
INTEGRATED IOT FRAMEWORK FOR REAL-TIME SOLDIER HEALTH AND LOCATION TRACKING

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ABSTRACT:

Modern defensive and combat operations place a premium on soldier well-being and efficiency. This article describes an Internet of Things (IoT) architecture that provides real-time tracking of soldiers' geolocation and vital health data during military deployments. Wearable sensors and integrated communication modules allow the system to wirelessly communicate data to a central unit, including movement, temperature, and heart rate. Also, in unpredictable and potentially hazardous situations, GPS enables exact tracking of troops' locations. The proposed technology would improve military commanders' situational awareness, enabling them to make better strategic choices and provide better medical procedures while on the move. It is perfect for use in hard or isolated locations due to its low power consumption and strong reliability architecture. Through the use of Internet of Things (IoT) technology, this research contributes to the development of intelligent, secure, and extensible systems that enhance military safety and mission efficiency.

I. INTRODUCTION

Defence and combat operations place a premium on troop well-being, operational efficiency, and safety. Intelligent technologies that can monitor health and status in real-time are urgently needed because to the increasing number of threats and the unpredictability of combat situations. Delays in reactions to critical situations are common due to the manual, reactive, and imprecise nature of traditional systems of monitoring troop status.

Smart defence systems are now within reach, thanks to recent developments in the IoT that have paved the way for better real-time data collecting, transmission, and analytics. Internet of Things (IoT) solutions continually track physical health indicators and location by integrating

wearable sensors, wireless connectivity, and cloud computing. The ability for command centres to instantly evaluate a soldier's physical state and whereabouts via these devices greatly enhances decision-making in combat settings.

The suggested system sends data from a person's vitals (heart rate, temperature, etc.) and their whereabouts (by GPS modules) to a central monitoring station over a wireless network. By giving commanders real-time situational knowledge, this technology improves mission coordination and increases troop safety via faster medical treatment.

In addition, the system is built to withstand unexpected and severe military settings thanks to its secure data transfer, low power consumption, and durable hardware integration. The system's goal is to

improve the efficacy of military operations while decreasing risks and deaths via the use of smart IoT architecture.

In this article, we will go over the proposed Internet of Things (IoT) soldier tracking framework's architecture, important components, communication protocols, and real-time monitoring capabilities.

II. LITERATURE SURVEY

A lot of people have been paying attention to the military and defence uses of IoT technology recently. A number of studies have looked at ways to improve military personnel's operational awareness and safety by integrating wireless networks, real-time monitoring systems, and wearable sensors. This section provides a summary of the main research and systems that have helped advance technology for monitoring the whereabouts and health of soldiers.

2.1 Internet of Things (IoT) Wearables for Use in Military Settings

A wearable health monitoring system that tracks a soldier's heart rate, body temperature, and mobility was suggested by Sharma et al. in [1]. The system would use Internet of Things (IoT) sensors. They proved the viability of transmitting biometric data to a base station utilising wireless sensor nodes with their prototype. Unfortunately, the system couldn't be used for geolocation tracking since it didn't have GPS connectivity.

2.2 Wireless Sensor Networks for Health Monitoring

To track the well-being of troops in faraway places, Kumar and Verma [2]

built a WSN. Zigbee and other short-range communication protocols were part of their system. It also had biosensors. The short transmission range and absence of real-time cloud integration made it difficult to expand and slow down the response time, but it worked well for small-scale deployments.

2.3 Location-Based Services for Monitoring Soldiers

To keep tabs on where troops are at all times, Rathi et al. [3] set up a tracking module that uses GPS. The system might use GSM to communicate with a control centre and provide updates at predetermined intervals. It was less thorough for emergency medical response, however, since the health monitoring part wasn't there.

2.4 Internet of Things for Ensuring Safety in The Combat Zone

For combat safety, Saini et al. [4] investigated an Internet of Things (IoT)-based, more comprehensive approach. Several sensors, a global positioning system, and an alert system were all part of their system, which could warn command units of any abnormalities detected in the vital signs of soldiers. Power consumption and data security concerns were mentioned as constraints, despite the encouraging findings.

2.5 Current System Restrictions

Despite several studies showing IoT's promise in defence situations, the majority of current solutions have at least one flaw:

The modules for monitoring one's whereabouts and one's health do not work together.

In difficult terrains, wireless signal strength and reliability are compromised.

Consumption of a large amount of electricity renders wearables unsuitable for long-term operations.

Concerns about the transfer of sensitive data are heightened by inadequate security mechanisms.

Situational decision-making is slowed down due to the lack of real-time cloud-based analytics.

III. METHODOLOGY

Using an Internet of Things (IoT) architecture, the suggested system would allow for the real-time monitoring of critical health metrics and the geographic position of troops. Several essential parts make up the methodology: sensors, data collecting, wireless connectivity, monitoring in the cloud, and alarm systems. Improving military operations' reaction capabilities and ensuring constant situational awareness are the overarching goals.

3.1 Overview of the System Architecture

Here are the primary parts that make up the system architecture:

- Mobile Data Collector
- The MCU, or microcontroller unit
- Global Positioning System
- Unified Wireless Communication System
- Dashboard for Monitoring and Cloud Server

Every soldier has a small, wearable gadget that can gather data in real-time and send it to a distant control centre for real-time tracking and decision-making.

3.2 Integration of Sensors

In order to record important health metrics, the following sensors are used:

- Wearable heart rate monitors (e.g., MAX30100 or MAX30102) track heart rate and oxygen saturation levels in the blood.
- The LM35 or DS18B20 are examples of body temperature sensors that may detect symptoms of fever or exhaustion.
- Detects motion and possible injuries or falls via an accelerometer (e.g., ADXL345).
- The soldier's geolocation may be tracked in real-time with the use of a GPS module, such as the NEO-6M.

3.3: Acquiring and Processing Data

Connected to the sensors is a low-power microcontroller (such an Arduino or an ESP32) that periodically reads the data from the sensors. Before transferring the data to the communication module, the MCU does some basic preprocessing and formatting. Usually, data packets contain:

Soldier ID

Beating heart rate (bpm)

Central core temperature coordinates provided by a global positioning system (GPS) gadget

Current time

3.4 Unwired Data Transfer

Through the use of wireless communication modules like:

The LoRa (great Range) standard allows for low-power communication across great distances.

In places where there is access to wireless networks, using the ESP32 chip.

For mobile access in outlying areas, GSM/GPRS (via SIM800L) is an option.

Sensitive health and location data is securely sent using data encryption methods like AES-128.

3.5 Dashboard and Cloud Integration

The information gathered from the wearable devices worn by each soldier is saved and processed on a cloud platform, such as Firebase, AWS IoT, or ThingsBoard. The military's command staff used a web-based interface to:

Keep tabs on the whereabouts and health condition of every deployed soldier in real time.

Observe notifications that are prompted by unusual health metrics or a lack of activity.

Come up with reports after analysing patterns.

3.6 A System for Notifications and Emergency Alerts

Such as when the user's heart rate is more than 150 beats per minute or their temperature is greater than 39 degrees Celsius, the system will activate:

On the dashboard, you may see and hear notifications.

Notifications sent to commanding commanders via email or text message.

The soldier has the option to manually transmit an SOS signal in the event of an emergency.

3.7 Controlling Energy Use

The following resources are used to sustain the system during extended field deployment:

- Durable lithium-ion batteries
- Add solar panels if desired.
- Energy conservation during idleness using sleep modes and low-power coding

3.8 Setting Up and Testing the System

The prototype is put through its paces in a controlled environment to ensure:

- Accuracy of data in real-time
- Dependability of wireless transmission
- Speed of the dashboard
- Efficiency of alerts and notifications
- Evaluation criteria include environmental resistance (e.g., shockproof design, waterproof enclosure), durability, power consumption, and latency.

IV. PROPOSED METHOD:

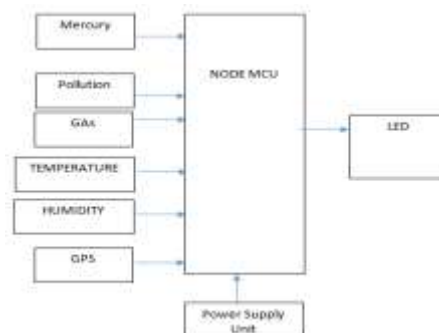


Fig1: Proposed block diagram

NODEMCU ESP8266:

Shanghai, China-based fabless semiconductor manufacturer Espressif Systems makes the ESP8266 family of Wi-Fi chips. At present, the ESP8285 and ESP8266EX are chips that are part of the ESP8266 family.

ESP8266EX A 32-bit Tensilica microprocessor, conventional digital peripheral interfaces, antenna switches, RF balun, power amplifier, low noise receive amplifier, filters, and power management modules are all packed into a tiny package on the ESP8266 system-on-chip (SoC). With its 2.4 GHz Wi-Fi (802.11 b/g/n, supporting WPA/WPA2), general-purpose input/output (16 GPIO), Inter-Integrated Circuit (I/C), analog-to-digital conversion (10-bit ADC), Serial Peripheral Interface (SPI), I/S interfaces with DMA (sharing pins with GPIO), UART (on dedicated pins, plus a transmit-only UART can be enabled on GPIO2), and pulse-width modulation (PWM). The "L106" processor core, so named by Espressif, is 80 MHz (or 160 MHz when overclocked) and based on the 32-bit Diamond Standard 106Micro controller core from Tensilica. Boot ROM is 64 kiB, instruction RAM is 32 kiB, and user data RAM is 80 kiB. (Also, ETS system data RAM of 16 KB and instruction cache RAM of 32 KB.) One way to access external flash memory is using SPI. A 5 mm x 5 mm Quad Flat No-Leads packaging houses the silicon chip together with 33 connection pads, 8 on each side and one big thermal/ground pad in the middle. Chinese manufacturer Espressif produces the ESP8266, a System on a Chip (SoC). An integrated Wi-Fi transceiver and a 32-bit Tensilica L106 microcontroller unit (MCU) make it up. There is an analogue input in addition

to its eleven GPIO pins*. So, it's just like any other microcontroller or Arduino in terms of how it can be programmed. Plus, it has Wi-Fi connectivity, so you can use it to link up to your existing Wi-Fi network, access the web, run a server with actual web pages, allow your smartphone to connect, etc. All sorts of things might be done! The fact that this chip has surpassed all others in terms of IoT device popularity is not surprising.

Any microcontroller may connect to your WiFi network with the help of the ESP8266 WiFi Module, a self-contained system on chip (SOC) with an integrated TCP/IP protocol stack. Either running an application itself or passing the responsibilities of Wi-Fi networking on to another application processor are within the ESP8266's capabilities. With the AT command set firmware pre-programmed into each ESP8266 module, all you have to do is connect it to your Arduino device to get WiFi-ability—and that's without ever using the module! One of the most affordable boards on the market, the ESP8266 module has a large and active user base.

Through its general-purpose input/output (GPIO) ports, this module may be easily coupled with sensors and other application-specific devices with little programming effort required both before and during runtime, thanks to its robust on-board processing and storage capabilities. It is meant to occupy minimum PCB space thanks to its high degree of on-chip integration, which allows for minimal external circuitry, including the front-end module. The ESP8266 has a built-in RF that can be adjusted to function in any environment,

supports APSD for VoIP applications, and doesn't need any other RF components. It also has Bluetooth co-existence interfaces.

V. MERCURY TILT SENSOR

The picture below shows the sensor in its "Not Tilted" configuration, with the mercury ball shorting the contacts at the bottom. Toggle the LED on and set the output to low.

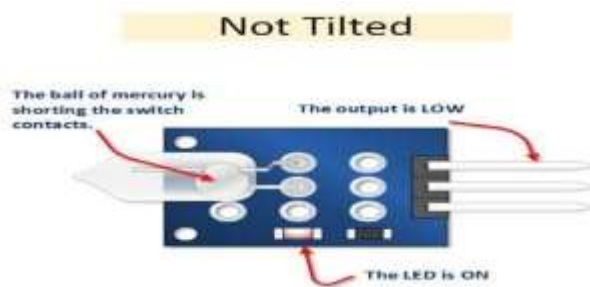


Fig 2: Not titled

As you can see in the picture below, the mercury ball will recede from the contacts when the sensor is in the "Tilted" position. By doing so, the LED will be turned off and the output will be set to HIGH.

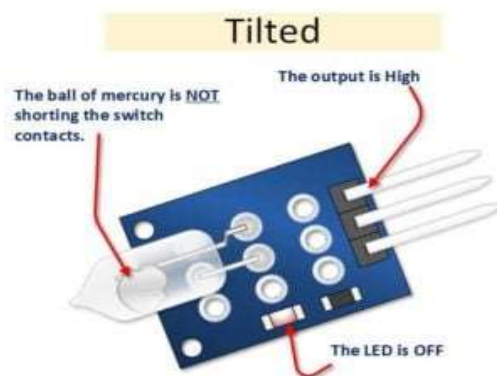


Fig 3: Tilted

POLLUTION SENSOR:

MQ135:

A current is applied to the sensing element via the connecting leads. This current, which is formally called heating current,

ionises and absorbs any gases that approach the detecting element. This changes the value of the current leaving the sensing element because it alters its resistance.



Fig 4: Pollution sensor

The maximum value for the analogue output is 1023 and the digital output is 1 in the absence of gas. The digital output is zero and the analogue output is much lower than 1023 when gas is present. By adjusting the value of the analogue pin, we may set the digital pin's off point using the chip's potentiometer. A load-resistor must be connected to the sensor's output in order to ground it. A number between 2kOhm and 47kOhm is possible. A less sensitive sensor is indicated by a lower value. The sensor becomes less accurate for larger gas concentrations as the value increases. Calibration of the load-resistor is possible by applying a known concentration of the gas being measured if just that gas is being monitored. The sensor might be calibrated to measure any gas (for example, in an air quality detector) by setting the load-resistor to around 1V output when the air is pure. After the burn-in period has passed, selecting an appropriate value for the load-resistor becomes valid.

MQ-135 Sensor Module Overview

The MQ-135 gas sensor module has a digital output (DO) pin and an analogue output (AO pin).

As the concentration of gas vapours coming into contact with the sensor increases, the analogue output voltage, which ranges from 0 to 5V, rises comparatively. Assuming all other factors remain constant, the sensor's output voltage is proportional to the PPM concentration of CO₂. The analog-to-digital converter in Arduino takes this output voltage and turns it into a digital value between 0 and 1023. The gas concentration in parts per million is the same as this number.

But the analogue output from the LM393 comparator, which is located on the sensor module's backside, is passed through to produce the digital output voltage (0/1). To adjust the digital output's sensitivity and establish a threshold value, the built-in potentiometer is calibrated by hand. The DOUT LED is used for this purpose. A low digital output indicates that the gas vapour concentration is about to exceed the predetermined threshold. The activation of the DOUT LED will make this easy to see. An other way to increase sensitivity is to turn the potentiometer clockwise.

MQ2 SENSOR:

The MQ2 gas sensor is a popular model in the MQ sensor family. Because it detects gas by measuring the change in resistance of the sensing material upon gas contact, this gas sensor is a Metal Oxide Semiconductor (MOS) type, which is also known as a chemiresistor. Gas concentrations may be measured with the use of a simple voltage divider network.



Fig 5: MQ2

The MQ2 gas sensor requires around 800 mW and operates on 5V DC. The detection range for LPG, smoke, alcohol, propane, hydrogen, methane, and carbon monoxide is 200 to 10,000 parts per million.

DHT11 FOR TEMPERATURE AND HUMIDITY:

Incorporate temperature and humidity data into your do-it-yourself electronics projects with ease with the DHT11 humidity and temperature sensor. This product is ideal for use in off-grid weather stations, home automation systems, and agricultural and landscape monitoring.

The DHT11's precision and range are detailed below:

- Humidity Range: 20-90% RH
- Humidity Accuracy: $\pm 5\%$ RH
- Temperature Range: 0-50 °C
- Temperature Accuracy: $\pm 2\%$ °C
- Operating Voltage: 3V to 5.5V

GLOBAL POSITIONING SYSTEM

Global Positioning System (GPS) receivers can determine the exact time and location of any given point on Earth by using a network of satellites and ground stations.

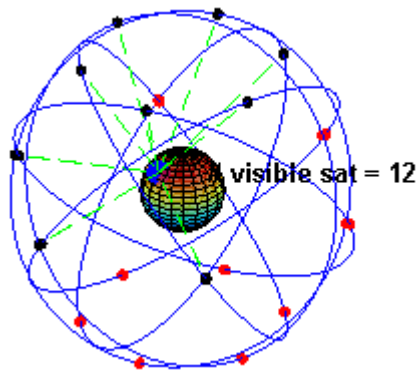


Fig 6: the moving point on the globe and the number of visible satellites.

Over 12,000 miles above Earth, there are constantly 24 operational satellites. There will never be more than 12 satellites in the sky above your location due to the design of the satellites' orbits. Data transmission to Earth via radio frequency (1.1 to 1.5 GHz) is the principal function of the twelve observable satellites. A GPS module or ground-based receiver may determine its location and time using this data and some basic mathematics.



Fig 7: Proposed hardware model

VI. CONCLUSION

Improving military safety and efficiency might be as simple as creating a system that tracks troops' whereabouts and health using the internet of things (IoT). The suggested system improves command units' situational awareness and allows for

quick medical response in crises by combining wearable biometric sensors, GPS tracking, and wireless communication into one real-time monitoring framework.

Even in dangerous or inaccessible places, the system can track the whereabouts and health of its users in real time via geolocation and constant monitoring of vital signs. Furthermore, the system is scalable and practicable for real-world implementation due to the use of secure data transmission protocols and low-power, cost-effective components.

In addition to connecting new Internet of Things (IoT) technologies to military requirements, this study paves the way for improvements in areas including artificial intelligence (AI) health prediction, search and rescue drone integration, and satellite communication-based extended connection.

Finally, less fatalities and better mission results may be achieved via the use of the suggested framework, which is a critical step towards safer, smarter, and more responsive military operations.

REFERENCES:

1. P. S. Kurhe, S. S. Agrawal, "Real Time Tracking & Health Monitoring System of Remote Soldier Using Arm7" International Journal of Engineering Trends and Technology Volume 4 Issue 3-2013.
2. Pankaj Verma, J.S Bhatia, "Design and Development of GPS-GSM Based tracking System with Google Map Based Monitoring", International Journal of Computer Science, Engineering and Applications. (IJCSEA) Vol.3, No.3, June 2013

3. Subhani Sk. M. Sateesh G.N.V, Chaitanya Ch. And Prakash Babu G., “Implementation of GSM Based Heart Rate and Temperature Monitoring System”, Research Journal of Engineering Sciences ISSN 2278 – 9472 Vol. 2(3), 43-45, April (2013)
4. Sweta Shelar, Nikhil Patil, Manish Jain, Sayali Chaudhari, Smita Hande (8th March, 2015).” Soldier Tracking and Health Monitoring Systems”. Proceedings of 21st IRF International Conference, Pune India. ISBN :978-93-82702-75-7 pages: 82- 87.
5. Dineshwar Jaiswar, Sanjana S. Repal (2015, July).” Real Time Tracking and Health Monitoring of Soldier using ZigBee Technology”. International Journal of Innovative Research in Science, Engineering and Technology: a Survey. Vol 4, Issue 7 pages 5560-5574.
6. Pangavne S. M. , Choudhary Sohanlal & Pathak Bhavik (2015).”Real Time Soldier Tracking System”. IOSR Journal of Electronics and Communication Engineering (IOSR-JECE), Nashik, Maharashtra: pp. 21-24.
7. Health Monitoring and Tracking System for Soldiers Using Internet of Things (IoT), International Conference on Computing, Communication and Automation (ICCCA2017)