Literature Review

S. No	Paper Title, Year	Methodology	Key Findings	Identified Research Gap	Relevance to project	Potential Research Direction
1	Design and Development of Artificial Intelligence - Enabled IoT Framework for Satellite-Based Navigation Services	This paper outlines a methodology that integrates machine learning (ML) models and Internet of Things (IoT) scenarios to enhance satellite-based navigation services. It employs the successive variational mode decomposition-kernel extreme learning machine (SVMD-KELM) method for real-time analytics and reliable GPS-TEC predictions, demonstrating improved computational efficiency and accuracy over traditional methods. The framework utilizes a long-range (LoRa) network for near-distance communication and Amazon Web Services (AWS) cloud for longer distances, achieving a high success rate (99.7%) in broadcasting GPS signal delay corrections. The overall system is designed as a cloud-based terrestrial navigation prototype for machine-to-machine (M2M) communication	Superior Performance of SVMD-KELM Method Efficient Data Acquisition and Transmission Integrated Cloud-Based Terrestrial Navigation System Cost-Effectiveness and Scalability	Scalability and Multi-Location Deployment Data Preprocessing and ML Model Optimization Real-world Practical Applications and Ionospheric Weather Parameters	The paper is relevant to our project as it demonstrates an AI-enabled IoT framework integrating LoRa communication, edge/cloud analytics, and GNSS data for real-time monitoring and reliable long-range transmission. These concepts align with our soldier health monitoring, GPS-based position tracking, and event-driven LoRa communication approach	Expanding Scalability and Geographic Coverage Advanced Data Preprocessing and Machine Learning Optimization Ensuring Security and Privacy Real-World Applicability and Dynamic Ionospheric Conditions
2	Automatic Location Tracking and Health Monitoring by System,	The research employs a mesh network-based system design utilizing NodeMCU ESP-8266 microcontroller with integrated Wi-Fi	The system successfully demonstrated automated GPS tracking,	Limitations include inefficient radio communicati	This paper directly addresses soldier health and position	Future enhancements include integrating acceleromet

	2024	capabilities. The implementation involves three components: soldier-worn devices, Android applications, and squadron leader units. Hardware includes NEO-6M GPS modules, MAX30102 heart rate sensors, SSD1306 OLED displays, and lithium-ion batteries. Development utilized Figma for UI design and Fritzing for circuit layouts, implementing PCB-based circuits. The experimental setup tested individual modules through simulation and hardware validation, verifying Wi-Fi data transfer, sensor functionality, GPS accuracy, and mesh network creation using multiple NodeMCUs. The system operates through secure private mesh topology enabling offline communication without internet connectivity.	secure private mesh network communication, integrated SOS emergency alerts, and real-time health monitoring of heart rate and SpO2 levels. Hardware validation confirmed NodeMCU data transfer capability, accurate GPS positioning, functional sensor integration, and offline Android navigation enabling independent soldier location tracking.	on methods, GSM network unavailability in high-altitude areas, LoRaWAN range constraints, and security vulnerabilities in base-soldier communication. The system lacks activity recognition capabilities through accelerometers and gyroscopes. Performance enhancement, robust design implementation, and machine learning integration remain unexplored areas requiring further research.	tracking through GPS-based location monitoring, vital signs measurement including heart rate and blood oxygen saturation, secure mesh network communication in network-denied environments, emergency SOS functionality, and offline navigation capabilities. The lightweight portable design and real-time data transmission align perfectly with military monitoring requirements.	ers and gyroscopes for activity recognition using machine learning algorithms, strengthening secure communication protocols, improving performance in challenging terrains, developing advanced alert mechanisms, expanding sensor arrays for comprehensive health monitoring, and integrating the system into broader military strategic frameworks for enhanced operational coordination.
3	HOT Watch: IoT-Based Wearable Health Monitoring	The system integrates MLX90614 temperature sensor, AD8232 ECG sensor, MAX30100 oximeter, and GPS with Arduino ESP8266	*Communication Protocol:* Bluetooth Connectivity:	Predictive Capabilities Contextual Constraints	sensor suite (MLX90614, AD8232, MAX30100), validated signal	Predictive Analytics Integration

	System,2024	microcontroller. Sensors continuously collect vital signs; ECG data undergoes Pan-Tompkins algorithm processing for heart rate calculation. Arduino transmits data via Bluetooth to a mobile application for real-time monitoring and alerts.	*Data Processing:* Pan-Tompkins Algorithm (PTA): Superior Accuracy: The HOT Watch achieved accuracy exceeding 99.4%, significantly outperforming existing solutions	Unexplored Areas-Long-term battery performance and power consumption metrics Data security and privacy protection mechanisms	processing (Pan-Tompkins algorithm), integrated GPS positioning, and real-time Bluetooth communication architecture directly address core requirements for soldier monitoring	Addressing Contextual Limitations Expanded Sensor Integration Algorithm and Processing Improvements
4	Driving Healthcare Monitoring with IoT and WearableDevices A Systematic Review, 2025	This systematic review employed PRISMA methodology with NLP toolkit for study selection. Searches covered IEEE Xplore, Springer, ScienceDirect, ACM, MDPI, and PubMed Central from January 2010 to May 2024. From 18,343 initial studies, 35 were selected after removing duplicates and applying inclusion criteria. Quantitative and qualitative analyses examined hardware, methods, features, and communications.	The review identified continuous data collection via integrated sensors as fundamental. ECG sensors were most frequent hardware. Heart rate and pulse rate were most analyzed features across 15 studies. Statistical methods dominated 21 studies, predictive	Major gaps include lack of real-world validation, hardware/software design constraints, data security challenges, and user comfort issues. Studies used small sample sizes limiting generalizability. Need exists for advanced AI algorithms, multi-modal sensor fusion, optimized communicati	Research enables real-time vital sign monitoring including heart rate, SpO2, and temperature critical for soldier assessment. Low-power communication protocols extend battery life for prolonged operations. GPS integration enables location tracking and	Future directions include integrating advanced AI algorithms for enhanced accuracy and predictive capabilities, developing multi-modal sensor fusion techniques for comprehensive health understanding, optimizing real-time data processing and communication protocols,

			methods in 17. Bluetooth was the primary communication protocol. Systems enable real-time monitoring and interventions for healthcare professionals.	on protocols, robust security measures, and comprehensive validation in diverse real-world scenarios with larger populations.	emergency response. Applications include stress detection, fatigue monitoring, injury detection, and continuous health monitoring in combat zones, enhancing soldier safety.	incorporating human factors engineering with real-world usability testing, and prioritizing robust encryption and secure channels for protecting sensitive health data comprehensively.
5	No Soldiers Left Behind: An IoT-Based Low-Power Military Mobile Health System Design ,2020	The paper's methodology centers on a Multilayer Inference System (MIS) and its Multilayer Inference Algorithm (MIA). This system aims to reduce data size and conserve battery power while maintaining accuracy through a two-tier, four-step inference and optimization process. It also incorporates secure automated messaging, data fusion, and enhanced biometric authentication for military mobile health applications	Multilayer Inference System (MIS) achieved 97.9% data reduction with satisfactory accuracy. Authentication accuracy is enhanced via biometrics and health data. Battery power is conserved by reducing data transmission frequency. Ad-hoc networks are feasible for military mHealth.	Key research gaps include ensuring data size reduction maintains accuracy, addressing insufficient sensor data for health status, overcoming limited access to public networks, managing computational and battery constraints, and developing advanced activity classification and decision support systems for precise notifications.	Our project aligns closely with this paper by implementing an IoT-based wearable health monitoring system with GPS tracking and low-power long-range communication. Both focus on real-time soldier health assessment, emergency alerts, and energy-efficient data transmission using inference/edge intelligence to support	Future research efforts should focus on improving both the accuracy and savings rates of inferencing algorithms to minimize the impact of data points. Additionally, centralizing power supply and battery types across equipment used by soldiers should be considered to maximize compatibility. Lightweight security measures also

			Real-time monitoring and actuation are supported by LPWAN-based devices	Further work is needed to optimize WSN energy usage and improve both accuracy and savings rates in inferencing algorithms	reliable operations in remote military environments	need to be implemented for LPWANs, potentially using smart hydrogel biomedical sensors for health data and personnel identification.
6	Predicting Soldier Performance on Structured Military Training Marches With Wearable Accelerometer and Physiological Data ,2024	The study developed a model to predict soldiers' time-to-completion (TTC) for a 12-mile ruck march using multimodal wearable sensor data. Predictions were made at discrete checkpoints using features from skin temperature (SKT), heart rate (HR), estimated core temperature (ECT), and triaxial accelerometry. A random forest regression model was trained at each checkpoint, incorporating features from current and past checkpoints, as well as prior 5-mile run data to account for soldier fitness	The model achieved a root-mean-square error (RMSE) of 7.12 min and a mean absolute error (MAE) of 5.21 min by 120 minutes into the march. Gait-related features, particularly the standard deviation of vertical acceleration (ACC), were integral to TTC estimation accuracy. The model demonstrated improved performance over simpler methods and showed a negative correlation between TTC and vertical ACC standard deviation, indicating that higher vertical ACC variance	The study identified limitations, including the need for training multiple models sequentially, which impacts deployment capabilities and battery life . Intermittent sensor noise and issues with signal quality, particularly for ACC, were noted as challenges .The model's generalizability is limited by its reliance on 12-mile ruck march data from a specific location, as different terrains or exercises may alter sensor measurement patterns	Our project is relevant to this paper as both leverage wearable sensors to monitor soldiers' physiological parameters like heart rate and temperature, combined with data analytics for real-time assessment. While the paper focuses on predicting performance (TTC), our system extends this by detecting health emergencies and transmitting location alerts using IoT and edge intelligence	Future work should investigate the deployment capabilities of the proposed framework in portable systems, considering data size and computational power effects on battery life. Developing a more robust signal quality block is crucial to prevent corrupted data from producing misleading results. Expanding the model to include TTC estimation for different march routes and incorporating additional global fitness features (e.g., physical training results) will

			is associated with lower TTC			enhance generalizability
7	Remote Health Monitoring System for the Estimation of Blood Pressure, Heart Rate, and Blood Oxygen Saturation Level ,2023	The system utilizes an IoT-based approach with a wearable body ring sensor to monitor blood pressure (BP), heart rate (HR), and blood oxygen saturation (SpO2). It employs a photoplethysmography (PPG) signal, an automatic multiscale-based peak (AMBP) detection algorithm, and a machine-learning regression model for BP estimation. Data is transmitted to the ThinkSpeak cloud platform via an Arduino MKR WIFI 1010 for remote monitoring and graphical representation	The developed sensor demonstrated high accuracy, with BP, HR, and SpO2 measurements showing close correlation to commercial devices. The accuracy for SpO2 was 99.5%, and for HR, it was 94%. The system effectively provided continuous remote monitoring, enabling real-time data visualization and early detection of potential health issues	The current study did not test the SpO2 estimation against low oxygen levels (hypoxemia) as all recruited volunteers had normal SpO2 readings . Additionally, the AMBP algorithm, while effective, was found to be computationally expensive and not ideal for wearable sensors, leading to a modified approach	Our project is closely related to this paper as both focus on IoT-based wearable health monitoring for real-time tracking of vital signs. The paper demonstrates remote measurement of heart rate, SpO_2, and blood pressure using sensors and cloud platforms, which supports our system's objective of continuously monitoring soldier health and transmitting critical data for timely response	Future research could focus on designing sensors capable of predicting and forecasting BP, HR, and SpO2 fluctuations over time. Further studies should also investigate the influence of daily activities like walking, resting, and running on these vital parameters. Additionally, exploring user experience and validating the system for patients on antihypertensive medications is suggested
8	Toward Joint Radar, Communication, Computation,	This paper provides a comprehensive survey of Joint Sensing and Communication (JSAC) technologies, including their definitions, preliminaries, key findings,	JSAC significantly enhances communication performance through sensing,	Challenges include joint waveform design, optimal trade-offs between	Our project is relevant to this paper because it applies the core idea of integrating	Future research should focus on JSAC in new frequency bands (sub-THz and

	Localization, and Sensing in IoT ,2022	and state-of-the-art applications in IoT. It classifies JSAC technologies and outlines their requirements, covering 115 communication- and sensing-related papers across various IoT areas	offering advantages like improved spectral and hardware efficiency, and reduced latency. It is crucial for various IoT applications such as enhanced mobile broadband, intelligent transportation systems, and smart factories/cities/homes, enabling capabilities like high-resolution imaging and precise localization	communication and sensing functionalities, and the need for complex signal processing in spectrum sharing paradigms due to interference. Hardware complexity and resource allocation optimization also pose significant challenges	sensing, computation, localization, and communication within an IoT framework. While the paper discusses Joint Sensing and Communication (JSAC) for efficient resource usage and real-time monitoring in IoT systems, our soldier health and position tracking system practically implements these concepts using wearable sensors, GPS localization, edge intelligence, and low-power long-range communication for timely emergency response	THz), designing novel waveforms, integrating ultra-massive MIMO, and leveraging RIS-empowered and distributed/collaborative JSAC systems. Machine learning and deep learning are key enablers for optimizing these systems
9	Advanced Soldier Tracking System Using Arduino	The system integrates an Arduino Uno microcontroller with GPS, GSM, and various sensors (heartbeat, temperature, accelerometer) to process	The advanced soldier tracking system effectively integrates GPS, GSM,	Previous research identified limitations in wireless communicatio	Our project is directly aligned with this paper as both focus on real-time	Future research could explore more robust and secure communicatio

	and Sensor Technology ,2024 (ACM Conference)	and transmit real-time data. The Arduino Uno handles sensor data and sends it via the GSM module to a central server, while the GPS module provides precise location coordinates. Data transfer between sensors and the microcontroller uses the I2C protocol	and biometric sensors, providing a comprehensive approach to real-time tracking and health monitoring. It enables precise location tracking and monitors vital parameters like heart rate and body temperature. Data is transmitted to a central command center via GSM, enhancing military personnel's safety and operational efficiency through continuous monitoring and rapid response	n options, noting that GSM is an obsolete technology and Zigbee has range and obstruction constraints . Some systems also store data in simple databases, which may not offer the same level of secure processing as cloud-based systems	soldier health monitoring and location tracking using wearable sensors, GPS, and a microcontroller-based system. The paper's Arduino–GPS–GSM architecture for transmitting vital signs and position to a control center closely matches our IoT-based health detection and emergency alert framework, validating our system design approach	n protocols beyond GSM and Zigbee, perhaps investigating advanced IoT integration or satellite communication for remote areas. Enhancing data processing capabilities to move beyond simple databases to more secure, cloud-based, or edge computing solutions could also be a focus. Additionally, improving sensor accuracy and battery life in extreme conditions remain areas for development.
10	IoT based Military Health Service in Battle Field and GPS Trackin, 2023	The system uses an IoT-based two-unit architecture: Soldier Unit and Server Unit. It integrates PIC16F877A microcontroller, heartbeat sensor, LM34 temperature sensor, GPS with NMEA0183 output, Peltier thermal module, and keypad. Data is transmitted wirelessly to servers with LCD dashboards using	The prototype achieved real-time monitoring of heartbeat, body temperature, and GPS coordinates with fixed-interval IoT transmission. Threshold	Earlier military monitoring systems lacked continuous real-time health plus GPS tracking, had poor reliability in no-cellular zones, high power consumption	This work provides a validated blueprint for IoT soldier health and position tracking using biosensors, GPS, threshold alerts, and server dashboards.	Future improvements include solar-powered charging, camera modules, secure encryption, energy-efficient routing, and edge computing for low-latency

		threshold-based alerts and automated heating and cooling control	alerts triggered buzzers and thermal regulation using Peltier elements. Emergency keypad signaling worked reliably. Data accuracy and module interfacing were stable, enabling rapid rescue response through continuous physiological and location tracking in battlefield scenarios	with GPRS/3G/4G, limited weather adaptability, weak security, and bulky wearables. Most designs relied on smartphone forwarding instead of direct base-station monitoring, causing delays and reducing operational response efficiency in combat environments.	The two-unit model, PIC microcontroller choice, NMEA0183 parsing, IoT transmission, and emergency keypad features directly guide scalable wearable system design for continuous monitoring and battlefield deployment	processing. Adding multi-sensor fusion such as SpO2, ECG, and blood pressure, plus machine learning prediction and blockchain-based integrity, can enhance autonomy, security, reliability, and proactive health risk detection in combat networks
11	Enhancing Real-Time Military Intelligence through LoRa and Advanced Data Analysis, 2025	This system uses wearable sensors to track heart rate, temperature, and GPS location. An ESP32 processes the data and sends it through LoRa for long-range communication. Alerts are triggered for abnormal health or boundary crossing. Field tests measured accuracy, delay, range, and durability.	The system improved soldier safety with real-time health and location tracking. It showed high accuracy and low delay (~70 ms). GPS readings were very precise. Alerts worked correctly during risky health conditions and border breaches, helping faster response and better coordination	Most older systems track only health or only location, not both together. They also lack direct soldier-to-soldier communication. This causes delays in emergencies. The proposed system fills this gap by combining health and GPS data with long-range LoRa communication.	This work supports IoT-based soldier tracking projects by showing how to combine sensors, GPS, ESP32, and LoRa. It proves real-time monitoring, alerts, and dashboards are practical. The design is lightweight, power-efficient, and suitable for harsh field conditions.	Future work can add AI to predict health risks early. Hybrid networks (LoRa + satellite/mesh) can improve coverage. New sensors can track more body signals. Stronger security and smarter routing can make the system safer and more reliable.

12	Integrated healthcare monitoring solutions for soldier using the internet of things with distributed computing ,2020	The research employs a three-layer service-oriented IoT architecture comprising WSBAN, Fog, and Cloud layers. It implements distributed computing with layer-wise data filtration using Mamdani fuzzy inference at WSBAN nodes and Sugeno fuzzy models with time-series pattern analysis at fog nodes. LoRaWAN enables long-range communication. A prototype validated the approach.	The system successfully monitors real-time soldier health parameters through distributed computing architecture. Layer-wise filtration effectively reduces data flooding and computational burden by filtering safe soldier data at WSBAN layer and momentary instability cases at fog layer. This significantly improves system response time, channel utilization, and enables timely emergency medical intervention.	Existing systems face challenges processing huge datasets in real-time, causing computational burden and slow response times. Conventional filtering using crisp data proves ineffective for vague health information. Previous solutions lacked data transmission capabilities and stage-wise filtering mechanisms. No distributed computing approach with layer-wise filtration existed for soldier health monitoring applications	This research directly addresses soldier healthcare monitoring in adverse conditions through real-time parameter tracking, distributed architecture, and long-range LoRaWAN communication. The wearable WSBAN nodes with integrated sensors, intelligent fuzzy-based filtration, and centralized cloud visualization enable early health degradation detection, rapid emergency response, and connection between military headquarters and	Future research should focus on designing suitable wearable nodes to enhance system effectiveness and practicality. This includes improving physical form factor, sensor integration, power efficiency, and user comfort. Continued optimization of system response time and channel utilization through advanced wearable node design would further benefit emergency healthcare applications.

					hospitals.	
13	IoT based Soldier Health and Position Tracking System, 2022	An IoT wearable system is built using NodeMCU ESP8266, Arduino ATmega328P, heartbeat, temperature, and GPS sensors. Data is continuously collected and checked against preset thresholds. ZigBee handles short-range links and LoRaWAN supports long-range transmission. Alerts and location data are sent automatically to the monitoring control unit.	The system enables real-time tracking of soldier health and position. It sends automatic alerts when heart rate or temperature crosses safe limits. Multi-level communication works reliably. Results show it is low-cost, wearable, and useful for rescue and combat support with timely emergency response capability	Unit leader selection is static and needs dynamic algorithms. Power consumption is high during transmission. Communication trade-offs are not optimized. The study lacks strong security, encryption, scalability testing, and extreme-condition validation. Integration with existing military networks is also not discussed	This work directly supports the project goal. It shows practical sensor + GPS integration, threshold alerts, and wireless data transfer. It uses affordable components and wearable design. The communication model and live tracking approach provide a clear base for system development	Future work can improve battery life using energy harvesting. Add machine learning for early health prediction. Include more sensors for threat detection. Use secure encrypted communication. Develop mesh networking for GPS-denied areas and edge computing for faster on-device decision making
14	Implementation of Soldier Tracking and Health Monitoring System, 2022	An IoT-based soldier monitoring system was built using Arduino Uno, GPS, temperature and heart-rate sensors, and a GSM module. Solar-powered battery supply supports operation. Sensors are worn by soldiers, while communication modules and display units are carried separately. Data is transmitted wirelessly to base stations and mobile devices	The system achieved real-time tracking and health monitoring. It successfully transmitted location, temperature, and heart-rate data through GSM networks. Emergency alerts and status updates were delivered reliably. Performance	Circuit optimization was incomplete and needs refinement. No proper base-station GUI was provided for command feedback. Power efficiency, sensor accuracy in harsh environments, data security,	The work provides a clear reference architecture for IoT-based soldier tracking systems. It validates combining GPS, biosensors, and GSM communication in a low-cost design. It also offers	Future work should add GUI-based command systems, stronger encryption, and multi-soldier networking. More biosensors (SpO_2, stress, injury detection) can improve monitoring. Machine learning can

			was stable in test scenarios, showing that continuous soldier monitoring and remote reporting are practically feasible	and electromagnetic interference resistance were not deeply addressed, though these are critical for real military deployment	practical guidance on sensor choice, power setup, and emergency alert mechanisms useful for similar projects	support anomaly prediction. Research should also focus on better battery life and rugged, high-accuracy sensor packages
15	IoT based Healthcare Monitoring and Tracking System for Soldiers using ESP32	The paper uses wearable IoT sensors (heart rate, temperature, GPS) connected to an ESP32 microcontroller for data collection. Wireless modules like Wi-Fi and LoRaWAN transmit data to the base station, often via cloud platforms like ThingSpeak. Edge computing reduces noise and processes data locally for quick alerts. Communication within the battlefield relies on short-range wireless tech like ZigBee without internet. It ensures real-time health and location monitoring in harsh environments	Sensors accurately monitor vital signs and location. Wireless tech enables real-time data transmission. Edge computing improves data accuracy and speed. Cloud platforms assist in data analysis and visualization. Panic buttons facilitate quick emergency alerts. Systems often depend on internet, limiting battlefield use. Combining sensors and wireless tech enhances soldier safety. Early health warning mechanisms are effective.	Insufficient focus on offline operation in connectivity-challenged zones. Energy efficiency and battery life in field conditions overlooked. Security of wireless data transfer needs more attention. Hardware robustness in extreme environments isn't discussed. Scalability for large troop deployment remains unaddressed. Lack of real-world field testing validation. Cybersecurity in wireless communication needs exploration. Integration	Need for ultra-low power, long-lasting wearable sensors. Secure, encrypted local data communication methods. System robustness in extreme environmental conditions. Incorporation of AI for predictive health insights. Extensive field validation under combat situations. Modular hardware for large troop scalability.	This project can be extended as a robust wearable IoT-based soldier monitoring system that prioritizes internet-independent communication for reliable battlefield operation. By replacing GSM-based data transfer with direct long-range wireless transmission to army base stations, the system can ensure uninterrupted health and location data flow in communication-denied environments. Future research can focus on

			The system supports better situational awareness. It can help reduce battlefield casualties.	with existing military systems is missing. Adaptability to different terrains is not evaluated. AI/predictive analytics are underutilized		enhancing real-time physiological assessment and precise position tracking to enable faster tactical response and soldier safety. The system may also explore improved reliability, latency reduction, and resilience against network failure in hostile conditions. Overall, this direction positions the project as a practical advancement over existing solutions by strengthening offline communication capabilities for military applications
16	IOT Based Soldier Tracking and Health Indication	The system used Arduino Uno as the main controller, integrating sensors such as SpO2, temperature, and vibration sensors to monitor vital signs and impact events. Data from these sensors are collected in real-time, with the GPS module tracking the soldier's location, all processed locally. The	The system effectively monitors vital signs (SpO2, temperature, heart rate) and detects impacts or falls in real-time. Location tracking via GPS enables	Limited health parameters monitored; advanced metrics like sleep quality, thermal regulation, or environmental physiological responses are not included.	Your project aligns closely with the core objectives of the paper in developing a wearable IoT-based soldier health monitoring and position tracking	Develop advanced battery optimization techniques, including low-power hardware selection, adaptive duty cycling, and energy-efficien

	System	collected health and position data are transmitted wirelessly via GSM modules, with triggers for emergency alerts like falls or collapses. The system features a Help button to manually send distress signals with location coordinates. Testing involved measuring health parameters and impact detection to ensure reliable real-time monitoring and communication.	swift rescue and resource deployment during emergencies. Wireless communication through GSM modules facilitates remote monitoring without internet dependency. The system successfully sends distress alerts, including location data, during critical events like soldier collapse. The low-cost hardware setup with widely available sensors demonstrates practicality for military use.	Battery life constraints during extended military operations are not addressed. The system's performance in extreme environments (high altitude, temperature variations) remains untested. Data security and encryption for transmitted health and location data are not discussed. Scalability for multiple soldiers and integration with broader military communication networks require further exploration.	system. Unlike the paper's reliance on GSM for wireless data transfer, your project emphasizes operating without internet connectivity, directly transmitting health and location data to the army base station. This approach enhances reliability in communication during battlefield conditions where internet access may be unavailable. Both systems aim to improve real-time health assessment and location tracking, ensuring timely assistance and safety for soldiers, making your project a practical extension with added	t communication protocols to support prolonged field deployment. Design and validate the system for extreme environmental conditions by incorporating ruggedized hardware and conducting extensive testing under harsh climates and terrains. Integrate strong communication security mechanisms such as end-to-end encryption and secure authentication to ensure safe and tamper-resistant data transmission. Implement reliable offline data transmission methods using long-range wireless technologies to enable continuous operation

					focus on offline data transmission.	without internet connectivity. Expand system capabilities by integrating additional physiological and environmental sensors for more comprehensive, real-time soldier health and situational monitoring.
17	IoT Framework for Modern Battlefield : Implementation of Soldiers Health Integration for Enhanced Location Deployment (SHIELD) System	The SHIELD system employs a three-tier hierarchical architecture with wearable IoT devices equipped with physiological sensors (MAX-30102 for heart rate/SpO2, LM-75 for temperature) and environmental sensors (AHT-10, MQ-135, Neo-6M GPS). Arduino Nano microcontrollers power the wearable transmitters while ESP32 modules manage receiver stations, enabling continuous real-time monitoring of soldier health and location. The system uses LoRaWAN communication protocol with SX1276 modules for internet-independent data transmission over	The system achieved ~7 km communication range using LoRaWAN without internet dependency, with resilience against jamming and signal interference in battlefield environments. Multiple physiological sensors (heart rate, SpO_2, body temperature) were successfully integrated with environmental sensors and real-time GPS tracking for	The system relies solely on battery power, lacking solar integration, energy harvesting, or advanced power management for long-duration autonomous missions. Audio-visual intelligence is missing, with no support for microphones, cameras, or video/image sensors to enhance situational awareness. Scalability and interoperability	The SHIELD system closely aligns with your wearable-based soldier health monitoring and real-time position tracking project using IoT technology. The LoRaWAN-based 7 km communication range directly supports your requirement for long-range, internet-independent battlefield communicatio	Explore advanced power management solutions such as solar-assisted charging, kinetic energy harvesting, adaptive sleep modes, and detailed long-term battery performance analysis for sustained operations. Enhance situational awareness by integrating multimedia and intelligence capabilities, including

		approximately 7 km range, connecting soldiers to squad leaders, field command posts, and central command centers. Data flows hierarchically through serial connections and LoRa transmission, with automated alert systems triggering when physiological parameters exceed predefined thresholds. Implementation includes dual-mode interfaces with LCD displays for field use and computer-based monitoring at command centers, ensuring comprehensive battlefield awareness without internet infrastructure.	holistic soldier monitoring. A three-tier hierarchical architecture (soldier → squad leader → field command post → command center) enabled scalable deployment with efficient data aggregation and low latency. An automated alert mechanism triggered instant notifications upon abnormal health parameters, supporting real-time tactical decisions and acting as a force multiplier. Extensive field testing confirmed reliable performance across diverse weather conditions with power-efficient operation suitable for prolonged battlefield use	analysis with existing military networks, NATO standards, and battlefield IoT systems is insufficient. Cybersecurity measures such as encryption, authentication, and protection against advanced electronic warfare attacks are inadequately addressed. Performance evaluation under extreme environments like arctic cold, desert heat, underwater conditions, or GPS-denied zones is limited.	n. Integration of physiological sensors with GPS tracking mirrors your project objectives and informs suitable sensor and controller selection. The hierarchical communication architecture provides a proven, adaptable framework for your base station and command-level data flow design. Identified limitations open opportunities for your project to innovate in power efficiency, security enhancement, and large-scale deployment.	audio capture, camera modules, thermal imaging, and AI-driven health prediction and anomaly detection. Strengthen cybersecurity by implementing robust encryption techniques, intrusion detection systems, blockchain-based trust frameworks, and secure authentication mechanisms. Conduct extensive validation under extreme operational environments such as high-altitude regions, underwater scenarios, arctic cold, desert heat, and GPS-denied or degraded conditions. Investigate system-level integration with electronic

						health records, telemedicine platforms, NATO-compliant communication standards, mesh networking for redundancy, and user-centric interface optimization
18	Soldier Health and Position Tracking System	The paper describes a wearable IoT-based system which uses sensors like heart rate monitors, temperature sensors, and GPS modules to continuously collect soldiers' health and location data. Data is processed locally using a microcontroller (NodeMCU) and displayed on an LCD, with emergency alert features like SOS buttons. The system emphasizes wireless transmission of data to a control center, primarily relying on sensors and communication modules without continuous internet dependency. Power management and security are considered, focusing on local data transmission to ensure operational efficiency and safety. The entire setup aims for cost-effectiveness and real-time monitoring for military applications.	The wearable system effectively monitors vital signs such as heart rate, temperature, oxygen saturation, and location. The system provides real-time alerts for abnormal vital signs and emergency situations via an SOS button. It reduces response time in case of health issues or injuries, improving soldier safety. Locally processed data eliminates dependency on internet connectivity, making it suitable for	Limited integration of additional physiological parameters such as hydration or glucose levels. Absence of advanced data security protocols for sensitive health and location information. Lack of wireless communication technologies beyond basic modules, which may limit data range and reliability. No mention of long-term power management solutions for extended field deployment.	Your project aligns closely with the core objective of real-time soldier health and position monitoring using wearable IoT devices. The focus on transmitting data without internet makes it highly relevant, as it emphasizes local data transfer to the army base station, addressing operational security and connectivity issues in remote areas. Incorporating health and location tracking	Developing energy-efficient power solutions for prolonged field operation of wearable devices. Integrating multi-parameter sensors for comprehensive health monitoring (hydration, glucose, etc.). Enhancing data security through encryption and secure local communication protocols. Exploring alternative wireless communication methods suitable for remote environments without relying

			field conditions. The system is low-cost, making it feasible for large-scale deployment in military settings	Few discussions on scalability or adaptability of the system for different environmental conditions	complements the paper’s approach, and your emphasis on not relying on internet aligns with practical battlefield constraints, enhancing soldiers' safety through immediate data relay	on internet. Implementing AI/ML algorithms for predictive analysis of soldier health and environmental risks
19	No Soldiers Left Behind: An IoT-Based Low-Power Military Mobile Health System Design	The paper proposes a multi-layer inference system (MIS) integrated within IoT and LPWAN networks to reduce data transmission from wearable sensors, thereby conserving battery life. It employs data inference at sensor and intermediary levels to minimize the volume of data sent to the cloud, without compromising critical accuracy. The system uses activity recognition and biometrics to enhance security and reliability. It adopts a hierarchical approach where significant data points are selectively transmitted based on thresholds and variance, optimizing power consumption. The framework supports fast, secure emergency alerts and health monitoring suitable for military applications without relying on continuous internet connectivity	The multilayer inference algorithm reduces data transmission by approximately 97.9%, significantly conserving battery life. The system maintains high accuracy (~98.6%) even after extensive data reduction, ensuring reliable health monitoring and activity recognition. The approach is effective in dynamic military environments, where ad-hoc networks are necessary, and internet access may be unavailable.	Limited discussion on power consumption metrics specific to wearable devices under different operational scenarios. The impact of sensor placement and mobility patterns on inference accuracy is not thoroughly analyzed. Real-world implementatio n challenges such as interference, latency, and hardware constraints are not extensively addressed. The system's performance in scenarios with	Your project focuses on deploying wearable IoT devices for soldiers to monitor health and track position data without relying on internet connectivity, sending critical information directly to a base station. This paper’s methodology aligns well with your objectives by emphasizing data inference to reduce power consumption and enable autonomous operation. Its architecture supports	Developing customized multilayer inference algorithms tailored to specific health parameters and movement patterns. Integrating multi-biometric s for improved identity verification and security in soldier monitoring systems. Exploring hardware optimization for wearables to enhance energy efficiency while maintaining mobility and durability. Extending the system to

			Combining biometrics and health data improves personnel identification and authentication in secure contexts. The proposed framework minimizes power usage by selectively transmitting critical data points based on variance and thresholds	high data variability or unexpected environmental disturbances remains unexplored. Lack of detailed analysis on scalability and interoperability across diverse military platforms and devices	health monitoring and position tracking in environments where internet access is unreliable or unavailable, making it highly relevant. Moreover, the security features and data-efficient communication strategies provide a strong foundation for designing a robust soldier health and location monitoring system that ensures safety and rapid response.	include environmental sensors for situational awareness in battlefield conditions. Investigating real-time data fusion techniques for combined health and position data to improve emergency response accuracy.
20	Soldier Health Detection and Position Tracking System using LoRa WAN Sensor for Low Power and Long-Range Access	Uses a **transmitter-receiver architecture** featuring STM32F103CBT6 microcontrollers and a LoRa Sx 1278 module for long-range, low-power data transfer. Integrates **MAX30100 (SpO2/HR)**, **DHT11 (Temp)**, and **NEO-6M (GPS)** sensors for continuous physiological and location data acquisition. Employs the **LoRaWAN protocol** to ensure	Demonstrated reliable long-range transmission of multiple vital signs and GPS data using a low-power LoRaWAN framework. Validated hardware accuracy through field tests showing consistent temperature,	Lacks discussion on **data encryption**, secure authentication, or protocols to protect sensitive military data from cyber interception. Provides no analysis of system performance or sensor	Directly aligns with your project's core goal of using wearable IoT devices for soldier health and location tracking via LoRaWAN. The transmitter-receiver model mirrors your **base station concept**, offering a	Develop **energy harvesting** (solar) and adaptive transmission intervals to significantly extend the device's operational lifespan. Integrate **Machine Learning algorithms** for predictive

		reliable communication independent of traditional mobile networks or internet dependency. Utilizes a centralized receiver with an **IoT module** to segregate critical data, store information in the cloud, and generate health reports. Features a dual-response system: **automated alerts** for abnormal vital signs and a **manual emergency button** for instant GPS distress signaling.	heart rate, and oxygen saturation measurements. Confirmed operational independence from cellular networks, providing a cost-effective solution for remote or compromised zones. Enhanced military surveillance efficiency by consolidating health monitoring and position tracking into a single wearable unit. Reduced medical response times via an automated alert system that triggers immediately upon detecting abnormal physiological conditions	reliability under **extreme environmental conditions** like heat, cold, or high humidity. Omits specific **power consumption metrics** and detailed battery life data required for planning extended field missions. Fails to address **network scalability**, including potential data congestion and receiver capacity limits during large-scale soldier deployments. Misses advanced integration features such as **predictive machine learning**, telemedicine capabilities, or interoperability with existing command systems	technical blueprint for internet-independent communication. Provides a validated reference for hardware selection, specifically proving the feasibility of the **STM32 and LoRa Sx 1278** stack. The inclusion of an emergency button and automated alerts offers a functional safety framework you can directly replicate and refine. Identified gaps in security and power management provide clear opportunities for your project to innovate and surpass this baseline	health analytics to detect fatigue or heat stroke before they become critical. Implement **AES-256 encryption** and blockchain-based logging to secure medical data against adversarial interception and tampering. Establish **mesh networking** capabilities to enable soldier-to-soldier relaying, ensuring connectivity in geographically challenging terrains. Expand the sensor suite to include **fall detection (IMUs)** and environmental hazard sensors for a more comprehensive situational awareness
21	Soldier’s Health Monitoring and	The system is built around an Arduino UNO that connects temperature and heartbeat sensors, GPS,	The prototype reliably captured and transmitted	Traditional tracking systems lack integrated	The work directly supports soldier health	Future improvements include hybrid communicatio

	Position Tracking System, 2024	GSM module, LCD, and an emergency button. It continuously collects health and location data, processes it locally, and sends it via GSM to the base station. Alerts are automatically triggered when abnormal values or distress signals are detected.	heart rate, temperature, and GPS data in real time. Emergency alerts with location worked correctly. Continuous monitoring was stable across conditions, and the LCD interface was easy to use. The system improved soldier safety, enabled proactive medical response, and increased operational visibility for commanders.	health monitoring. This system fills that gap but exposes weaknesses: GSM networks can fail due to jamming or infrastructure damage, and Arduino-class boards are not rugged enough for battlefield environments. The study highlights the need for secure, redundant communicatio n and military-grade, environment-r esistant hardware.	and position tracking goals by combining wearable sensors, GPS, and wireless alerts in one architecture. It demonstrates practical design choices, centralized monitoring, and distress signaling. It also shows deployment challenges like power, sensor accuracy, and network reliability, useful for improving real-world implementatio ns.	n (GSM + satellite + RF), offline data storage, and rugged microcontrolle rs. Research can add advanced biosensors, AI-based anomaly detection, energy-efficien t power systems, mesh networking, and stronger cybersecurity. Focus on miniaturization and battlefield-gra de testing will increase reliability and operational readiness.