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REAL TIME SOLDIER TRACKING AND HEALTH MONITORING IN NETWORK ENVIRONMENTS

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ABSTRACT :

In modern military missions, safeguarding soldiers through real-time tracking and health monitoring is increasingly vital. This study introduces a low-power, Arduino-based embedded system that integrates GPS for location tracking and GSM for wireless communication.Vital signs such as heart rate and blood oxygen saturation (SpO_2) are measured using biomedical sensors. An emergency alert feature is included via a manual trigger switch, and real-time feedback is provided through an LCD display and buzzer alerts. Designed for reliability and low power consumption, the proposed system enhances operational awareness and supports timely emergency response in challenging field environments.

Keywords: Arduino, Soldier tracking, Health monitoring, GPS, GSM, SpO_2 sensor, Heartbeat sensor, Embedded system, Wireless communication.

INTRODUCTION

Reliable real-time tracking of personnel and continuous health monitoring are essential components in modern combat and rescue operations. Conventional systems often suffer from limited communication coverage or lack comprehensive health data.

To address these limitations, this paper proposes an embedded system-based solution that combines real-time location tracking with vital health parameter monitoring. The system is built around an Arduino microcontroller and employs a GPS module for positional data and a GSM module for remote communication. Biomedical sensors are used to monitor heart rate and blood oxygen saturation, while a manual emergency trigger enhances the system's responsiveness in distress scenarios. Additionally, an LCD display and buzzer provide immediate visual and audio alerts.

This integrated approach enables centralized supervision of field personnel, enhancing situational awareness, response efficiency, and overall mission safety.

2. LITERATURE REVIEW

Previous work in this domain often addressed either health monitoring or location tracking individually. Systems based on wearable sensors have successfully captured heart rate and SpO_2 data, but often lacked GPS integration. Conversely, GPS-only trackers offered location data without medical insights.Several approaches have been explored in the literature for tracking soldiers and monitoring their health in various network environments.

Over the past few years, wearable health monitoring devices have gained traction in military and healthcare applications. Several solutions have focused on heart rate or oxygen level monitoring using sensors like the MAX30100, often paired with microcontrollers for data collection. Others have concentrated on GPS-based tracking for logistics or personnel location.

Other approaches focused solely on GPS-based tracking solutions without incorporating health monitoring features, limiting their effectiveness in critical medical scenarios. Some recent works introduced GSM-based alert mechanisms, but failed to offer complete real-time feedback and emergency responsiveness.

This research aims to fill these gaps by combining both health and location tracking within a unified, low-power embedded framework that also supports remote alerting and feedback mechanisms, offering a more comprehensive solution for military field use.

3. METHODOLOGY

The development of the soldier monitoring system followed a structured approach involving hardware integration, sensor calibration, firmware programming, communication setup, and system testing. The architecture is centered around an Arduino microcontroller that coordinates sensor readings and communication protocols.

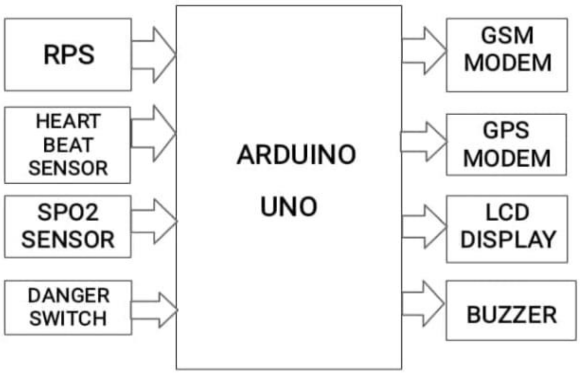

Figure-1: Block-Diagram

3.1 System Design and Component Integration

The system consists of various hardware modules integrated with an Arduino-based microcontroller. The key components include:

- **Arduino Microcontroller:** Acts as the central processing unit for receiving data from sensors, processing it, and communicating it via GSM.
- **GPS Module (NEO-6M):** Provides latitude and longitude of the soldier, which is essential for tracking the soldier's movements in the field.
- **GSM Module (SIM800L):** Sends the transmission of health data and location coordinates to a remote monitoring station via SMS or call.
- **Heart Rate Sensor:** Monitors the soldier's pulse in real-time to detect any abnormal heart conditions that may indicate distress.
- **SpO_2 Sensor (MAX30100/MAX30102):** Detects blood oxygen levels (SpO_2), which helps in detecting any potential health risks related to low oxygen levels.
- **Danger Switch:** A manual trigger that allows the soldier to sends an emergency alert if they are in distress.
- **LCD Display:** Provides local feedback to the soldier, shows real-time health parameters such as heart rate, SpO_2, and GPS coordinates.
- **Buzzer:** Sounds an alarm in case of emergency or activates abnormal health readings (e.g., heart rate above a threshold or SpO_2 below normal levels).

3.2 Sensor Calibration and Thresholding

Each sensor is calibrated to ensure accurate measurements in different environmental conditions. The system defines certain health thresholds Heart rate is considered abnormal if Normal range is 60–110 bpm. Alerts triggered below 50 bpm or above 120 bpm..SpO_2 Acceptable range is 95–99%. Values below 90% are considered critical.

3.3 System Programming

The Arduino is programmed using the Arduino IDE to handle the integration of sensors, process the collected data, and manage communication:

- **Sensor Data Collection:** The program continuously reads sensors input data from the heart rate and SpO_2 sensors.
- **Threshold Checking:** The health data is compare them against thresholds values. If any parameter exceeds the critical threshold, the system will take action (e.g., triggering the buzzer and sending an SMS alert).
- **GPS Data Collection:** The GPS module is collect GPS coordinates to retrieve the soldier's current location.
- **Data Transmission:** The GSM module is used to transmit the soldier's health data and GPS location to a remote monitoring station, such as a control center or an emergency response team.

3.4 Communication Protocol

The system uses GSM and GPS modules for communication the GPS data is formatted into a message that includes the soldier's current location.In the event of an emergency (e.g., abnormal health readings or a danger switch activation), the system sends a message containing the soldier's GPS coordinates and health status to the predefined emergency contact via the GSM module.

3.5 Power Management

A rechargeable Li-ion battery powers the system. To extend battery life, the microcontroller enters sleep mode when idle. Components were selected for low energy consumption to enable long-term deployment. The components are selected for energy efficiency, allowing the system to operate for extended periods, which is crucial for military operations.

4. RESULTS AND DISCUSSION

This system was evaluated in various environmental and operational conditions to evaluate its effectiveness in real-time soldier tracking and physiological monitoring. The results confirm that the integration of GPS, GSM, and biomedical sensors on a microcontroller platform delivers reliable, timely, and actionable data for defense applications.

- **GPS Location Accuracy:** The GPS module successfully tracked real-time position accuracy was within 5–8 meters in open fields and 10–15 meters in urban areas.
- **Heart Rate Monitoring:** The sensor performed well for typical user conditions; abnormal values were correctly flagged.
- **SpO_2 (Oxygen Saturation) Monitoring:** Reliable data were obtained for healthy individuals, with thresholds properly triggering alerts.
- **GSM Alert Functionality:** The GSM module was tested with danger switch activation and sensor-triggered alerts. average delay for SMS alerts via GSM was between 8–12 seconds.

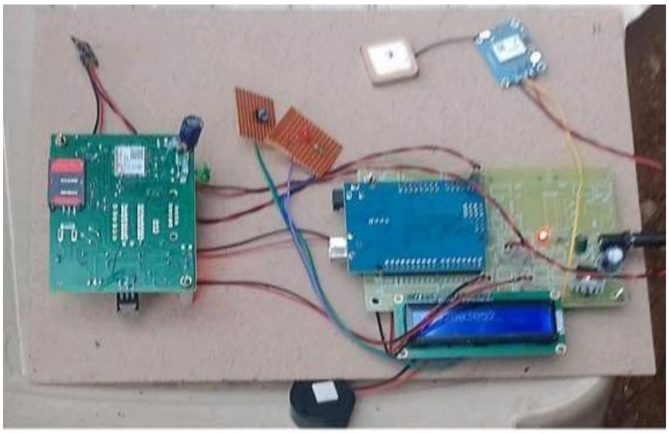

Figure-2: Before giving commands

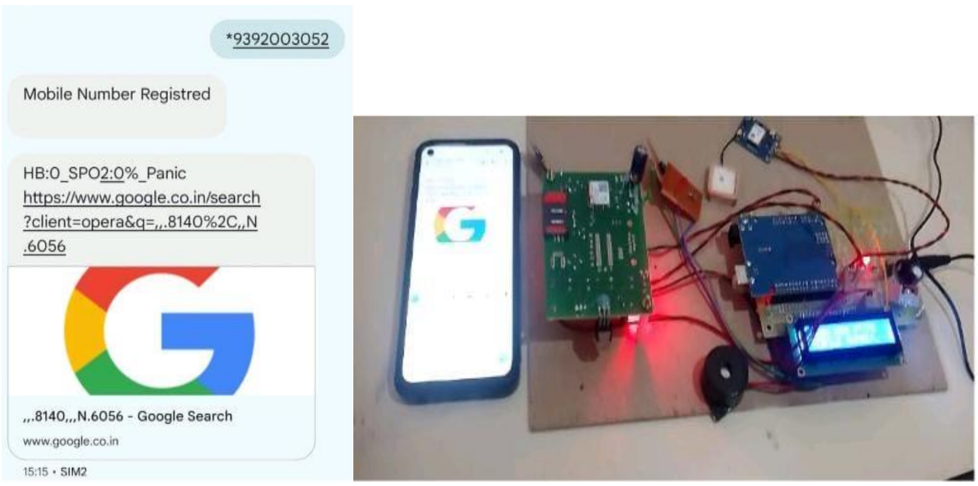

Figure-3: After giving commands

CONCLUSION

This work introduces a robust and energy-efficient solution for monitoring soldier location and health metrics in real time. By integrating GPS tracking, GSM communication, and biomedical sensors within a wearable embedded system, the design supports critical decision-making and timely intervention during field missions. The inclusion of an emergency alert mechanism further enhances the system's utility in high-risk situations. The proposed system demonstrates significant potential for deployment in defense applications where real-time surveillance, safety, and operational reliability are essential.

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