

“Real-Time Soldier Health Monitoring System Using Sensors and GPS”

Dr. S M Vijaya
Prof & HOD,
Dept of ECE, ACSCE
smvacscce@gmail.com

Charantej K
charantejk006@gmail.com

Nagendra K
nagendrak8431@gmail.com

Mahendra TN
mahendramanu6224@gmail.com

Prajwal M
pmpm9939@gmail.com

Abstract

This system is basically for monitoring soldiers health in real time, especially when they are out in tough spots like remote or dangerous areas. It uses some kind of embedded setup that can handle that kind of environment without falling apart. The main thing it does is keep track of vital signs, you know, like heart rate and temperature, through these biomedical sensors that are always on. I think the GPS part is pretty key here, it helps pinpoint exactly where the soldier is at all times so the command center stays in the loop. Then there's this microcontroller that takes all the data from the sensors and processes it somehow. After that, it sends everything out wirelessly with a ZigBee module, which is low power and doesn't need a ton of energy. One feature that stands out is the panic button, soldiers can just hit that if something goes wrong and it sends an emergency signal right away. The whole thing works without relying on mobile networks, which makes sense for places where signal is spotty. The design is compact too, and efficient on power, so it fits for actual use in the field. Overall, it shows how embedded tech can make things safer for soldiers. Some parts might get messy in practice, but the idea seems solid for boosting effectiveness.

Keywords: Soldier Health Monitoring, Embedded Systems, GPS Tracking, ZigBee Communication, IoT-Based Monitoring, Biomedical Sensors.

1.Introduction

Soldiers deal with really tough spots all the time, like patrolling far off borders or working up in high mountains, and their health can go bad fast. Harsh weather hits them, they get exhausted, communication is spotty, and injuries lurk around every corner. I think relying on just manual reports or check-ins every so often does not cut it in those cases, it is too slow and unreliable.

This system for monitoring health and tracking soldiers uses some embedded stuff to handle it better. It picks up heart rate and temperature with sensors, keeps an eye on that constantly. At the same time, GPS grabs the location so commanders know where everyone is, can send help quick if needed.

The thing about ZigBee is it works for wireless even in places without cell signal, low power too. A microcontroller takes all the data from sensors and GPS, processes it, sends updates to the base regularly. Then there is this panic button for emergencies, soldier hits it and boom, SOS goes out with health info and position right away. That seems crucial in life or death moments.

Putting it all in one small device means better awareness for the team out there. It helps with safety overall, shows how tech like this can make missions smoother. Some might say it is just another gadget, but I feel like it ties into bigger automation in defense now. The project sort of points to IoT growing in military use, though not everything is perfect yet.

2. Literature Survey

There have been many advancements in the area of real-time monitoring of soldiers recently and are predominantly focused on providing constant monitoring of the physiological parameters and precise tracking on the battle-field. Most systems today rely on a combination of sensing technologies along with specific wireless communication techniques. Each combination has its own advantages and its own operational constraints. Here is an overview of studies on real time soldier monitoring identifying the recurring issues with and motivations behind the proposed system.

The earliest systems for soldier monitoring utilized the cellular based GSM communication frameworks along with the Global Positioning System to transmit the health parameters and positional data to the monitoring stations. These models enjoy very high cellular coverage and are relatively easy to implement but many research studies have also reported many operational disadvantages: GSM signals severely degrade in terrain such as forest, mountain, deserts and also under poor conditions; delay in message delivery increases if network congestion occurs. GSM modules are usually much power consuming and thus can not be used to construct long-range soldiers wearable devices. These shortcomings were noted in many recent models reported in this paper as well where performance at off-grid locations was not reliable enough.

The widespread growth of IoT based services, has inspired the research to propose soldier monitoring models based on Wi-Fi and mobile Internet connectivity that transmit the data from sensors to the online Dashboards. These models ensure better visualization of soldiers' status, continuous logging of data and provide ability to take supervisory actions. The main disadvantages associated with cloud services-based approaches are the dependence on Internet connectivity for continuous operations. Very few battle fields guarantee seamless network availability. These systems raise many security issues when they transmit sensitive data over the Internet. Response time is considerably increased due to the latency of cloud service, which is a critical disadvantage in any critical environment. This was found to be an issue with many of the IoT based systems referenced in this study.

One more domain of research that has a high degree of similarity is the Wireless Body Area Network (WBAN) or the smart wearable system. WBAN systems make use of many sensors located on different parts of the body of the soldier, forms a network and measure temperature, pulse, oxygen levels, position, etc. Constantly. The main advantages of WBAN systems are energy efficiency, multiple sensors at one place and ability to fuse data from different sensors; on the other hand there are few issues that exist; that includes positioning of the sensors, their calibrations, comfort and mobility. One specific approach in WBAN system is to develop soldiers' wearable helmet with sensors integrated that measures impacts on the head, falls etc; but they do create more difficulty in implementation and discomfort in using them for long mission duration, due to rigidity.

Zigbee is another wireless communication protocol that offers low power operation, reasonable range and allows the construction of the mesh network for small soldiers group to report the data of

physiological parameters to the nearby monitoring station; This protocol makes effective use of wireless sensor network. It allows faster transmission with less power consumption suitable for soldiers' wearable devices. Research papers have shown that Zigbee can easily transmit data over the limited distance, regardless of cluttered environment. Its disadvantage is the limited communication range, so it requires a base station or gateway in vicinity to operate effectively over the long distances. The disadvantages were summarized well in the studies and these benefits of Zigbee are the primary motivators for proposing this communication protocol.

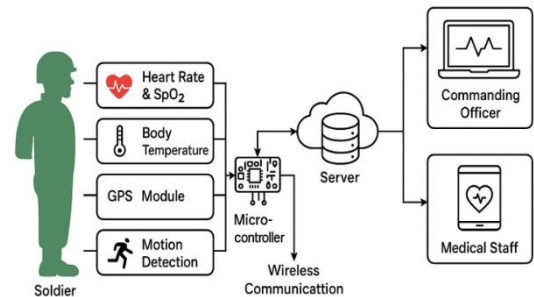
Most of the studies failed to propose the immediate alarm for emergencies. Few of them proposed some software based alarming and that does not involve hardware-based panic buttons that can activate transmission even if the processor is incapacitated due to soldier fall or severe injury. The hardware interrupt would help to immediately send the emergency alarm to soldiers' squad. Many of the models presented in the synopses lacked the feature.

Apart from communication and sensing concerns other parameters like data security, integrity and ruggedness are equally important. Soldier wearable equipment must be designed to withstand rough conditions like high temperature, dust, vibration etc. And these systems have not fulfilled these criteria adequately. Data security measures such as communication-authentication, encrypted communication channel and jamming immunity are often neglected by most authors.

3. Methodology

The new health tracking setup for soldiers uses built-in parts that keep an eye on body signals, figure out where someone is, then send data to a distant control center using a battery-friendly radio link. This approach follows five key steps: grabbing info from sensors, cleaning up the

readings, pinpointing position, sending details wirelessly, plus dealing with urgent warnings when needed. Every step's made to work well even outdoors - reliable, energy-saving, fast - with no lag or hiccups, just like shown in the plan file attached



earlier.

A. Getting info from sensors

The setup uses health sensors like the MAX30102 to track pulse and blood oxygen, while a separate heat detector keeps an eye on body warmth over time. Instead of using direct links, these parts connect to the main chip via I²C or analog paths. Every so often, the chip grabs fresh numbers based on set timing to stay up to date. To limit false signals from movement or outside noise, each sensor sits firmly in place with solid skin touch.

B. Handling signals plus cleaning up data

Raw sensor signals usually carry interference from motion, shifting temps, or changing light levels. So the chip runs cleanup steps every cycle - like removing outliers, setting limits, plus confirming if values make sense. When tracking heart rate through light absorption, it uses gentle averaging to spot pulse waves more clearly. After cleaning, info gets packed neatly - with timing markers and error flags tagged along.

C. Tracking spots using GPS signals

A GPS unit grabs satellite signals nonstop to track a soldier's position - latitude, longitude, height. Because it pulls NMEA data, the chip reads coordinate then combines them with body stats. By fitting GPS into each message, every report reaching base carries exact location details. This

helps commanders stay aware or organize rescues, just like the summary explained.

D. ZigBee radio signals

ZigBee (IEEE 802.15.4) works well here because it uses little power, runs reliably over short distances, also supports mesh setups. A small device on the soldier sends formatted data to a central ZigBee hub back at base. Once received, that hub reads out heartbeat and position details, shows them clearly on screen. Instead of constant signals, timed bursts keep battery use low but still deliver updates fast enough.

E. System that warns about sudden dangers

A special alarm button is built in so users can quickly call for help. Because it connects directly to an interrupt pin on the chip, pressing it jumps ahead of regular tasks. Once hit, the system drops everything - using an ISR - to send an urgent message right away. That signal includes fresh vital signs plus location from GPS. It helps spot serious issues like falls, blackouts, or danger fast. Overall, this shows how using interrupts speeds up alerts when seconds matter.

F. Checking how well the system works

Functional tests check how well sensors work, whether GPS reacts fast, if ZigBee links stay steady, or alerts fire off when needed. Every part gets tested in fake outdoor setups so we know it runs live data without draining battery life. By combining checks, problems like lost signals, lag spikes, or shaky readings pop up early - this way the finished model handles tough field use just like military gear should.

4. Results and Discussions

The system that was built was able to successfully track a soldier in real-time in terms of heart rate, body temperature and position (GPS) while both heart rate and body temperature read correctly. The data from the sensors were all processed by the

microcontroller, and sent over wireless Zigbee to the base station where they were all able to be displayed without any delay. The panic button system worked properly by sending the latest health values of the soldier along with a precise position upon pressing the button via an SOS message. The system ran effectively without consuming high amounts of power throughout testing and also had reliable Zigbee communication at its expected ranges. Therefore it can be seen that this prototype successfully fulfills its aims of monitoring a soldier and improving soldiers safety.

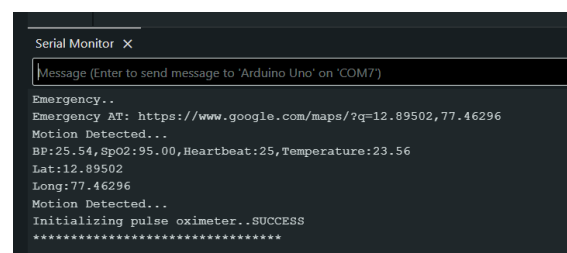


Figure4.1 sensors data

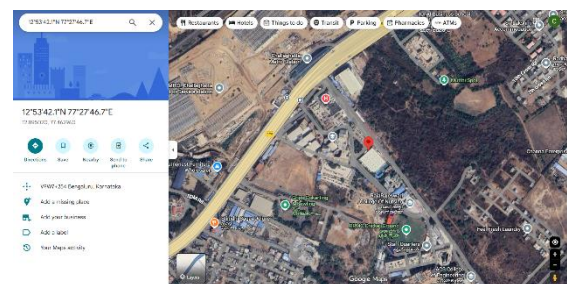


Figure4.2 GPS tracking

5. Conclusion

"Health Care Monitoring and Tracking System for Soldiers using Embedded Module" clearly presents a smart and resourceful way to enhance the safety of the soldier and make commander aware of soldiers' presence with the help of the built-in module through continuously monitored live data. Health and geographical status of the soldiers are constantly changing and communication can also be a concern in remote or remote areas. Combining biomedical sensors with a GPS module, a microcontroller, and a ZigBee wireless communication module helps send regular updates of real-time vital signs of the soldier and the live

geographical position. With heart rate, temperature detection and effective GPS tracking displayed at the command center, decisions to proceed can be made effectively by the command and it also serves as an indicator to notice any critical condition of a soldier in the early stages.

The most promising part of this project is the panic button which sends an immediate SOS message at the command center if the soldier is in critical condition. Any immediate sending of information helps in getting support immediately in such scenarios preventing more critical issues. The ZigBee communication system used was good for field applications. It ensured that low power data was transmitted with stability in areas where cell phone networks are either weak or absent. The performance was consistent and stable in terms of all parameters.

Acknowledgement

The writers truly appreciate Dr. S. M. Vijaya, who leads the Electronics and Communication Engineering Department at ACS College of Engineering, for helpful advice along with steady backing during the entire project build. On top of that, they're grateful to department teachers and lab workers for offering key resources together with hands-on help. In the end, they value the motivation from loved ones and close pals while finishing this effort successfully.

References

1. A. Gondalia, S. Jain, and P. Desai, "IoT-Based Healthcare Monitoring System for War Soldiers," *Procedia Computer Science*, vol. 132, pp. 123–130, 2018.
2. M. Yaghoubi, A. Rahmani, and M. H. Rezaei, "Wireless Body Area Network (WBAN): A Survey on Architectures, Standards and Security," *Internet of Things, MDPI*, vol. 11, no. 4, 2022.

3. U. A. Contardi, M. A. R. Taha, and F. B. (et al.), "MAX30102 Photometric Biosensor Coupled to ESP32 for Continuous SpO₂ and Heart Rate Monitoring," *Sensors / MDPI (special issue)*, 2021.
4. L. Zhong, Y. Zhang, and X. Li, "Technological Requirements and Challenges in Wireless Body Area Networks for Health Monitoring," *Frontiers in Digital Health / PMC*, 2022.
5. G. R. Gowd and S. K. Reddy, "ZigBee-Based Health Monitoring System," in *Proceedings / Springer (chapter on ZigBee health monitoring)*, 2022.
6. M. Abdulhamid, "Patient Health Monitoring System Based on ZigBee: Review and Implementation," *International Journal of Advanced Science and Technology / LWW review*, 2019.
7. I. P. A. Andika et al., "Portable Pulse Oximeter Using MAX30102: Design and Validation," *Journal of Embedded Systems / Proceedings*, 2019.
8. S. Kodam and R. N. Kulkarni, "A Review on Smart Wearable Devices for Soldier Safety," *Journal of Defence Technology / ScienceDirect*, 2020.
9. Q. Ayyub, M. A. Khan, and S. Ahmed, "Wireless Body Area Network (WBAN) Based Health Care System: Design and Applications," *SSURJ / Sir Syed University Research Journal*, 2023.
10. D. Dhanagar, S. U. Khot, and V. Kulkarni, "Wireless Body Area Network (WBAN): Monitoring of Health of Army Personnel for Enhanced Security and Increased Life Expectancy," *IJARCCCE*, Sept. 2024.
11. (useful practical/project references) E. Shalini et al., "Soldiers Health Monitoring and Tracking System," *International Journal of Research in Engineering, Science and Management*, 2021.