Internet of Things Based Soldier Position Tracking and Health Monitoring System

[1]Priyanka R. Pawar, [2]Devendra S. Chaudhari
[1]P.G. student, [2]Professor
[1]Department of Electronics and Telecommunication Engineering,
[1]Government College of Engineering, Jalgaon, Maharashtra, India

Abstract : Soldiers are asset of our nation's security system. During wars and military search operations, soldiers get injured and many of soldiers will be lost. To find soldiers and monitor their health, army base station needs the device of Global Position System for locating soldiers, wireless base station to sense health related parameters of soldiers and a wireless transceiver to transmit and receive communication signals wirelessly. Upon losing soldier in the battlefield it was necessary for the base station to guide the soldier to safest location. The given system can be mounted on the soldier's body to track their current location and health status. The system comprises of tiny wearable physiological devices, sensors, transmission modules etc. The data captured by sensors and GPS receiver was transmitted wirelessly to the base station through Internet of Things. The base station can access the current status of the soldier which was displayed on the Personal Computer. Hence, system can be used to implement a low cost, light-weight technique to protect the valuable human life on the battlefield.

Index Terms - Arduino board, Biomedical sensors, GPS, IoT, Oxygen Analyzer, Remote health monitoring, Tracking.

I. INTRODUCTION

In present word, the science and technology were growing rapidly with new innovations and with advance level of their implementations. These immerging advance technologies were firmly adapted by defence services to provide some safety systems to soldiers. There were many parameters by which defence services can provide safety to the soldiers. The nation's security was monitored and kept by army, navy and air-force. It was important to save soldier, who sacrifice their life for their country. There were many concerns regarding the safety of the soldiers. Many soldiers lost their lives in war fields as there was not getting proper health backup as well as connectivity between the soldiers on the war-fields and army base stations. So it was very vital for the army base station to know the location as well as health status of all soldiers.

All must be really concerned about the safety of the soldiers, so it was decided to design a system which would efficiently keep checking the health status and precise location to provide the soldier with necessary medical treatments as soon as possible. By using bio-medical sensors such as temperature sensor and heart beat sensor the health parameters of soldier can be monitored. Gas analyzer sensor was used to monitor atmospheric toxic gases, so that in any climatic changes the soldiers will be equipped accordingly. Soldier's position can be tracked by using GPS. Wi-Fi module was used to establish wireless communications.

The infantry soldier of tomorrow promises to be one of the most technologically advanced modern warfare had ever seen. Around the world, various research programs were conducted, such as Future Force Warrior (FFW) and Future Infantry Soldier Technology (FIST), with the aim of creating fully integrated combat systems. This device would improve situational awareness not only for the host but also for collocated military personnel who would able to exchange information using wireless networks. The challenge was to integrate these piecemeal components into a lightweight package that could achieve the desired result without being bulky and inconvenient or requiring more power. One of the fundamental challenges in military operations lies that the soldier's were not able to communicate with control room station. In addition, the proper navigation between soldier and organizations plays important role for careful planning and co-ordination. So this paper focuses on location tracking of soldier using GPS and IoT based wireless communication also health status of a soldier using biomedical sensors.

Hence, a portable, low cost, wireless tracking system with high reliability was the need of hour for the protection of valuable life of the soldiers on the battlefields. Further, the said system 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 system was designed in this paper. The given system was based on IoT concept. This system would be helpful in the real-time continuous monitoring of soldier's health parameters and location. Pulse rate, humidity with body temperature, and oxygen level in an environment can be monitored along with the location tracking of the soldiers using GPS. The transmission of these parameters to the control room was carried out by IoT. The control room receives the position and orientation of soldier from GPS. Accordingly soldiers can be guided for the correct directions during the operations using GPS.

II. RELATED WORK

Many efforts were reported by different academicians and researchers to track the location of the soldiers along with their health condition on the battlefield. However, people's awareness of the current situation varies depending on the information they possess and their ability to interpret it critically, in the specific context of the society or social group they belong to, live and work in.

Hock *et al*[1]had discussed on recent advances in growing technology and on various wearable, portable, light weighted and small sized sensors that have been developed for monitoring of the human physiological parameters. The Body Sensor Network (BSN) consists of many biomedical and physiological sensors which can be placed on human body for health monitoring in real time and describe an idea to develop a system for real time health monitoring of soldiers, consisting of interconnected BSNs.

The location tracking has great importance since World War II, when military forces realized its usefulness for navigation, positioning, targeting and fleet management. Kurhe *et al.* [2] had introduced a system that gives ability to track the soldiers at any moment. Additionally, the soldiers will be able to communicate with control room using GPS coordinate information in their distress. This system is reliable, energy efficient for remote soldier health monitoring and their location tracking. It is able to send the sensed and processed parameters of soldier in

real time. It enables to army control room to monitor health parameters of soldiers like heart beat, body temperature, etc. using body sensor networks. The parameters of soldiers are measured continuously and wirelessly transmitted using GSM.

Walker *et al.* [3] proposed mobile health monitoring system for bicycle rider by using biomedical sensor network. This remote mobile monitoring system extracts information about bicycle rider and sends to a remote server. Then this information is send to remote user. One possible application of system is a military scenario where soldier position and sign tracks from a remote command centre. Also Jassas *et al.* [4] presented an e-health smart network system. System focuses on medical sensors which measures patient physical parameters using wireless sensor network. This system can be used in accident and emergency situations, to stop manual data entering, and to increase beds capacity in hospitals.

Vineeth *et al.* [5] proposed a design of pollution monitoring mobile system that can monitor vehicular and environmental pollution in real time along with the information about particular area. Here they used various gas sensors to monitor pollution level in different locations.

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

III. SYSTEM DESIGN AND IMPLEMENTATION

The developed system not only performs the task of health monitoring but also does the tracking of soldiers using IoT. The Internet of Things was interconnection of devices, which were embedded with sensors, software, network connectivity and necessary electronics that enable them to collect and exchange data between the physical world and computer systems over existing network infrastructure.

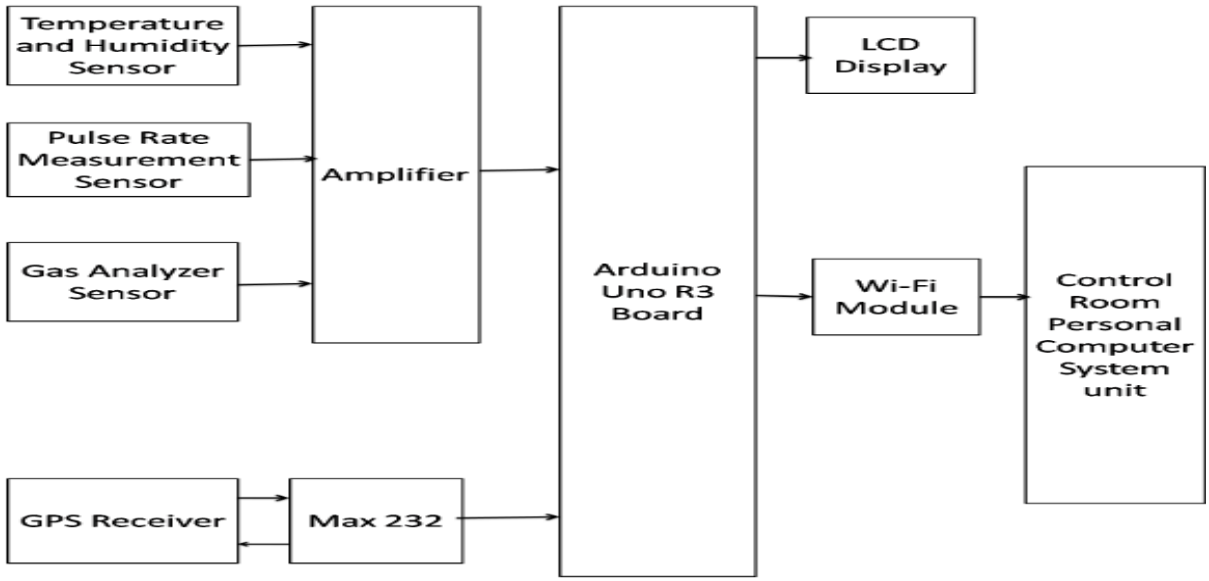

Figure 1 Constructional block diagram of IoT based soldier position tracking and health monitoring system

Figure 1 shows constructional block diagram of the IoT based solider position tracking and health monitoring system. It includes three types of sensors connected in series namely temperature and humidity sensor, pulse rate measurement sensor and gas analyzer sensor respectively. All the data sensed by sensors with the help of amplifier. Amplifier was capable of adding or subtracting large offset voltages on command and then all the data sent towards the arduino. The arduino uno R3 board with at mega 328P controller provided with a serial communication by using UART and sent it to LCD display. On the other hand GPS device measured the positional values in the form of latitude and longitude with the help of antenna and MAX 232. The MAX 232 had two receivers that convert digital data from RS-232 to TTL voltage levels and two drivers that convert digital data from TTL logic to RS-232 voltage levels. These data sent to arduino and finally displayed on LCD in terms of values. Wi-Fi modem was connected with the arduino board, which sent all captured data to control room using cloud computing.

The control room can acquire the details about the position, orientation and health status of soldier using IoT. This information will be stored on the cloud and can be extracted on the PC of control room as and when required. Based on this information, the authorities can initiate immediate action by deploying a medical rescue team or any backup force for their help.

IV. PERFORMANCE ANALYSIS AND RESULTS

A. Analytical Solution for Health Parameters

Two types of sensors such as temperature sensor and heart beat rate sensor were used to calculate precise and accurate results of the solider health parameters. Various recorded values of temperature and heart beats are shown below in Table 1.

Table 1 Health monitoring parameters with mean and standard deviation

S.N	Parameter	1	2	3	4	5	6	7	8	9	10	Mean	SD
1	Temperature (℃)	35.2	35.4	35.7	35.9	36.2	36.8	37.2	36.9	36.7	36.1	36.21	0.67
2	Heart beat (BPM)	61	63	65	68	70	72	74	72	71	69	68.5	4.24

The Table 1 shows the mean value and standard deviation of health parameters. From above data, it was known that for 1°C rise in temperature, there was heartbeat increase by 10 BPM. Sample standard deviation varies with respect to mean value. A low standard deviation indicates temperature and heart beat values tend to be close to the mean of the set. For analysis, ten samples of soldier were considered which shows temperature and heart beat data values. The mean of temperature was 36.21°C while standard deviation was 0.67. Also mean of heart beat rate was 68.5 BPM while standard deviation was 4.24. Calculating mean with standard deviation predict health condition of soldier.

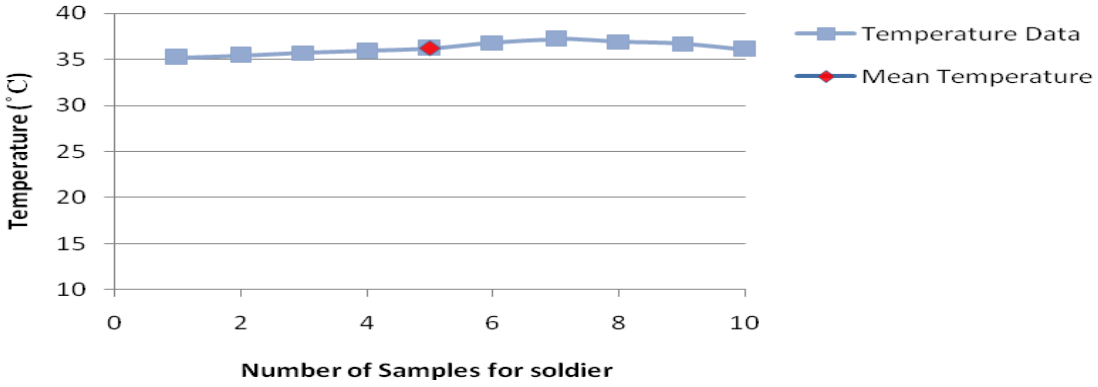

Figure 2 Temperature data of various soldier samples with mean temperature value

Figure 2 shows the temperature distribution of ten samples for a soldier. X axis shows the number of samples for soldier and Y axis shows temperature in˚C. All the samples were collected at every 30 min of an interval. Blue dot in Figure 2 shows temperature value of respective sample and red dot shows calculated mean temperature value of samples. With the help of mean temperature value base station can predict the average health status of the soldier. The normal body temperature was generally accepted as 37˚C; some studies had shown that the normal body temperature can have wide range from 36.1˚C to 37.2˚C. Experimental mean temperature is 36.21˚C which was falling within specified range; hence predict that the soldier was in safe condition. If the resulted data goes beyond the limit then predict that soldier was in critical condition or had some health issue.

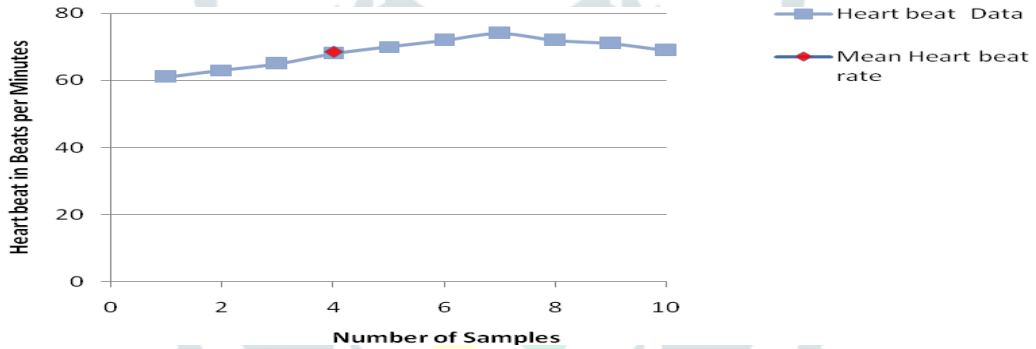

Figure 3 Heart beat rate of various soldier samples with mean value

Figure 3 shows the heart beat data of ten samples for a soldier. The blue dot shows heart beat value of respective sample and red dot shows calculated mean heart beat value of samples. X axis shows the number of samples and Y axis shows the heart beat ratio in terms of Beats per Minutes (BPM). With the help of mean heart beat value base station predict the average health status of the soldier. A normal resting heart rate for adults ranges from 60 to 100 Beats per Minutes. Generally, all over heart rate at rest implies more efficient heart function and better cardio vascular fitness. When resulted data was within specified limit then predict soldier was safe, otherwise data exceed beyond the limit then predict that the soldier in critical condition. Here average mean heart beat rate was 68.5 Beats per Minutes which falls within specified range, hence predict that the soldier was in safe condition.

***B.* Analytical Solution for Resistance of Gas Sensor**

MQ135 gas analyzer sensor was basically an electrochemical analyzer. When surrounded by polluted air, the electrical conductivity of MQ135 would increase with the increase of pollutants and the change in electrical conductivity can be converted to corresponding output signal.

Refer the following example from Table 2.

Temperature 25˚C, Humidity 10% RH, O_2 concentration 25%, R_L=20kΩ

R_0: Sensor resistance at 100ppm of NH3 in the clean air

R_S: Sensor resistance at various concentrations of gases

$$\boldsymbol{R_s = \left(\frac{V_c}{V_{RL} - 1}\right) \times R_L} \quad \ldots(1)$$

By using above formula, calculate the value of R_S and then calculate the ratio of R_S/R_0 for finding the respective gas PPM value.

$$\boldsymbol{R_S = \left(\frac{5}{5-1}\right) \times 20k\Omega}$$
$$\boldsymbol{= 25\ k\Omega}$$

Ratio of R_S/R_0 can be calculated as,

$$\boldsymbol{\frac{R_S}{R_0} = \frac{25}{25} = 1}$$

Where, R_0 = resistance of referring concentration of gas.

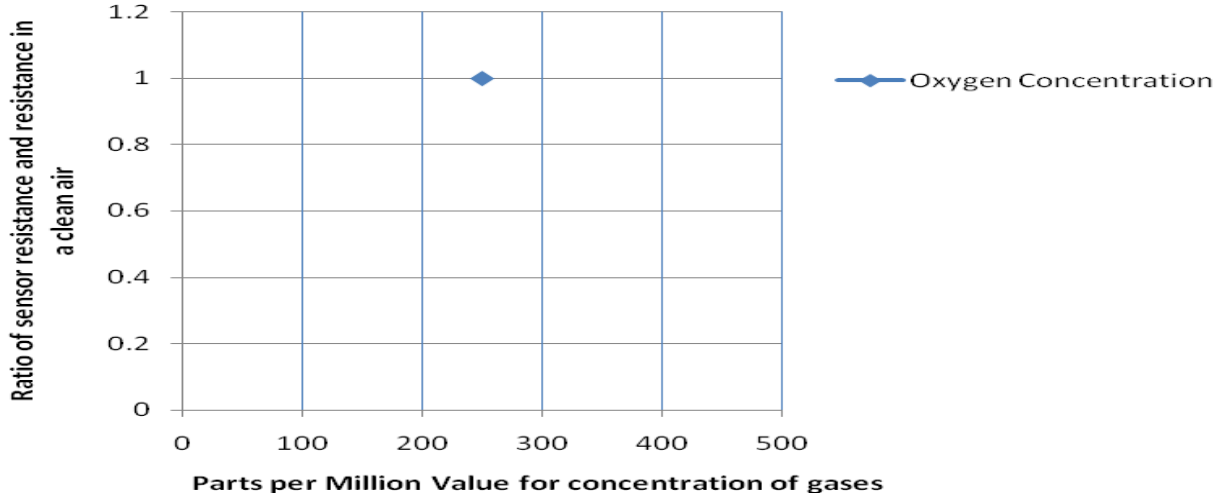

Figure 4 Oxygen concentration level to determine Parts per Million values with respect to ratio of sensor resistance and resistance in clean air

Figure 4 shows that the exact Parts per Million (PPM) level of oxygen gas in environmental air. From this graphical, representation predict that PPM value of oxygen concentration was 250 PPM at 25%. Normally the fresh air range was between 19 to 30% which contains first layer of the atmosphere. From this, base station predict that the soldier environmental air was fresh and good for the health of soldier.

C. Simulation Results

The developed system based on IoT for the health monitoring and tracking of the soldiers. Arduino board which had a low cost solution for the processing purpose was used to develop a system. Biomedical sensors provide heartbeat and body temperature data of every soldier to control room. To develop a system humidity and temperature sensor named DHT11 which were inversely proportional with each other respectively was used. All the parameters were varying with respect to output voltage. First all the sensors sense the data and then this captured data would be displayed on LCD. ESP8266 Wi-Fi module the data sent data to the control room.

Table 2 Health and GPS parameters displayed on control room's personal computer unit indicating latitude at 21.001408N, longitude at 75.549026E and air quality with 25% of oxygen concentration

Sr. No.	Date 27/03/2018 at Time hh:mm:ss	Humidity (%Relative Humidity)	Temperature (°C)	Heart Beat (BPM)
1	09:12:51	14.0	35.2	61
2	10:12:14	11.2	35.4	63
3	11:11:54	11.1	35.7	65
4	12:11:16	10.9	35.9	68
5	13:10:56	10.7	36.2	70
6	14:10:08	10.4	36.8	72
7	15:08:54	10.2	37.2	74
8	16:05:10	10.1	36.9	72
9	17:04:30	10.2	36.7	71
10	18:00:10	10.8	36.1	69

Table 2 shows all health parameters with their equivalent values as per date and time. From this precise data, one can predict the health of soldier and track exact position of soldier. Similarly, it shows real time recorded values for humidity, temperature and heart beat rate. Experimental data had considered ten samples of a soldier. From this data it was observed that as temperature increases humidity decreases. Mean temperature and heart beat rate values predicts health status of a soldier.

Figure 5 Soldier exact location on Google map displayed with red oval shaped dot

In Figure 5, red oval shaped dot shows the exact location of soldier by using web mapping service which was provided by Google map. The Global Position System (GPS) coordinate values such as longitude at 75.549026E and latitude at 21.001408N which can be sent towards army base station computer with the help of Wi-Fi module.

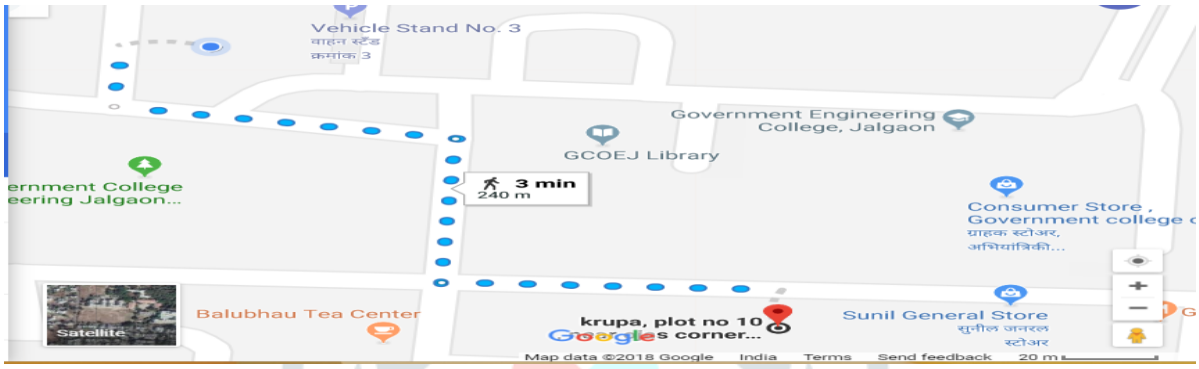

Figure 6 Directions to navigate a soldier location encircled with blue dot towards the base station with oval shaped red dot

Figure 6 shows directions to navigate a soldier location encircled with blue dot. The blue dotted path shows navigation towards exact location of soldier from control room. It also provides distance and time required to reach soldier location. It also shows satellite imagery , street maps and 360° panoramic views of particular location.

V. Conclusion

A portable, light-weight, wireless soldier position tracking and health monitoring system with high reliability was developed for the protection of valuable life of the soldiers on the battlefields. The system was designed by using pulse rate, humidity with body temperature and toxic gas level in an environment. It can be monitored along with the location tracking of the soldiers using GPS. Wi-Fi module was used to establish a network between soldier and base station for faster communication. All the data exchange related to soldier health parameters and position was completed using cloud computing technique. The recorded data of mean temperature and heart beat rate values within the range of standard specified values was indicating the soldier's safe condition. The PPM value of oxygen concentration was 250 PPM at 25% which predict the environmental air around the soldier was fresh. Global Positioning System (GPS) had provided latitude and longitude value of soldier position anywhere on the globe, hence provides direction for navigation to control room. This system had large capability, wide area range, strong expandability and easy to use. Hence the system can be effectively provides security and safety system which was made by integrating the advancements in wireless and embedded technology. It might be used in successful secret missions as well as in critical conditions during wars in real time.

References

[1] H. Lim, B. Wang, Z. Kalbarczyk, R. Iyer, K. Watkin, "A Soldier Health Monitoring System for Military Applications", International Conference on Body Sensor Networks, IEEE, pp.246–249, June 2010

[2] P. Kurhe, S. Agrawal, "Real Time Tracking and Health Monitoring System of Remote Soldier Using ARM 7", International Journal of Engineering Trends and Technology, ISSN: 2231-5381, vol.4, pp.311–315, March 2013.

[3] W. Walker, A. Aroul, D. Bhatia, "Mobile Health Monitoring Systems", 31st Annual International Conference of the IEEE EMBS, Minneapolis, Minnesota, USA, IEEE, pp.5199–5202, November 2009.

[4] 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, pp.712–716, May 2015.

[5] K. Vineeth, B. Vamshi and V. Mittal, " Identifying High Pollution Level Regions Through A Terrestrial Mobile MonitoringSystem", Technological For Smart Cities IEEE TENNSYMP, IEEE, pp. 978–980, March 2017

[6] Z. Raza,K.Liaquat and S.Ashraf, "Monitoring of Soldier Health and Transmission of Secret Codes", Journal of Multimedia Processing and Technologies, vol.8, pp.40–48, June 2017.

[7] M. Sailesh, C. Kumar, B. Cecil, B. Deep, P. Sivraj,"Smart Soldier Assistance using WSN", International Conference on Embedded Systems , IEEE, pp. 244–249, July 2014.

[8] 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, vol.3, pp. 4750–4755, March 2016.

[9] 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, pp. 46–52, December 2013.

[10] 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, pp.101–103, July 2014.

[11] P. Wararkar, S. Mahajan, A. Mahajan, A. Banerjee, A. Madankar, A. Sontakke, "Soldier Tracking and Health Monitoring System", The International Journal of Computer Science & Applications, ISSN: 2278-1080, vol. 2, pp.81–86, April 2013.

[12] S. Nikam, S. Patil, P. Powar, V. Bendre, "GPS Based Soldier Tracking and Health Indication System", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, ISSN: 2278-8875, vol. 2, pp.1082–1088, March 2013.