module

The GPS module as depicted in Figure 10 continuously tracks the soldier's location. It communicates with a base station or remote-control unit via GSM or Bluetooth, ensuring commanders are aware of the soldier's exact position at all times.

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 03 Issue: 10 October 2025
Page No: 3973-3977
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2025.0580

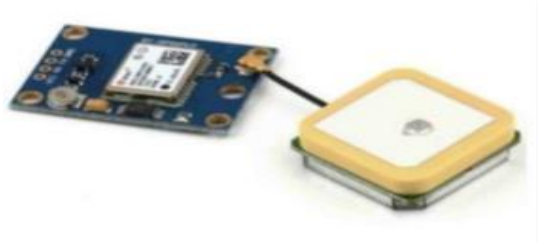

Figure 10 GPS Module

3.1.10. Wi-Fi Camera

The Wi-Fi camera, mounted on the helmet, captures real-time video and streams it wirelessly. This allows for live monitoring and situational awareness, providing remote command with a soldier's perspective in combat zones. Figure 11 shows the picture of a Wi-Fi camera.

Figure 11 Wi-Fi Camera

3.1.11. GSM Module

The GSM module as shown in Figure 12 enables long-range communication by transmitting data, such as the soldier's location and vital signs, to command centers. It ensures connectivity in remote areas where typical radio signals may fail.

Figure 12 GSM Module

3.2. Software

Arduino IDE: The Arduino IDE is a powerful platform for programming microcontrollers using C and C++. It is ideal for works where sensors, communication, and control systems interact in real time. In vest, sensors (like temperature, heart rate, or motion) can be connected to the ESP32 board. The IDE allows programming to monitor these sensors and send data to a display or wireless module (e.g., Bluetooth or Wi-Fi) for real-time feedback. For a smart helmet, the Arduino IDE enables integration with sensors, GPS for location tracking, and wireless communication for sending alerts in case of an accident. The program can notify emergency contacts or trigger safety mechanisms.

4. Results and Discussion

The smart protective vest monitored the heart rate and temperature of the individual. It showcased the capability to perform temperature management using the Peltier module. The unit successfully detected metal objects also.

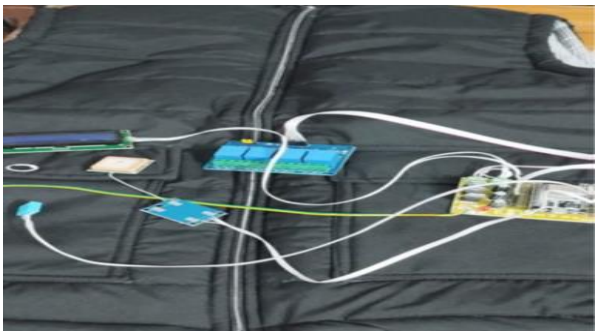

Figure 13 Prototype Concept of Smart Vest

Figure 13 and 14 shows the prototype concept of smart vest and vest with Peltier module integration respectively.

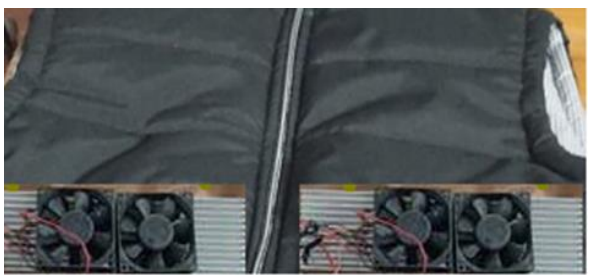

Figure 14 Prototype Concept of Peltier Module Integration

The helmet as shown in Figure 15, was able to monitor the quality of the surrounding air and detected toxic gases too. The camera embedded in

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 03 Issue: 10 October 2025
Page No: 3973-3977
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2025.0580

the helmet provided real time visuals. The GPS module integrated into the helmet provided the location of the individual and the GSM module enabled the sharing of location information and other vital information too.

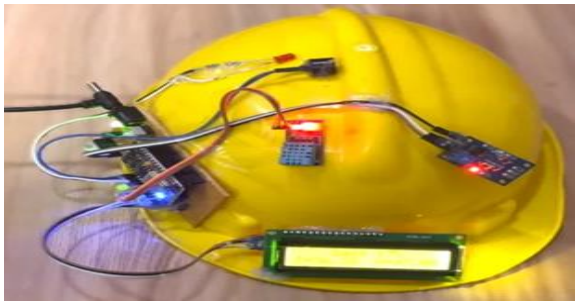

Figure 15 Prototype Concept of Smart Helmet

Conclusion

The combination of smart vest and helmet represents a significant leap in personal protective technology for soldiers, offering enhanced safety and operational efficiency. The helmet equipped with a camera and communication system, provides real-time visual feedback and seamless connectivity between soldiers and their command centers. The camera allows soldiers to share their perspective on the battlefield, giving commanders a clear view of their surroundings, while the communication system ensures constant, reliable communication and supports better decision-making during high-pressure missions. The vest complements the helmet by focusing on the soldier's health and environmental safety. By continuously monitoring the vital signs, the vest can detect early signs of stress, dehydration, or potential injuries, allowing for timely intervention and preventing more severe health issues. This constant health surveillance ensures that soldiers remain in optimal condition and can carry out their missions more effectively.

References

[1]. Raut, S., Jaisinghani, G., Doshi, N., and Gaikwad, G. (2024). Smart Warfare: Designing Intelligent Vests for Enhanced Military Operations. International Conference on Inventive Computation Technologies (ICICT), Lalitpur, Nepal, 1016-1022. doi: 10.1109/ICICT60155.2024.10544719.

[2]. Chandra, P. A., Chandra, M. H., Raj, V. A. and Ramakrishnaiah, T. (2024). Smart Soldier Jacket for Health Monitoring and Secured Data Transmission. 4th International Conference on Intelligent Technologies (CONIT), Bangalore, India, 1-5. doi: 10.1109/CONIT61985.2024.10627209.

[3]. Pund, V. S., Dongare, S. K., Amate, P. S., Jadhav, D. R., Bibave, R. R. and Pardeshi, D. B. (2023). Soldier Health Monitoring and Position Tracking (E-Vest). 4th International Conference on Electronics and Sustainable Communication Systems (ICESC), Coimbatore, India, 257-261. doi: 10.1109/ICESC57686.2023.10193616.

[4]. Raman, R. and Vyakaranam,L. (2024). IoT-Enabled Smart Military Training for Virtual Simulation and Real-Time Performance Analysis. International Conference on Advances in Data Engineering and Intelligent Computing Systems (ADICS), Chennai, India, 1-6. doi: 10.1109/ADICS58448.2024.10533460.

[5]. Joshi, N. V., Joshi, S. P., Jojare, M. S. and Askhedkar, A. R. (2021). IoT based Smart Vest and Helmet for Defence Sector. International Conference on Communication information and Computing Technology (ICCICT), Mumbai, India, 1-8. doi: 10.1109/ ICCICT50803.2021.9510067.

[6]. Keerthana, K., Yamini, R., Dhesigan, N., Gangadharan, N. B. and Kirubha, S. A. (2020). Smart Lifeguarding Vest for Military Purpose. International Conference on Communication and Signal Processing (ICCSP), Chennai, India, 637-639. doi: 10.1109/ICCSP48568.2020.9182321.