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Automated Soldier Support Using Drone

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ABSTRACT

In today's technologically advanced era, adversary warfare remains a critical component of national security. A nation's Défense largely depends on its three primary uniformed forces: the Army, the Air Force, and the Navy. Within these forces, soldiers play an indispensable role. During specialized missions or operations, soldiers often face high risks, including injury or becoming untraceable on the battlefield. Given their vital role in national defense, it is imperative to ensure their safety by minimizing the risk of losing contact and ensuring rapid medical assistance when needed. To safeguard these frontline defenders, it is essential to develop a technology capable of real-time monitoring, tracking, and tracing of soldiers. Such a system would significantly reduce response time during emergencies and help avoid the complex negotiations often required to recover captured personnel. The technology proposed in this paper is designed to monitor the health vitals of soldiers while simultaneously tracking their real-time location using an array of integrated sensors. Data collected from these sensors is transmitted wirelessly to a central control unit. This allows the command centre to continuously monitor both the physical well-being and geographic position of each soldier using a combination of a wireless body sensor network and GPS modules at regular intervals. A microprocessor at the control unit processes incoming data from all connected subsystems. Should any health metrics exceed predefined thresholds, an alert is automatically triggered. This real-time health monitoring and tracking system not only enhances soldier safety during combat operations but also ensures that immediate support can be dispatched by the control unit or squad leader in the event of anomalies.

KEYWORDS
Drone, Soldier, ARM, GPS, Sensor, Health, Encryption module, Zigbee

1. INTRODUCTION

Drones are playing an increasingly vital role in modern soldier support systems, significantly enhancing situational awareness, logistics, and combat effectiveness [1]. Key applications of drones in military operations include Reconnaissance & Surveillance where Real-Time Battlefield Awareness is carried out by Providing live video feeds and data for enhanced situational understanding, Night Vision & Thermal Imaging by Enabling operations in low-light and obscured environments and Persistent Surveillance by Allowing continuous monitoring of enemy movements [1][2], Tactical Combat Support where Target Acquisition & Precision Strikes are carried out by Facilitating accurate engagement of enemy targets, Kamikaze Drone Operations by Utilizing drones for direct impact attacks and Electronic Warfare by Jamming enemy communication systems [1], Logistics & Resupply where Ammunition and Medical Supply Delivery by Ensuring essential supplies reach frontline troops, Casualty Evacuation (CASEVAC) is carried out by Assisting in extracting injured personnel from hostile zones [5], Search & Rescue (SAR) Operations where Locating and assisting trapped or injured soldiers using drone-based sensors and imaging [5], Base & Convoy Protection where Providing perimeter surveillance and threat detection for static and moving units [1], Urban Warfare & Close Quarters Battle (CQB) where conducting indoor reconnaissance and executing swarm tactics in dense urban environments [2], AI & Autonomous Operations where Autonomous target recognition and decision-making to support combat Operations, and Psychological & Misinformation Warfare where Deploying decoy drones and holographic projections to confuse or mislead adversaries[3]. Monitoring **soldiers' health** is essential to maintain peak performance, prevent injuries, and ensure timely medical intervention [4]. The key health parameters include vital signs monitoring such as heart rate (HR), blood pressure (BP), respiratory rate (RR) and body temperature. The oxygen & blood monitoring such as oxygen saturation (SpO_2), hemoglobin levels, blood glucose levels and lactate levels. The hydration & electrolyte balance includes hydration levels and electrolyte balance (Na, K, Cl), stress & mental health indicators such as cortisol levels, EEG (Brain Activity) and sleep patterns. The physical activity & injury monitoring such as muscle fatigue & strain, gait & posture analysis, impact & trauma detection [4]. The environmental exposure monitoring like radiation levels, toxic gas & chemical exposure and altitude sickness detection, wound & bleeding detection like smart bandages and blood loss estimation, AI & predictive health analytics such as predictive fatigue models and early disease detection

[6].

These sensors are integrated into soldier gear, including wearable smart suits having embedded biometric sensors in uniforms. The Smart helmets equipped with sensors monitoring brain activity, oxygen levels, and concussion risk & exoskeletons for assisting in mobility and tracking joint stress [4].

To improve survivability in reconnaissance and combat, drones are equipped with **stealth features** to avoid radar detection [3][7]. The key techniques included are Radar Cross-Section (RCS) reduction by shaped design, angled surfaces to deflect radar waves and smooth, non-reflective surfaces, minimizing radar reflections. Using Radar-Absorbing Materials (RAM) & coatings like carbon-based composites absorbs the radar signals and radar-absorbent Paints use to coat surfaces to reduce detectability. Adopting Low-Observable flight patterns such as low-altitude flight (Nap-of-the-Earth) and using terrain to stay below radar. The flying between radar gaps helps avoiding known radar zones and silent mode. Use of electric propulsion helps to reduce noise and heat signature. Use of Infrared (IR) & thermal signature reduction by low-heat engines like electric propulsion reduces thermal visibility and IR-absorbent materials coatings reduces infrared detection [7]. These integrated stealth technologies enable drones to operate undetected in enemy airspace for extended reconnaissance and precision strike missions.

Border disputes and ceasefire violations frequently require deployment of foot soldiers, often in harsh, remote terrains with extreme temperatures. In such conditions, transportation and communication are major challenges. Soldiers are at risk of being lost due to environmental stress—even without physical injury. Combat-induced fatigue further reduces survivability [6].

To address this, health monitoring and real-time tracking become critical. The objective is not only to monitor vital health indicators but also to deliver first aid using drones. This ensures immediate response and support, enhancing survivability and operational effectiveness in remote, high-risk areas [5][6].

2. OBJECTIVE

The primary objective of this prototype is to develop a system capable of continuously monitoring the health parameters of soldiers and providing autonomous, drone-based first aid delivery in extreme or remote environments. This system aims to improve survivability and medical response time in frontline combat zones, where harsh climates and communication challenges are prevalent [4], [6].

The system tracks essential physiological parameters to identify abnormalities in real time by monitoring critical health parameters like body temperature, physiological stress, heart rate and blood pressure. [4][8]

During adverse conditions environmental and psychological stressors significantly impact health metrics. The s**tress & exercise e**levate heart rate to >200 bpm in extreme cases. The r**espiratory variations a**lter both heart rate and blood pressure. The t**emperature extremes like c**old triggers vasoconstriction and elevated heart rate for thermoregulation. The heat increases blood flow and heart rate for cooling. Hypothermia results in reduced body temperature, blood pressure, and heart rate [8].

Sr No	Status	Temp Range
1	Normal	36.5°C to 37.5°C
2	Hypothermia	Below 35°C
3	Hypothermia	Above 38.5°C
4	During physical activity	38°C to 40°C

Table No 1: Temperature statistics

Sr No	Status	Heart rate
1	Normal	60–100 bpm
2	Athletes	~40 bpm
3	Severe hypothermia	~30 bpm

Table No 2: Hear bit Rate

While elevated heart rate does not always cause an increase in blood pressure, reduced heart rate generally leads to lower pressure. In trauma scenarios, pain and stress activate the sympathetic nervous system, elevating heart rate and pulse pressure [8]. For instance, gunshot injuries often result in lowered systolic blood pressure and a compensatory rise in heart rate [8].

A quad copter-based system is designed to deliver preloaded medical kits based on real-time analysis of soldiers' vitals [6], If critical thresholds are breached, the drone autonomously navigates to the soldier's location and delivers the appropriate first aid supplies. Zigbee modules enable communication between the monitoring unit and control system [9], while f**uture integration with** LoRa modules are being explored to extend range and ensure robust communication, especially in remote terrain and GPS-denied zones [9].

Challenges associated in aerial delivery are the drone-based delivery system faces environmental and logistical challenges [10] **GPS denied zones where s**ignal obstruction in mountainous terrain is possible. The h**igh altitude limitations due to r**educed air density affects drone lift and control. The ex**treme weather like r**ain, snow, and high wind can severely impact drone flight and delivery accuracy [10].

3. PROPOSED DESIGN

The proposed system is divided into three distinct modules: Soldier Module, Control Unit Module, and Drone Module. Each of these modules is integrated to work seamlessly, enabling real-time health monitoring, communication, and emergency response in battlefield conditions.

The Soldier Module is designed to continuously monitor and transmit key health parameters of the soldier in real time. This module consists of various sensors and processing units to track the soldier's physical condition and send alerts in case of any medical emergency.

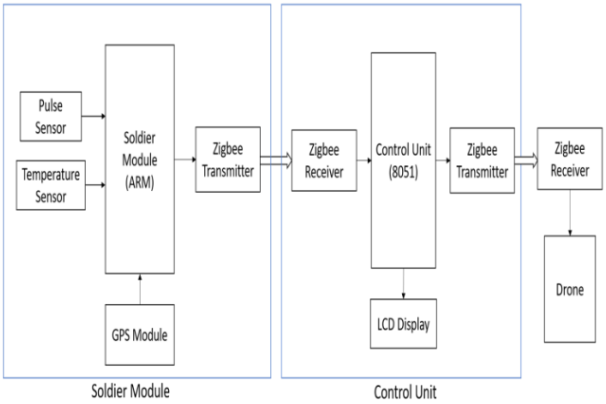

Fig. 1 Block Diagram of proposed system

Soldier module has health monitoring sensors where several physiological sensors are integrated into the soldier's wearable gear to monitor critical health parameters. These sensors includes pulse rate to monitor heart rate and detect any abnormalities, body temperature to detect potential signs of fever, hypothermia, or hyperthermia. Additional sensors can be added to monitor oxygen saturation, blood pressure, or muscle strain based on the mission's needs.

The data from these sensors is collected and processed by an ARM processor (LPC2148). The ARM processor is capable of handling multiple sensor inputs and performing necessary calculations for real-time health assessments. This central processor acts as the brain of the soldier module, ensuring that the health data is captured accurately and sent to the base station.

The soldier module is integrated with a GPS transmitter that allows real-time location tracking. This is essential for monitoring the soldier's position, especially in hostile or remote environments. If the soldier is in distress, their precise location is immediately sent to the control unit for prompt assistance. In case of medical emergencies, such as severe changes in vital health parameters (e.g., extreme body temperature, heart rate irregularities, or injury), the ARM processor will trigger an alarm and the emergency signal, along with the soldier's GPS coordinates, will be sent to the base station using the Zigbee communication protocol.

Additionally, an emergency button is included in the soldier's gear. When the soldier manually presses the emergency button, it signals the control unit and activates an urgent response. The Control Unit Module acts as the central hub that receives, displays, and processes the data from the soldier module. It allows the base station personnel to monitor the health and location of each soldier in real time.

The Control Unit continuously receives health data from the soldier modules. This information is displayed on a monitor where operators can track parameters such as pulse rate, body temperature, and soldier location. This enables base station authorities to identify any medical anomalies at a glance.

When an emergency alert is received from a soldier module (via Zigbee), the control unit displays the coordinates of the soldier on the screen, marking their exact location. Shows an emergency message, detailing the nature of the alert (e.g., heart rate abnormality, body temperature out of range, etc.).

This immediate visual feedback ensures that base station personnel can prioritize their response and make critical decisions regarding the soldier's wellbeing. Upon receiving an emergency signal, the control unit is responsible for transmitting the soldier's GPS coordinates to the drone module. This is done to trigger an immediate response from the drone, which will fly to the soldier's location for first aid intervention. The base station coordinates with the drone to ensure that first aid supplies reach the soldier as quickly as possible, facilitating timely medical support.

The Drone Module is designed to be the first responder in a medical emergency. The drone is equipped with essential first aid supplies and is capable of autonomously navigating to the soldier's location to deliver medical assistance.

The drone is equipped with enough payload capacity to carry essential first aid supplies, including bandages, medications, intravenous fluids, thermal blankets, and other emergency medical kits. The drone uses the GPS coordinates provided by the base station to autonomously fly to the soldier's location. It is equipped with navigation systems (e.g., GPS, IMU, and cameras) to ensure accurate and efficient route planning. Once the drone arrives at the soldier's location, it can either land or use a winch system to lower medical supplies directly to the soldier if terrain conditions do not allow for safe landing.

The primary task of the drone is to provide immediate medical aid in the form of first aid kits containing basic medical tools and supplies. Medication based on the parameters sensed (e.g., administering anti-fever medication for elevated body temperature). Thermal blankets or other items that can provide immediate care until human medical support arrives.

The drone module is designed for quick deployment, reducing the response time significantly compared to traditional methods of evacuation or assistance in combat zones.

All three modules (soldier module, control unit, and drone module) are interconnected to function as a unified system. The soldier module continuously sends health data to the control unit, allowing for continuous monitoring of soldier health and location. In the event of an emergency, the base station communicates with the drone, directing it to the soldier's location for first aid assistance. The system ensures a rapid response in emergency situations, minimizing the time between identifying the problem and providing medical assistance. The soldier module communicates wirelessly with the control unit using Zigbee, which offers low-power, short-range communication, making it ideal for real-time data transmission in battlefield conditions [5].

The GPS system in the soldier module and drone ensures that the soldier's location is continuously updated and communicated to the base station, facilitating prompt responses.

The proposed design effectively integrates health monitoring, emergency alerting, and first-aid delivery via a drone-based system. This approach ensures that soldiers in remote or combat zones receive immediate medical assistance, potentially saving lives and improving the efficiency of field medical support.

4. CIRCUIT DIAGRAM

Detailed flow chart of Soldier Tracking Security System proposed is as shown in Fig 2. And the Fig 3 shows the circuit diagram that provides a comprehensive representation of the design for a security system aimed at soldier tracking. The system is organized into three distinct modules, the Soldier Module, Control Unit, and Drone Module. Each module plays a crucial role in ensuring real-time health monitoring, tracking, and emergency response.

This section explains the functioning of each module in detail, highlighting the components, interconnections, and how the overall system operates together to ensure the safety and well-being of soldiers in the field.

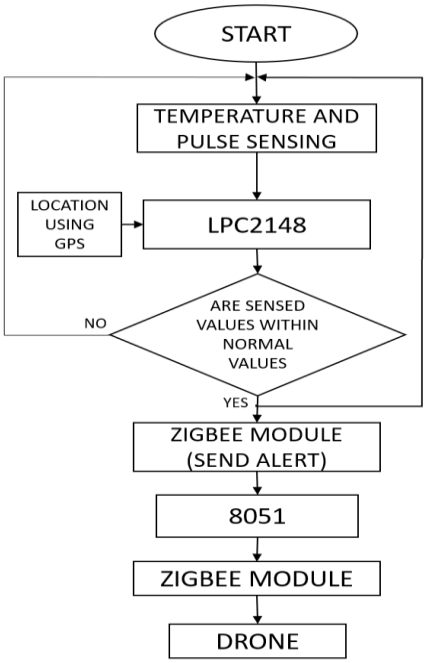

Fig. 2 Flowchart of proposed design

The Soldier Module is a critical component of the system that continuously monitors the health parameters of soldiers and sends real-time data to the control unit. The soldier module incorporates various sensors that measure vital health signs such as pulse rate, body temperature, and location. The pulse sensor is used to monitor the soldier's heart rate, allowing the system to detect any abnormalities that may signal distress or medical issues medical issues.

The temperature sensor is designed to continuously track the soldier's body temperature. Any drastic deviations from the normal range can be indicative of fever, hypothermia, or other health concerns. The soldier module is equipped with a GPS Neo m8n module transmitter that provides real-time location tracking. This allows the control unit to monitor the soldier's position in the field and is especially useful in locating soldiers during emergencies or in difficult terrain.

All the health data from the sensors is processed by the ARM Processor (LPC2148). This microcontroller serves as the central hub for managing sensor inputs, processing the data, and making decisions based on predefined health thresholds.

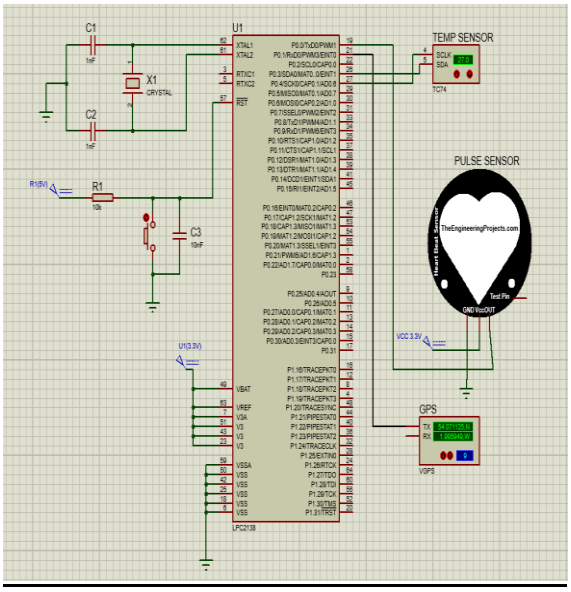

Fig. 3 Circuit Diagram

The LPC2148 microcontroller is responsible for converting analog sensor data into digital signals and performing any necessary calculations. The processor is also connected to a Zigbee communication module, enabling wireless transmission of the data to the Control Unit Module. In the event that any monitored health parameter deviates from the acceptable range (e.g., abnormal pulse rate or body temperature), the ARM processor will generate an alarm signal. This signal is sent through the Zigbee communication protocol to the Control Unit Module for further action.

Additionally, the Soldier Module features an emergency button. This button allows the soldier to manually signal for medical assistance in critical situations. When pressed, the emergency button triggers an urgent alert to the control unit, including the soldier's current GPS coordinates, enabling a swift response. The Control Unit Module acts as the central management and monitoring hub for the entire system. It receives and processes real-time health data from the soldier modules, displays it for the authorities, and coordinates emergency responses. The control unit continuously receives the health data transmitted by the soldier modules. This data is then displayed on a monitor, which allows personnel to track the soldier's health parameters such as pulse rate, body temperature, and location in real time. The control unit software has been designed to show the status of each soldier's health, alerting the authorities when critical conditions are detected. When an emergency signal is received from a soldier module, the control unit takes immediate action:

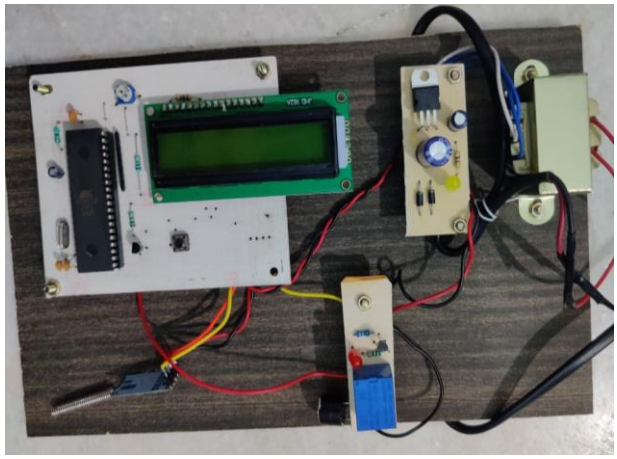

Fig. 4 Soldier Module

The soldier's GPS coordinates are displayed on the screen, marking the soldier's exact location. An emergency message is displayed, detailing the nature of the health anomaly (e.g., elevated body temperature, irregular pulse rate). This feature enables the control unit authorities to assess the situation quickly and prepare for rescue operations. By having the soldier's location and health status at hand, response teams can prioritize their actions and act efficiently.

Once the emergency alert is confirmed, the control unit is responsible for sending the soldier's GPS coordinates to the Drone Module. The control unit communicates with the drone, instructing it to autonomously navigate to the soldier's position. The drone will then deliver the necessary medical supplies, such as first aid kits, medications, or other emergency equipment, based on the soldier's condition.

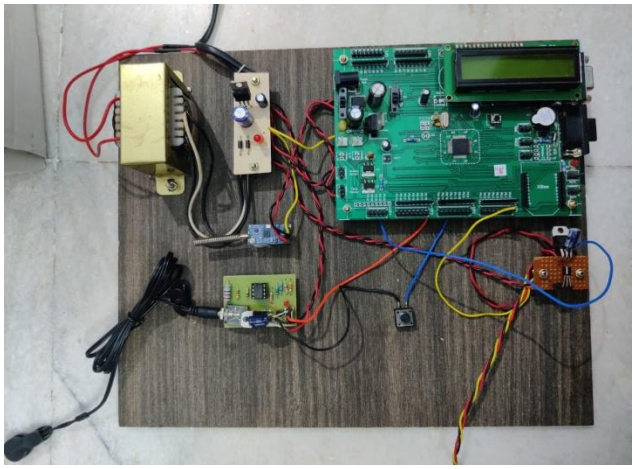

Fig. 5 Control Assist Unit

The Drone Module is the autonomous aerial unit responsible for providing first aid and medical assistance to soldiers in the field. It is designed to carry essential medical supplies and navigate autonomously to a soldier's location in the event of an emergency. The drone is equipped with sufficient payload capacity to carry critical first aid supplies, including bandages, painkillers, intravenous fluids, and thermal

blankets. This allows the drone to serve as the first responder in emergency situations. Using the GPS coordinates provided by the control unit, the drone autonomously navigates to the soldier's location. The drone is equipped with a navigation system that ensures it reaches the correct coordinates even in challenging environments. Upon reaching the soldier's location, the drone either lands to deliver the medical supplies or uses a winch system to lower supplies if the terrain does not allow for safe landing. This ensures that the soldier receives immediate medical assistance, even in remote or difficult-to-access areas.

Fig. 6 Drone Module

The primary function of the drone is to provide medical assistance as quickly as possible. The drone can deliver first aid kits containing bandages, antiseptics, and other essential supplies. Transport medications based on the soldier's condition, such as pain relievers or fever-reducing drugs. Provide thermal blankets to prevent hypothermia or heatstroke, depending on the environmental conditions. By acting as a first responder, the drone helps minimize the time between identifying a medical emergency and delivering the required treatment, increasing the chances of a successful outcome. All three modules – the Soldier Module, Control Unit, and Drone Module – work together seamlessly to provide a complete soldier health monitoring and emergency response system. The soldier modules constantly transmit health data to the control unit, allowing for immediate action if needed. In case of emergency, the control unit instantly triggers the drone response, enabling first aid to reach the soldier as quickly as possible. The drone's autonomous navigation ensures that medical supplies are delivered without delay, while the continuous health monitoring ensures that soldiers' conditions are tracked at all times.

The system employs several communication technologies to ensure smooth operation. Zigbee is used for communication between the soldier module and the control unit, Zigbee offers reliable, low-power wireless communication in a range of up to 100 meters, ideal for battlefield conditions. GPS is integrated into both the soldier module and drone, GPS technology allows for precise location tracking and navigation, ensuring accurate delivery of medical supplies.

This security system provides a comprehensive solution for monitoring the health and safety of soldiers in remote or hostile environments. By combining real-time health tracking, emergency alerts, and autonomous drone-based first aid delivery, the system ensures that soldiers receive timely medical attention, even in the most challenging conditions.

5. RESULT

Our aim was to receive coordinates of soldier at the control unit which we have achieved as seen in Fig. 3. These coordinates can be used to map the location of the soldier.

Fig. 7 Coordinates of Soldier on Screen

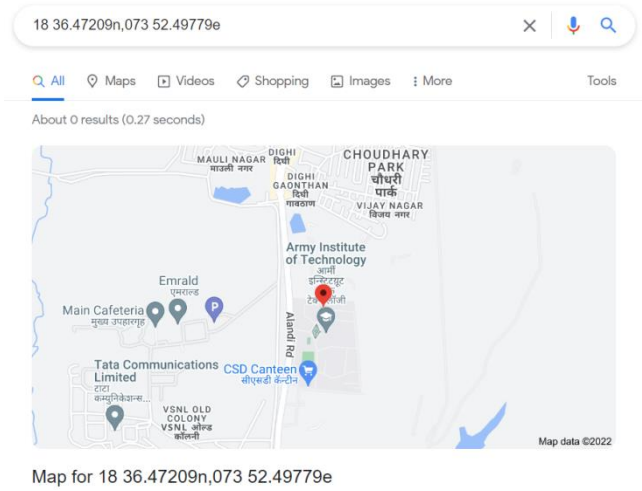

Fig. 8 Coordinates of Soldier on map

6. CONCLUSION

This integrated soldier tracking and health monitoring system offers a comprehensive solution for enhancing the safety and well-being of soldiers operating in challenging environments. By combining real-time monitoring of key health parameters with rapid emergency response capabilities, the system ensures that potential health risks are detected early, and timely medical assistance is delivered promptly. The use of advanced technologies, such as **Zigbee** for communication and **GPS** for precise location tracking, enables seamless data transmission between the **Soldier Module**, **Control Unit**, and **Drone Module**. This system empowers control unit authorities to act swiftly in critical situations, ensuring the best possible outcomes for the soldiers. Moreover, the **Drone Module** provides an efficient and effective method for delivering life-saving medical supplies in emergencies, acting as a first responder in the field. Overall, this system improves

soldiers' safety, accelerates emergency medical response, and contributes to the operational effectiveness of military missions.

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