Health Monitoring and Tracking System For Soldiers Using Internet of Things(IoT)

Niket Patil, *Student Member, IEEE* and Brijesh Iyer, *Member, IEEE*
Department of E & TC Engineering
Dr. Babasaheb Ambedkar Technological University, Maharashtra, Lonere-402103, India
niketpatil11@gmail.com, brijeshiyer@dbatu.ac.in

***Abstract*—The paper reports an Internet of Thing (IoT) based health monitoring and tracking system for soldiers. The proposed system can be mounted on the soldier's body to track their health status and current location using GPS. These information will be transmitted to the control room through IoT. The proposed system comprise of tiny wearable physiological equipment's, sensors, transmission modules. Hence, with the use of the proposed equipment, it is possible to implement a low cost mechanism to protect the valuable human life on the battlefield.**

Keywords—***Arduino board, Biomedical sensors,GPS, IoT,Oxygen Analyzer, Remote health monitoring, Tracking.***

I. INTRODUCTION

Indian armed forces are the third largest standing army in the world with 1,200,255 active troops and 990,960 reserve troops. The army suffers a lot due to the unavailability of information of injuries to its personnel which may increase the death/ permanent disability toll. It is observed that the causalities are caused due to injuries rather than the direct assaults in the battlefield [1, 2]. These number can be minimized if the real-time information is available at the control room about the health and location of the soldier.

There are many issues regarding the safety of soldiers. Knowledge of current location of soldiers, inability of continuous communication with the control room during the operations, lack of immediate medical attention andoperations under different geographical conditions are the few prominent safety issues.

In the last decades, technologies such as cable based systems, RF transceiver, walkie-talkie, ZigBee and GSM based tracking systems were most dominantly used methodologies for the tracking of soldiers life on the battlefield. However, all these technologies suffered from one or more reasons like high installation cost, loss of signal, high noiseas well as the bulky nature. Hence, a portable, wireless low cost tracking system with high reliability is the need of hour for the protection of valuable life of the soldiers on the battlefields. Further, the said mechanism must also be real-time in nature so that the immediate and effective rescue operations can be initiated. Motivated from these issues, a portable real-time tracking mechanism is proposed in this paper. The proposed system is based on IoT concept. The proposed system will be helpful in the real-time continuous monitoring of soldier's health parameters and location. Fig.1 depicts the block diagram of the proposed IoT based system.

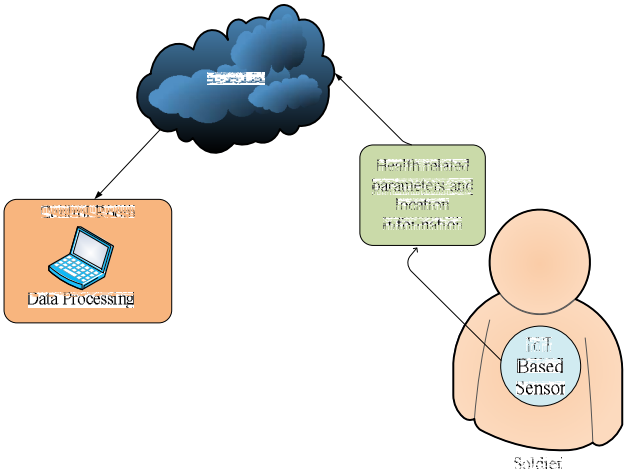

Fig.1. Block Diagram of Soldier Health Monitoring and Tracking System.

Pulse rate, body temperature, and oxygen level in an environment can be monitored along with the location tracking of the soldiers using GPS can be monitored using the proposed system. The transmission of these parameters to the control room is carried out by IoT. The control room receives the position and orientation of soldier from GPS. Further, soldiers can be guided for the correct directions during the operations using GPS.

Section 2 of the paper discuss the existing technology in the area of soldier health monitoring and location tracking system. Section 3 discuss the operation of the proposed system and the paper is concluded in the section 4 along with the future research direction.

II. THE LIETERATURE REVIEW

Many efforts were reported by different academicians and researchers to track the location of the soldiers' along with their health condition on the battlefield.

Pavan Kumar *et.al.* reporteda GPS based technology to monitor the soldier health parameters and location tracking using GPS. AT89C51 microcontroller was used to collect health parameters and then these parameters are transferred through GSM to the base unit [3]. A ZigBee based approach was proposed in [4]. A *Raspberry Pi*based approach was proposed in [5] to monitor the body temperature, respiration, movements and heartbeat of the patient. The collected information were then added to the cloud-based websites with the help of IoT.

A real-time, ARM processor based approach for the monitoring and collection of temperature, heartbeat, ECG parameters of patients by R. Shaikh *et. al.* [6]. ZigBee and GSM wireless technology were used to send current updates of patients to the doctor and then doctors can take immediate action against that patient. A wireless body area sensor networks (WBASNs) technology using ZigBee was reported in [7] to continuously monitor the human health and its location. RF based module to gather the live information of soldiers on the battlefield was proposed by G. Raj *et. al.* in [8]. Further, a one-time password (OTP) based system was proposed in [9] to secure and authenticate the data processing. Jassas*et. al.*proposed an idea of integration of wireless sensor network and cloud computing for the information processing in real-time and speedy manner [10]. A google map based approach was proposed in [11] to track the location of the soldiers.

However, all these systems are stuck-up by one or more reasons like costly implementation, delay in response and bulky nature. Hence, a portable wireless real-time system based on IoT concept is developed and proposed in this paper which will be an effective alternative to the existing technologies in the area of soldiers' health and location tracking on the battlefields. Table 1 provides the state-of-the-art soldiers health and location monitoring system.

III. THE PROPOSED SYSTEM

The proposed system not only performs the task of health monitoring but also does the tracking of soldiers using IoT. The control room can acquire the details about the position and orientation of soldier from GPS.

Even in case of losing their direction, it is the responsibility of the GPS to guide the soldier in correct direction. The base station can access the current status of the soldier using IOT as the different tracking parameters of the soldier get transmitted via Wi-Fi module. These information will be stored on the Cloud and can be extracted on the PC of control room, as and when extracted. Based on these information, the authorities can initiate immediate action by deploying a medical, rescue team or any backup force for their help. Using various biomedical sensors, health parameters of a soldier is observed along with its surrounding environment condition observed.The proposed system is divided into two unit i.e.Soldier unit and control room unit.

LM35 temperature sensor, Pulse Ratesensor and oxygen level detector sensor for continuously monitoring health status of soldier. GPS is used to determine real time position and orientation. Data originating from sensors and GPS receiver is processed and collected using Arduino (ATmega328P) processor. The specific choice of processor is due to the facts that, as compared to the other data possessors used in existing system; Arduino board is a low cost and easily available with flexible interfacing capability.so ATmega328P better than other processors.

A. Soldier Unit

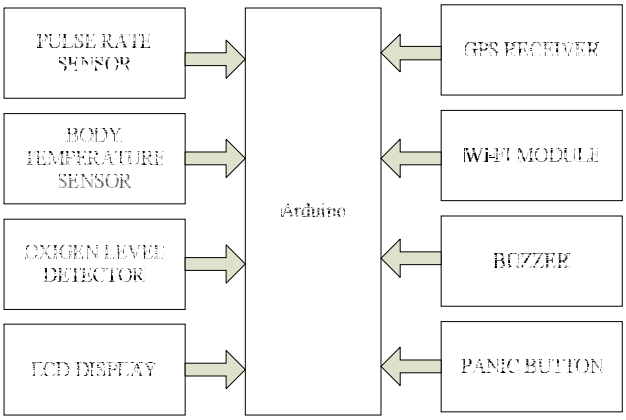

Fig. 2. Block Diagram of Soldier Health Monitoring and Tracking System Using Arduino (Soldier unit)

TABLE I. STATE OF THE ART SOLDIRES HEALTH AND LOCATION MONITORING SYSTEM

Contribution	List of Biometric Sensors	CommunicationTechniques	Data Processer
Pavan Kumar *el. al.* [3]	Temperature sensor (LM35), Heartbeat Sensor.	GPS, GSM.	AT89C51
Surbhi Sharma el. al. [4]	Pulse rate Sensor	GPS, ZigBee (IEEE 802.15.4).	Waspmote
R.Kumar*et. al.* [5]	Temperature, Respiration, Heart Beat, Accelerometer Sensors.	IOT	Raspberry Pi
Kumar and Repal [7]	Temperature, Heart Beat Sensor.	ZigBee, GPS.	ARM 7
H. Kedar*el. al.*[12]	LM35, Pulse Rate Sensor	RF Transmitter & Receiver, GPS	ARM Process
Proposed System	Pulse rate Sensor, Oxygen Analyzer, Temperature Sensor.	GPS,IOT	Arduino (ATmega328P)

The proposed system is deployed along with the soldier's kit. The ATmega328P processor will act as the brain of the unit. Soldier unit consist of LM35Temperature Sensor,Pulse rate sensor, Grove - Gas Sensor (O_2), GPS Receiver, Arduino, Panic Button, Buzzer, 16*2 LCD display, Nodemcu ESP8266 Wi-Fi module (*Nodemcu* ESP8266). The threshold values of the desired parameter is set and preprogrammed in the *Aurdino* as per the surrounding environment and the person under test. In the proposed experiment we have considered body temperature for the verification purpose. Whenever the temperature is deviated from the set threshold value, system gets alert and sends the data to the control room with a buzzer beep.

B. *The Algorithm*

1. Track the exact location of soldier using GPS receiver and send it to control room and also display on LCD
2. Measure body temperature of soldier using LM35 temperature sensor. When it crosses the threshold level, system will alert and inform to control room.
3. Compute pulse rate of soldier using pulse rate sensor. When it crosses the threshold level, system will alert and inform to control room. Desired data is also display on LCD.
4. Grove- Gas Sensor measure oxygen concentration in environment if there is any changes in environmental status system will alert and inform to base station.
5. Panic Button will help the soldiers in any Emergency situation.

C. *Hardware Description*

- *Heart beat sensors*

This sensor is designed to measure heart beat when finger is placed on it. The digital output of this sensor will be interfaced to Arduino board and it will directly measure heartbeats in beats per minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse. A normal heart rate depends on the individual's age and body size. For adults 18 and older, a normal resting heart rate is between 60 and 100 beats per minute (bpm), depending on the person's physical condition and age [5]. Hence, the measurement threshold is set form 60 to 100 bpm. Whenever heartbeat of soldier will deviate from the threshold value, the system will transmit information to control room.

- *Temperature Sensor: LM35*

LM35 is a temperature sensor which is widely used to measure body temperature. This device is rated to operate over a −55°C to 150°C Temperature range. The normal human temperature is around 37^0C [5]. Hence, a threshold value in the range of 30^0 to 40^0C is considered.

- *Grove - Gas Sensor (O_2)*

Every environment has different level of oxygen and soldiers are continuously travelling through different environments. However, the human body requires and regulates very precise and specific balance of oxygen for health. The Grove-Gas Sensor (O2) is a better option as ithas quality to test the oxygen concentration in air and is based on the principle of the electrochemical cell.

- *GPS Receiver*

Fig. 3. GPS Module SIM28M [7]

The GPS unit is installed in addressing system so that base camp can track their movements and real time information in all weather, at all times form anywhere on globe.

- *Panic Button and Buzzer*

Panic button is one kind of switch which is provided to soldiers to help in panic situation. If soldier presses panic button then the buzzer will make sound and system will generate an alert by which the base camp will come to know soldiers are in difficult situation.

- *ESP8266 Wi-Fi Module*

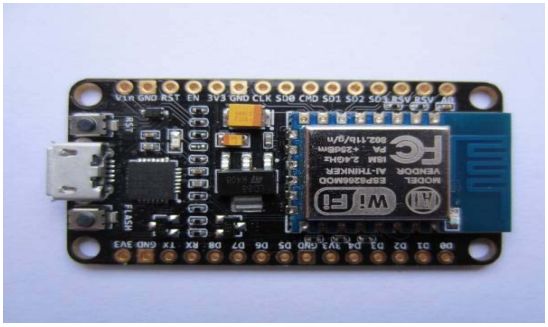

Fig. 4. NodeMcuESP8266 Wi-Fi Module [14]

The NodeMCU EPS Wi-Fi 8266 module provides minimum of 512Kb flash memory. It is low cost user friendly plug and play module with easy to configure and set up. It is widely used to develop hardware platform in IOT application. This device is also called as mini Arduino. Every module has unique IP address which is special identification of every Soldier. Every soldier is connected with control room with the help of EPS8266 module IP address.

D. Control Room Unit

The measuring devices are connected to the Arduino and Wi-Fi module. Wi-Fi Module has unique register IP address. It plays an important role in order to transmit the information in a real time monitoring and creates a data base on internet. From the data base of every soldier, control room will extract actual information of the soldiers using its unique IP address. The officer at the base station can find soldier's location on Google map and current health status on GUI page.

IV. RESULTS AND DISCUSSION

A. GPS Location on Serial Monitor

GPS receiver compute NMEA (National Marina Electronics Association) parameters like $GPGGA(Global Positioning System Fix Data), $GPGLL(Geographic position, Latitude and Longitude),$GPGSA(Satellite status), $GPGSV(Satellites in view), $GPRMC(Recommended Minimum sentence C), $GPVTG(Track made good and ground speed). Here, GP stands for Global Position.

TABLE II. GPS RECIEVER DATA IN NMEA FORM

NMEA data	**GPS location**	**Decode of selected position**	**Description**
$GPGGA	000745.262,,,,0,0,,M,,M,,*48	*48:Checksum Data, 000745.262: fix data type.	Position, time and fix data type
$GPGLL	,,,,000745.262,V,N*7A	Latitude: 000745.262,V Longitude: N*7A	Latitude, longitude, UTC time
$GPGSA	A,1,,,,,,,,,,,,,,*1E	A: Auto selection of 2D or 3D fix	GNSS DOP and active satellites
$GPGSV	1,1,00*79	1: Number of sentences for full data 1: sentence 1 of 2	GNSS satellites in View
$GPRMC	000745.262, V,,,,,0.00,0.00,060180,,,N*42	000745.262,V: Fix taken at 12:35:19 UTC	Date, position, time, course, and speed data
$GPVTG	0.00,T,,M,0.00,K,N*32	0.00k: Ground Speed, in KM	Speed and course information relative to the ground.

Table II describes the experimentally calculated parameters for the location tracking of a person. In this experiment, we made a person to sit on a specific location and the tracking information is obtained as per the details provided in Table II. Further, the same is verified with the help of Google map navigation tool. Fig. 5 shows GPS locations on the serial monitor. Fig. 6 shows the Location information using Google map using NMEA data. It is observed that the proposed system has accurately calculated the position.

B.Body Temperature Sensor Result on serial monitor.

LM35 body temperature sensor senses body temperature continuously. Here we set 33.60^0c as threshold level. Whenever temperature of body will be less than 33.60^0c, system will alert and send desire data to control room and also send the message i.e. "Soldier in Panic situation need Help" accordingly control room will take action. Fig.7 depicts the alert message generated from the proposed system. Further, a qualitative comparative analysis is carried out to discuss the viability of the proposed system. Table III provides the qualitative comparative analysis of the prosed system. It is clear from Table III that then proposed system is the best alternative as compared to the existing systems.

TABLE III. QUALITATIVE ANALYSIS OF THE PROPOSED SYSTEM

Contribution	***Communication Techniques***	***Data Processer***	***Total Cost in INR (Approx.)***
P.Kumar el. al. [1]	GPS, GSM.	AT89C51	1300
H. Kedar el. al. [12]	RF Transmitter & Receiver, GPS	ARM Process	3000
Kumar and Repal [7]	ZigBee, GPS.	ARM 7	3600
R.Kumar et. al. [3]	IoT	Raspberry *Pi*	3400
Proposed System	**GPS, IoT**	**Arduino (ATmega 328P)**	**850**

V. CONCLUSIONS

The paper reports an IoT based system for the health monitoring and tracking of the soldiers. *Aurdino* board is used which is a low cost solution for the possessing purpose. Biomedical sensors providesheartbeat, body temperature, and environmental parameters of every soldier to control room. This technology can be helpful to provide the accurate location of missing soldier in critical condition and overcome the drawback of soldiers missing in action. The addressing system is also helpful to improve the communication between soldier to soldier in emergency situation and provide proper navigation to control room. Thus we can conclude that this system will act as a lifeguard to the army personnel of all over the globe. In future, a portable handheld sensor device with more sensing options may be developed to aid the soldiers.

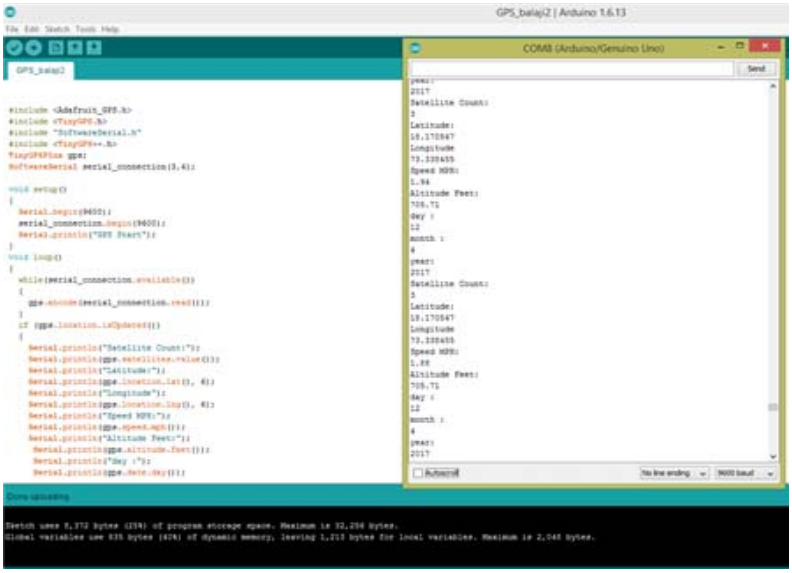

Fig. 5. GPS Location on Serial Monitor

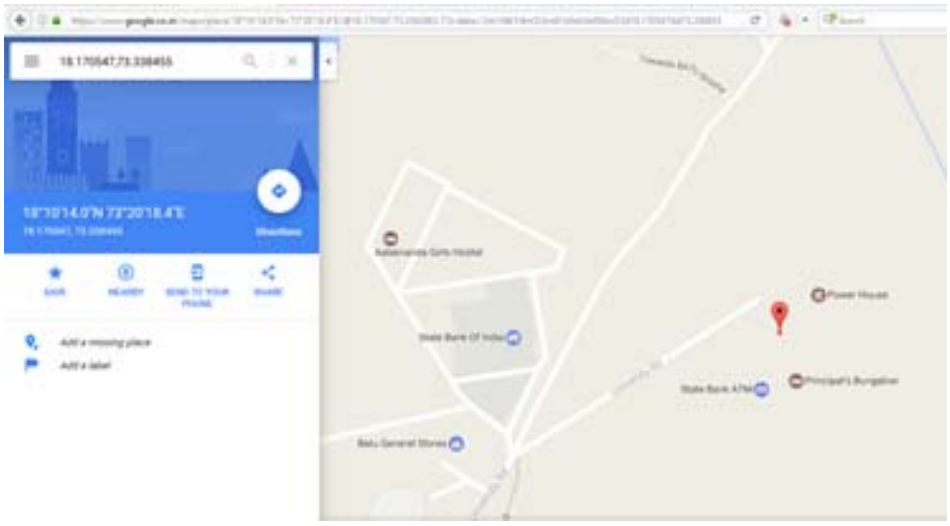

Fig. 6. GPS Location verification on Google Map

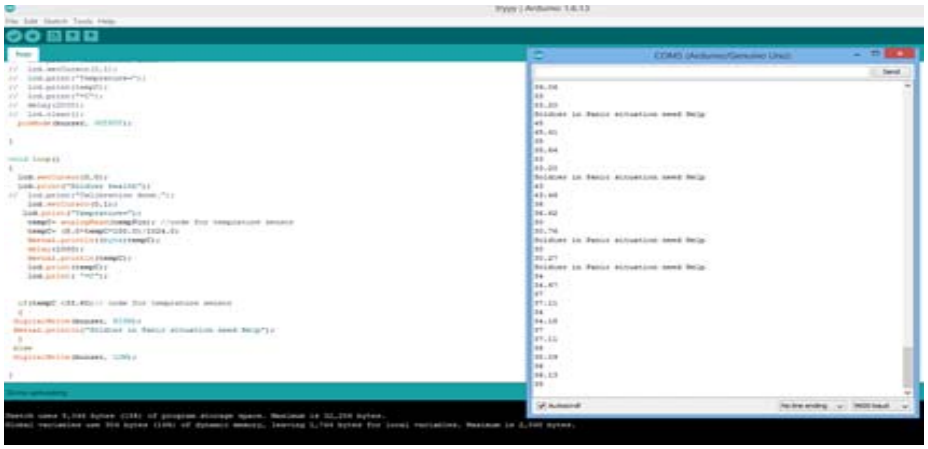

Fig. 7. Body Temperature verification on serial monitor

REFERENCES

[1] International Institute for Strategic Studies (3 February 2014). The Military Balance 2014, pp. 241–246. London: Routledge. ISB 9781857437225.

[2] "Press Information Bureau". pib.nic.in.

[3] P. Kumar, G. Rasika, V.Patil, and S. Bobade, “Health Monitoring and Tracking of Soldier Using GPS,’’ International Journal of Research in Advent Technology, vol.2, no.4, pp. 291-294, Apr. 2014.

[4] S. Sharma, S. Kumar, A. Keshari, S. Ahmed, S. Gupta and A. Suri, "A Real Time Autonomous Soldier Health Monitoring and Reporting System Using COTS Available Entities," Second International Conference on Advances in Computing and Communication Engineering (ICACCE), Deharadun-India, May 2015, pp. 683-687.

[5] R. Kumar and M. Rajasekaran, "An IoT based patient monitoring system using raspberry Pi," International Conference on Computing Technologies and Intelligent Data Engineering, Kovilpatti-India,Jan. 2016, pp. 1-4.

[6] R. Shaikh,’’ Real Time Health Monitoring System of Remote Patient Using Arm7,’’ International Journal of Instrumentation, Control and Automation (IJICA), vol. 1, no. 3-4, pp.102-105, 4, 2012.

[7] D. Kumar and S.Repal, “Real Time Tracking and Health Monitoring of Soldiers using ZigBee Technology: a Survey,” International Journal of Innovative Research in Science, Engineering and Technology, vol. 4, no.7, pp. 5561-5574, Jul. 2015.

[8] G. Raj and S. Banu, “GPS Based Soldier Tracking And Health Indication System With Environmental Analysis”International Journal of Enhanced Research in Science Technology& Engineering, vol. 2, no. 12, pp. 46-52, Dec. 2013.

[9] V. Ashok, T. Priyadarshini, and S.Sanjana, “A Secure Freight Tracking System in Rails Using GPS Technology” Second International Conference on Science Technology Engineering and Management (ICONSTEM), Chennai, India Mar. 2016, pp. 47-50.

[10] M..Jassas, A . Abdullah.and H. Mahmoud, “A Smart System Connecting e-Health Sensors and the Cloud” IEEE 28thCanadian Conference on Electrical and Computer Engineering Halifax, Canada, May 2015, pp.712-716.

[11] S. Dixit and A. Joshi, “A Review Paper on Design of GPS and GSM Based Intelligent Ambulance Monitoring” International Journal of Engineering Research and Applications,vol. 4, no. 7, pp.101-103, Jul. 2014.

[12] H. Kedar, K. Patil and S. Bharti, “ Soilder Tracking and Health monitoring System”, vol. 2m, no.17, pp. , Mar. 2015.

[13] H. Furtado and R. Trobec, “Applications of wireless sensors in medicine”,MIPRO, 2011 Proceedings of the 34th International Convention,Opatija-Croatia, pp. 257-261, Jul. 2011.

[14] Nodemcu. [Available at]:www.esp8266.com/wiki/doku.php?id.