A low-cost IoT-based system for monitoring the health of individual soldiers and tracking their real-time whereabouts in combat zones

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Abstract

The security of the soldiers is said to play a significant role in the security system of the country today because it is dependent on the enemy's fight. It is extremely impossible for the army base station to be aware of the location and health state of every soldier as soon as one more soldier cross into the enemy lines. Numerous tools are available to monitor a soldier’s physical well-being and ensure their safety. The suggested system employs GPS to track the soldier's direction in terms of latitude and longitude values to make finding direction simple. The suggested technology, which uses GPS to track the soldier's whereabouts and health state, can be mounted on their body. The IoT will be used to provide this information to the control panel. The system that is being suggested consists of tiny transmission modules, sensors, and wearable physiological equipment. As a result, it is feasible to establish a low-cost mechanism to preserve priceless human life on the battlefield with the use of the proposed equipment. Using GPS (Global Positioning System) and GSM (Global System for Mobile) in its design, this device provides a wireless platform for monitoring the soldier's body temperature and heart rate while also tracking their whereabouts. Thus, every troop can easily share their health status with the nearby ground station during combat.

Keywords. Navigation system, GPS System, GSM module, Mobile Health Monitoring, Global security system.

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1. INTRODUCTION

In India, the Army, Navy, and Air Force are responsible for maintaining and monitoring national security. Soldiers who give their lives in service to their country play a significant and crucial role. A lot of people are worried about the soldier's safety. A lack of communication tends to result in dead civilians as they approach enemy territory, so it is imperative that the army base station is aware of both the whereabouts and health status of every soldier. Because there was inadequate medical support and communication between the men on the battlefield and the authorities at the army base stations, India has already lost a significant number of soldiers in combat. Supporting the armed forces is essential. Launching this initiative is necessary in order to reveal the soldiers' health status and provide for their needs when they are in terrible straits on the battlefield [1]. Everyone must be concerned about the soldiers' safety, so a new monitoring system has been developed to track the soldiers' health and provide immediate medical attention as soon as possible.

One physiological signal that is monitored by the geolocation-based heart rate monitoring system is heart rate, which is measured on board or by a wearable heart rate sensor. This methodology makes use of the resources offered by mobile technology. The created mobile application enables consultation with health experts and provides alert messages via notification [2].

A wireless combined vital sign technology that can assess both heart rate as well as oxygen levels has been demonstrated [3]. navigation system to track the whereabouts of soldiers and track their health metrics. The AT89C51 microcontroller was employed to capture vital signs, which were then communicated to the main unit over GSM [4]. Another wireless system with a health monitoring system has been designed using a Fiber Bragg Grating (FBG) sensor and the Zigbee network [5]. The idea of putting GPS [6–8] into practise has been handled as a GPS-based tracking system that is made up of open-source software, cheap hardware, and a remarkably easy user interface via a web application using Google Earth software. It is suggested to use a smart watch-based fitness surveillance device [9] that provides information on heart rate, blood pressure, and the ECG. A communication interface is created using Bluetooth.

The objective of this project is to create trustworthy, non-interference health status indicators that are cheap, low power-consumption, and reliable. It is also used to find the location of the soldier.

The soldier's current location will be provided via the GPS tracker, which will help locate the soldier and get medical assistance to him as quickly as possible. Using the GSM modem built into the gadget, if a soldier is hurt, nearby medical

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centres or the central node will receive an SMS to call the emergency services. GPS is used to track troops, and GSM is used to enable network connectivity.

2. HARDWARE COMPONENTS

2.1. ARDUINO Nano

The Arduino Nano is, as its name implies, a small, feature-rich, and breadboard-friendly microcontroller board. The Nano board has dimensions ranging from 4.5 cm to 1.8 cm and weighs approximately 7 grammes (L to B). Like the Arduino UNO [10], the Nano comes equipped with an ATmega 328P microprocessor [11].

Figure 1(a). Arduino Nano (b) GPS Module

The UNO board is offered in PDIP (Plastic Dual-In-line Package) form with 30 pins, while Nano is offered in PQFP (Plastic Quad Flat Pack) form with 32 pins. This is the primary distinction between both. While the Arduino UNO has six ADC ports, the Arduino Nano has eight, which are served by the extra two pins. In contrast to other Arduino boards, the Nano board only contains a mini-USB connection for power. Both serial monitoring and programming are done using this port.

- Operating Voltage: 5V
- Flash memory: 32 KB (ATmega328P) of which 0.5 KB is used by the bootloader
- Clock frequency: 16 MHz

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2.2. GPS Module

It is a navigation system that is based in space and delivers precise location and time information in all weather conditions. Anybody with a GPS receiver can publicly access the global positioning system (GPS), which will be administered by a US business. It has thirty or more GPS satellites in ordinary earth orbit (2000 - 3500 km), and a dozen satellites will work together to form what is known as a satellite network. It is mostly utilized in various applications related to surveying and navigation. The orbital period of the GPS satellites is 12 hours, and they fly in a sphere at a height of 20,200 kilometres. They are made up of at least six satellites that can be seen from anywhere on the planet, and their orbital planes are centred on Earth.

2.3. Wi-Fi module ESP8266EX

The ESP8266 is a low-cost system on a chip (SOC) Wi-Fi microchip made by Espressif with integrated TCP/IP network communication and microcontroller characteristics. A Wi-Fi-based microchip with a 9600 baud rate capable of serial communication is the ESP 01 chip. The Wi-Fi module's self-contained soc, which is integrated with the TCP/IP protocol, allows access to any microcontroller on its Wi-Fi network. An AT command set was initially programmed into ESP01. It can be connected to any sensor because of the large storage capacity and on-board processing it possesses

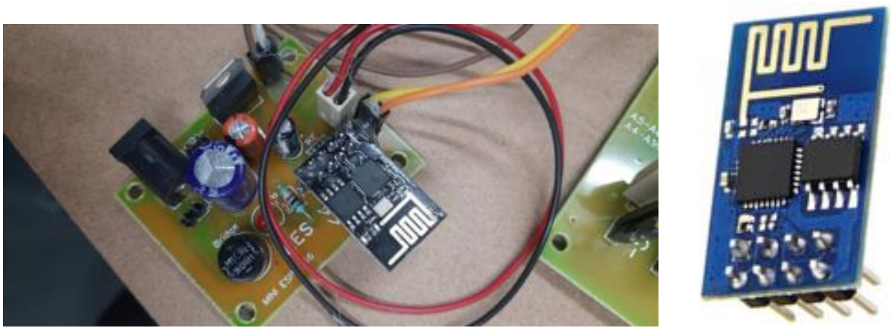

Figure 2. Wi-Fi Module

2.4. Heartbeat Sensor

The term "sensor" refers to a device that generates a signal corresponding to the quality being measured. The physical parameter being monitored by the sensor is converted into an electrically measurable signal by the sensor. A sensor is frequently used in conjunction with other electronics, although it can also be a mechanical sensor. There are huge sensors available for a variety of purposes. A biomedical sensing device is employed in this study. Heartbeat sensors operate

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based on a change in optical power; as light is absorbed while travelling through the blood, its optical power changes according to the rate at which the heart beats.

Figure 3(a) Heartbeat Sensor (b) Temperature Sensor (c) Display unit

Light-emitting diodes [12] and photodiodes are used in the heartbeat sensor. Whenever the heart is beating, the heartbeats will fluctuate, resulting in changes in blood circulation throughout a variety of body parts. This also happens when tissue lights up due to light from an LED. Plasma would absorb a portion of the illuminating light, with the photo diode capturing the leftover light reflected. Brightness has always been related to Jersey heart rate, and the quantity of light absorbed corresponds to the volume of blood in the tissue.

2.5. Temperature and humidity sensor (DHT11)

The DHT11 digital temperature [13] and humidity sensor is a hybrid instrument with a standardized digital signal output for both temperature and relative humidity. The device offers exceptional long-term stability and high dependability thanks to the application of temperature and humidity sensing technologies as well as a dedicated digital module collection.

- 3.5 V to 5.5 V voltage range
- 3 mA measuring current 60 µA standby current
- Serial data output
- from 0°C to 50°C in the temperature range.
- Both temperature and humidity are 16-bit measurements.
- 1°C and 1% precision

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3. PROPOSED SCHEME

This model includes body sensor networks, including temperature and heartbeat detectors. The health vitals of soldiers are monitored using these devices. The heartbeat sensor measures the troops' pulse rate in beats per minute (BPM), while the sensor module (DHT11) keeps track of the temperature of the person and their immediate surroundings. The model's pictorial depiction is demonstrated in figure 4.

A situation is deemed urgent if there is any difference between the detected data and the established threshold. The node is upgraded to include a GPS receiver in addition to the body sensor networks to track and locate the soldier. To report his whereabouts using a GPS module in an emergency, the soldier might hit the panic button. The micro controller processes and records all the data coming in from the sensors, and then sends it to the next node, the squadron leader's node, which then sends it to the control room via a wifi module built into the system. The experimental setup for the suggested system is shown in Figure 5.

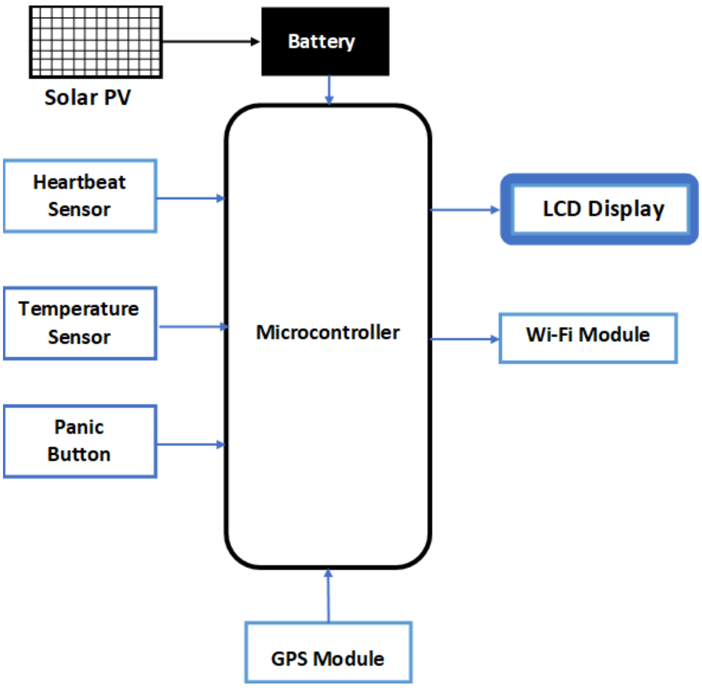

Figure 4. Proposed system block diagram

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4. WORKING MODEL

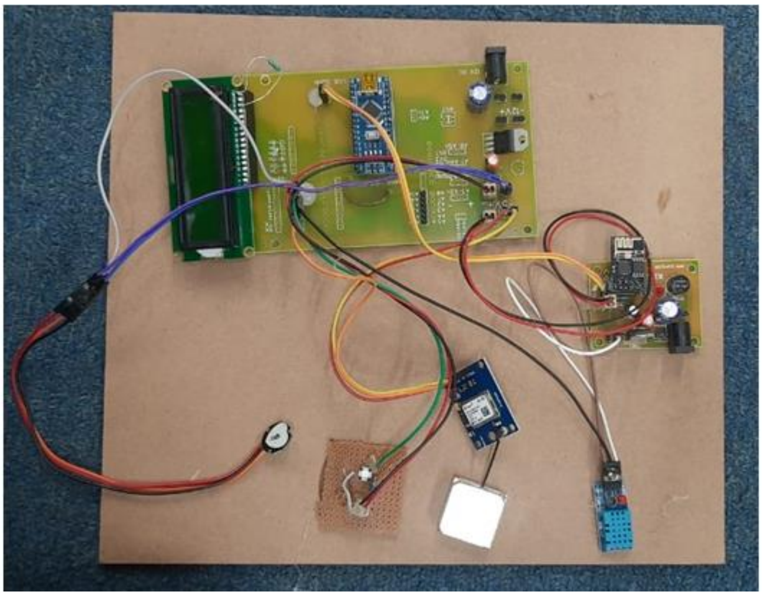

Figure 5. Experimental setup of the proposed system

The fitness of the trooper as determined by his pulse and body temperature is essentially our scheme's biggest priority. When a warrior is shot and knocked out, or if he loses consciousness for any other reason, his pulse progressively tends to rise or drop. In an emergency, a soldier may press the panic button to use a GPS module to transmit his whereabouts. All the information, along with the geolocation, was gathered by the microcontroller and sent to the closest ground station. The different tracking parameters of the soldier are relayed via a Wi-Fi unit, allowing the central server to access the trooper's present position via IOT. This information will be kept on the web and can be retrieved from the command centre as needed. Based on these details, the authorities can take fast action by sending out a health care team, an emergency response team, or any other support group to assist.

The module exclusively uses inexpensive, low-power semiconductors. Only simpler components were employed in this module, making it simple for soldiers to transport it to the battlefield. Several accessories can be fitted inside the soldier's jacket. The entire arrangement is powered by a solar-powered electric battery. Soldiers, those taking part in special expeditions, or individuals on specific assignments will benefit from this service.

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5. Conclusion and Future Scope

The study describes a low-cost Arduino-based prototype system for tracking and monitoring the soldiers' health conditions. Biomedical sensors provide each soldier's heart rate, body temperature, and ambient data to the command post. This technique may assist in solving the problem of soldiers going missing in combat by accurately locating missing soldiers who are in critical condition.

To enhance the system's performance, new designs and sophisticated technologies may be used. Additionally, by utilising AI/ML algorithms, we could predict which soldiers will need medical assistance soon. Additionally, it could predict whether a sensor or component would need to be replaced or maintained. Other enhancements that can be made include the use of modern security protocols and techniques on the wireless RF modules, which will increase the security and dependability of the entire process of transmitting and receiving sensor data.

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