

# Monitoring of Soldier Health and Transmission of Secret Codes

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**ABSTRACT:** Strong and efficient army of any country plays a vital role in the today modern and scientific world. Soldiers are crucial to build a strong army. In developed countries, for the health monitoring purpose of army personal, a number of gadgets or devices are attached with them to take the look on their healthiness and their ammunitions. Health relating devices like heartbeat sensor, body temperature measuring sensor, processing capabilities and transmission, can thus help to make economic wearable gadgets for monitoring of health. Different techniques and algorithms are used to pin-point the exact location of the soldier. In this paper, we are going to design a smart device for the soldiers using modern technologies and techniques. This device would be carried by soldiers in warfare. The device will be able to sense the heart beat and body temperature of the soldier and transmit the reading to the base station where the cumulative to data will be displayed. A small database is organized for storage, of readings. The soldier can also send a secret message to the base station. In order to make the reading accurate and precise a formula is designed, which brings a correlation of the body temperature and heartbeat. The health condition of the soldier will be predicted in our work; furthermore the base station can also send the answer of secret code. This system is particularly proposed for army soldiers of any country who are fighting against the terrorism.

**Keywords:** Tracking, Biomedical Sensors, Navigation

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## 1. Introduction

“Future Soldier 2030” is a US Army program that provides an extensive idea of how a soldier will be equipped in various combats. The future Soldier shall be couturier with design considerations for each technology area with superior emphasis on cognitive performance to improve the soldier effectiveness and to increase in operational tempo. The Future Soldier will be capable of full spectrum operations with role-based capabilities. The national security of any country relies on army (ground), navy (sea) and

air-force (air). The vital and important role is done by the military soldiers in defense. There are several considerations concerning the security of those troopers. The future soldier should be more advanced in technology in every crucial situation like warfare or any secret mission. In the entire world, numerous analyses platforms are presently being arranged, like the United States Future Force Warrior (FFW) and the United Kingdom Future Infantry Soldier Technology (FIST) where they have a plan of making the total modern fight methodology. Helmet-attached screens, accomplished of presenting information from maps and video using varieties of physiological sensors. These devices have the capability to improve wakefulness according to the situation, not just for the soldier in battle field. However, additionally all the military personnel at base station, involve in interchange data via wireless communication. But the main concern was the creation of a light weight system, which can give desired results. One in all, the basic challenge in military operations in many countries is that the troopers are not in the position to interconnect with base station. Additionally, the accurate navigation between the soldiers plays precious role for careful forecasting. The defense department of a country must be effective for the security of that country, as well as the soldiers must also be effective. The challenges are to use these fragmentary components into a lightweight suite that could attain the anticipated result without being too massive and unwieldy. The second one is the life of the system if a soldier is in warfare with no facility to recharge the device and how much time the device will take to send the signal to base station is unknown. The important issues are to design a circuit on a low power consumption and this is not the smart feature that the device contain large number of batteries along with device; the monitoring of the soldier's health should be independent of the soldier's activities. The signal generates automatically like the heart beat and body temperature of the soldier and will be updated in the base station spontaneously. In recent research, many ideas have been evolved for 21st century soldier to make him/her more comfortable and secured and to make feasible his/her communication with the base station using devices such as smart shirt, smart watch and sensors helmet [4].

In section 2, we will discuss the basic idea behind our proposed system; then in section 3, we will study the methodology of our model which will explain the soldier and base unit with the help of circuit diagram and flow diagram; in section 4, the operational frame work will be described, after that in section 5, simulation diagram is placed which verifies the circuit diagram and working of soldier unit and base station; in section 6, we will design the Algorithm which compute a single value based on temperature and heartbeats on the bases of a formula which is derived; in section 7, the results are formulated using the real time reading of human and find out the approximate values on which the health of soldier can be predicted and described using ratio graph. Using the goal of our work that where the proposed technology enables the communication about the health of the soldier to base station which controls the mission in warfare against terrorists. In section 8, we will conclude our work and in section 9, we will propose future work that can be updated on our prescribed model.

## **2. Basic Idea**

In this paper, the concept of tracking and monitoring of the health status of the soldiers is discussed. Many researchers worked on navigation between 'soldier to soldiers' and the studies, for example of Shruti Nikam and Supriya Patil produced an idea on navigation between soldiers such as perceptive their quickness, distance, height and health status of them during the conflict [2]. Our basic idea is to track the location of the soldier, health of the soldier such as heart beat rate and temperature so that his/her health condition can be predicted. If he/she died during the tasks, the team in the base station can understand the fact. When he/she faces some difficult situation or requires some help in any form like more soldiers or weapons on mission, it can be sent by the base station. He/she can able to transmit a signal in the form of secret codes. In our system, the continuous records of the soldier heart beats, body temperature and secret codes will be received on Visual Basic software using GPS and GSM technologies and our proposed system will also produce longitude and latitudes with help of the Google earth the exact position of soldier that can also be determined as well as with the help of software on laptop to see all the status of soldiers on screen. On the basis of a few samples of the body temperature and heart beat, we are driving a correlation formula. With the help of medical experts we analyze the outcome reading of our formula and predict the soldiers' health condition. If the condition is matched with a death prescribed condition an alarm will be horn on the base station with the indication of dead soldier; and as well as critical conditions are also differentiated with the help of different alarms or colors. Each device has unique ID so that it could easily distinguish. From the storage of data, the analysis can also be formed on total soldiers health and environmental condition like how many are in serious conditions, and how many are in normal conditions as well as it shows their requirements on that critical situations.

And hence the team on base station may take instant stroke by sending rescue for the soldier in the battle field or sending backup for threats.

### 3. Methodology

The designing methodology of our system contains two units where one is the soldier unit and the other is the base station. The soldier unit which is positioned on the soldier body and this unit consists of the different parts like Biomedical sensors, Emergency keys, GPS+GSM unit , microcontroller and the base station contain a base unit and a GUI.

Two systems are famous when we are going to work in WSN technologies which are near-term system and far-term system and we use the concept of near-term system in our methodology. In this wireless personal area network (WPAN), for the better performance of the WPAN, it is important that low energy power sensors and equipment like controller should be selected because the army operations against terrorists can be in long hours so the WPAN should be active to perform. Now-a-days the devices have varieties of health monitoring system sensors like heart beat, body temperature, heart flux, accelerators, Galvanic Skin Response, Skin Temperature, and Near-Body Temperature, that are used in the first part of our proposed system and are going to indicate the health of the soldier. We designed an effective correlation, using the reading of only two sensors, the heart rate and the body temperature sensor, where we found a precise value regarding the health of soldier who is fighting in warfare against terrorists. Easy Pulse v1.1 (Heart Beat sensor) is used to measure the pulse rate of the soldier and it is connected with the digital pin of Arduino Uno microcontroller. The Easy Pulse is made for projects of hobby-based and curriculum utilities to explain the method of (PPG) photo-plethysmography as a non-intrusive photosensitive method in order to identify cardiovascular beat surge from skin. Infrared LED is used to light up the finger, and on the other side a light detector positioned to identify even the minor changes in the intensity of pass on light. The changes to the photo sensor signal are associated to the variation in bulk of blood intimate the finger. To get a fine and spotless PPG waveform the signal is amplified and filtered, which is same as the pulse rate. To measure body temperature, LM35 is used and connected with ADC pin of Arduino Uno. The LM35 are Precision integrated circuit temperature sensor whose output voltage is linearly proportional to the degree Celsius.

The Crystal Oscillator of 12 MHz is used to increase the clock rate of the microprocessor to increase the speed of program flow. Keypad is attached for the communication purpose.

The Arduino UNO R3 is a microcontroller board based on the ATmega328 which is used. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal and 32Kb of flash memory provides it with added speed, a USB connection, a power jack, an ICSP header and a reset button. Moreover, this microcontroller is small which in turn decreases the size of the whole unit as compared to its predecessors. GPS SKM53 is used to get the location of the soldier. The Global Positioning System (GPS) is a radio location using navigation satellites. These systems provide round-the-clock information on the three-dimensional position, velocity and time for users with the appropriate equipment and are at or near the earth's surface (and sometimes outside it). The first GPS system, widely available to civil users, and has become NAVSTAR, and serviced by the Ministry of Defense.

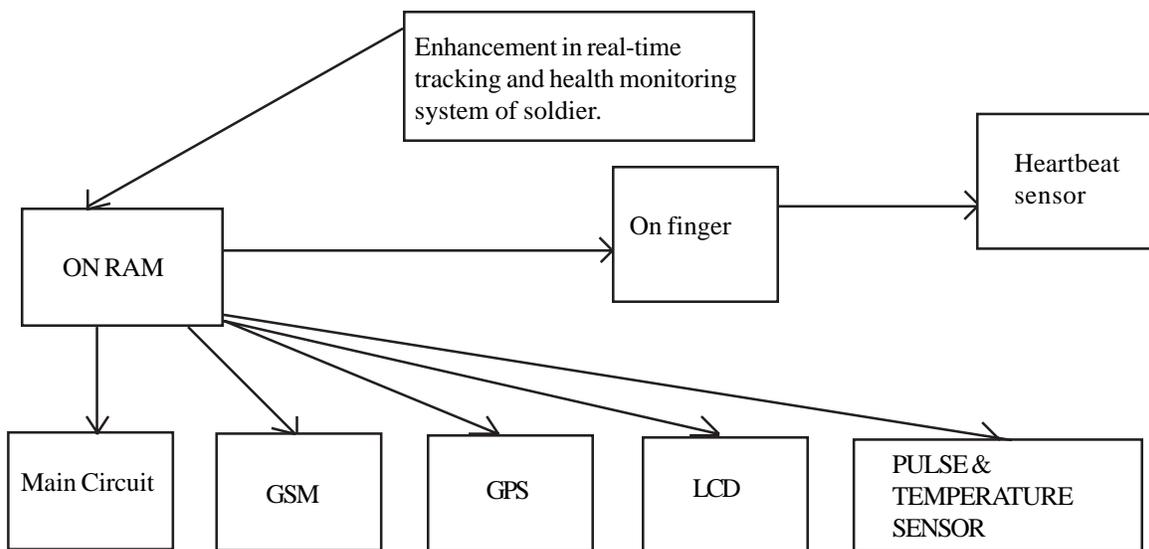


Figure 1. Breakdown structure

One of the important parts in the soldier unit is the power supply because the soldier will be far away from the base station on some military task so the soldier unit should have a good source of power so that it continually sends the signals to base station. The supply must be capable of the feature where it can provide the required power for each component in the circuit. The protection from over-voltage must be essential to save component to burn. The very basic step in the designing of any electrical system is to design the power supply compulsory for the system. The Battery of 7.4v is used to keep the circuit alive. This can produce the life of system up to 72 hours. Rajdeep Limbu [5] tests his soldier unit with 5V power supply for GPS, 3.7v for GSM Module and 5v to LCD screen. The Voltage regulator LM7805 is used to get 5 volts power for components mounted in device.

Finally, GSM SIM900D and 20x4 character bit LCD are used to send information in the form of SMS to base station and for display of data at the soldier unit respectively.

The SIM900D is developed for worldwide market. SIM900D is a quad-band GSM/GPRS engine that works on GSM 850MHz, EGSM 900MHz, DCS 1800MHz and PCS 1900MHz frequencies. SIM900D structures GPRS multi-slot class 10/ class 8 (optional). The Circuit Diagram of the soldier unit is shown in Figure 2.

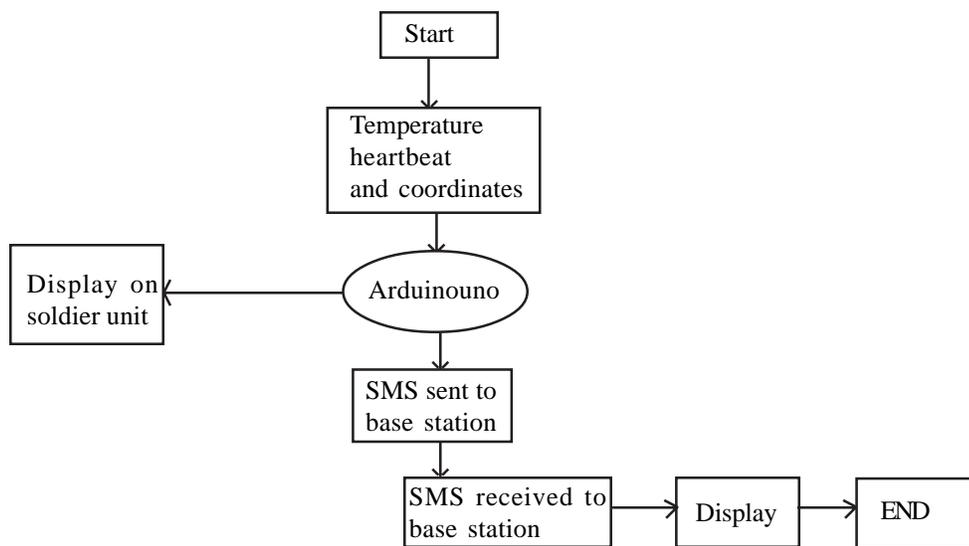


Figure 2. Complete circuit diagram

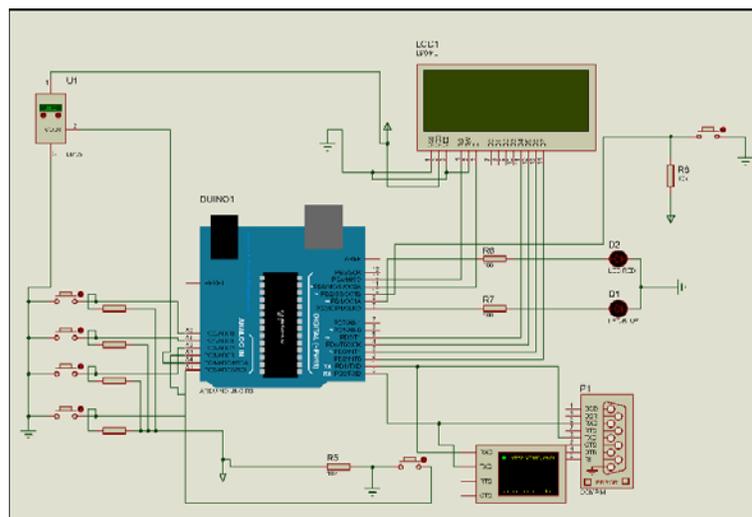


Figure 3. Logical structure of working

Data routing is application-specific and it is not time-driven or event-driven. In our model, we have two heterogeneous nodes connected with the controller. The program for this project is written in Arduino software (IDE), which consists of microcontrollers own language and the coding for the sensors that are attached is complete here. However, for the base unit a GUI is made using Visual Basic which helps to predict and act accordingly for different situation of different soldiers.

#### 4. Operational Framework

The operational framework (of MSTTS) is described as, the soldier unit is fabricated in a smart gadget which is placed on the arm of the soldier. The heart beat sensor would be placed in the finger of the soldier and key pad is attached with his hand microcontroller and it will process the signal from heart beat and temperature sensor also, if the soldier wants to send some secret code to the base station. Every information will also display on LCD for the knowledge of the soldier about his/her health and at the same time GSM will transmit same data to the base station in the form of SMS. The base station can be either a mobile phone or computer. A platform is designed in visual basic with the help of software, a data sheet would be prepared on which the each soldier on mission will have unique ID. According to their health condition, the ID will blink with a particular color, for example if a soldier died ultimately, then his/her heart beat value prove this fact and his ID will blink with red color. The secret codes will also show on data sheet which would be decoded by authorized person.

#### 5. Simulations

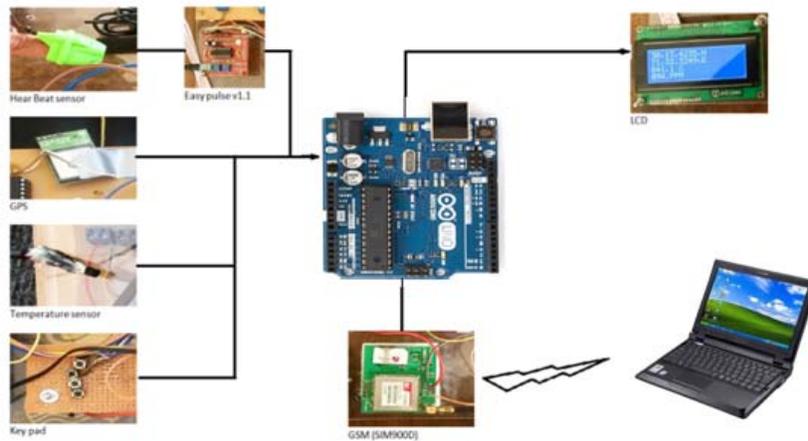


Figure 4. Operational framework

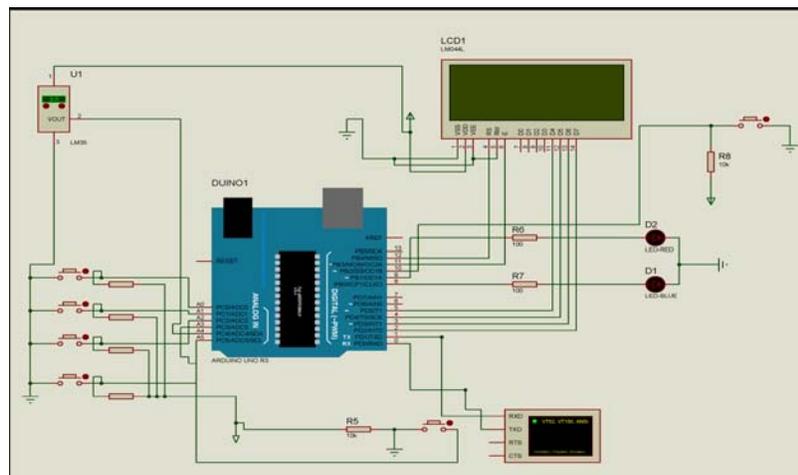
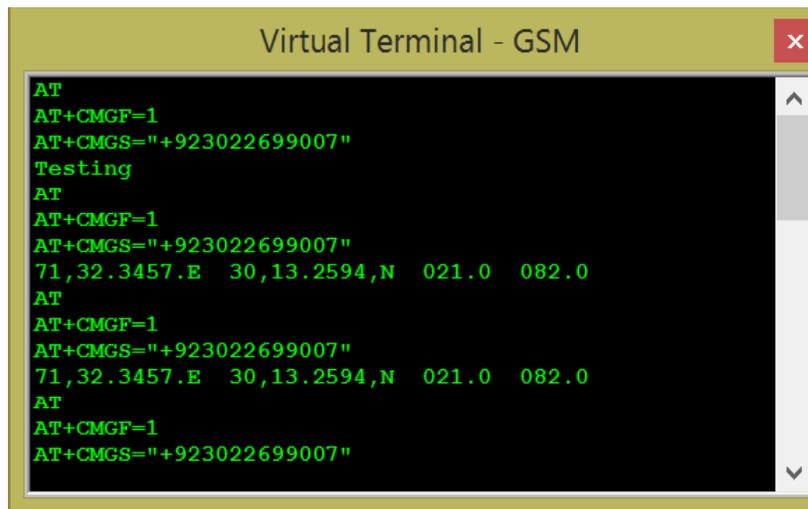


Figure 5. Complete Simulation Diagram

The simulation for MSTs is performed. The Code is written in Arduino IDE for Arduino UNO and proteus is used for simulation. This is shown in the Figure 5.

Finally, GSM sends data in the form of SMS to the base station as shown in the figure. The message contains longitude, latitude, and temperature as well as pulse rate of the soldier. The results are shown on the diagram in Figure 6.

The soldier can send four kinds of messages from the soldier unit owned by him. The device is implemented according to the above circuit diagram and the complete system is shown in the Figure 7.



```
Virtual Terminal - GSM
AT
AT+CMGF=1
AT+CMGS="+923022699007"
Testing
AT
AT+CMGF=1
AT+CMGS="+923022699007"
71,32.3457.E 30,13.2594,N 021.0 082.0
AT
AT+CMGF=1
AT+CMGS="+923022699007"
71,32.3457.E 30,13.2594,N 021.0 082.0
AT
AT+CMGF=1
AT+CMGS="+923022699007"
```

Figure 6. Results of working

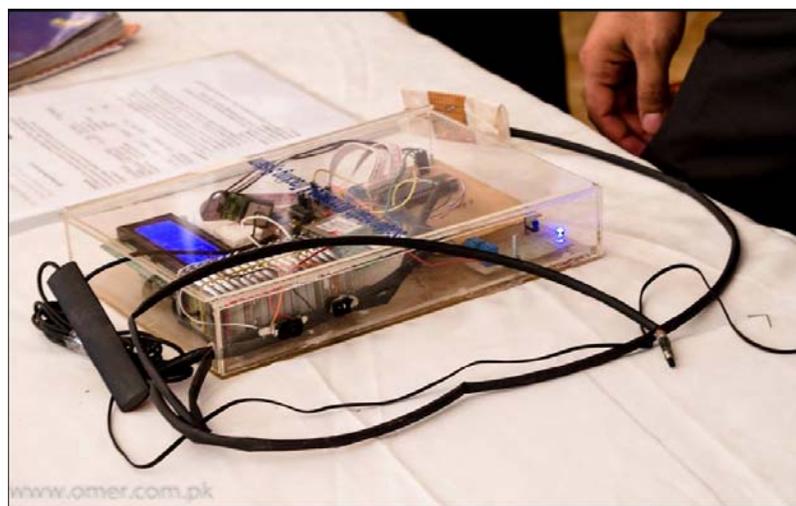


Figure 7. Complete view of experimental device

## 6. Health Monitoring Algorithm

As it is mentioned earlier that we are using only two types of sensors to produce our precise and accurate result of the soldier health, the operational frame work has been also discussed. We designed a correlation formula using the parameters like heart beat rate and temperature which is converted into a single variable. This cumulative value will intimate the condition of the soldier. A medical expert is consulted to develop the precise prediction. The formula to calculate range is listed below:

MSTSALGO(x, temp y. heart beat rate)

1. (initialize )

X = Temperature

Y = Heart beat rate

2. Calculate the mean of each variable in sample set, then subtract the mean from original values

$$x_1 - E(x_1), x_2 - E(x_2), \dots, x_n - E(x_n) \tag{1}$$

$$y_1 - E(y_1), x_2 - E(y_2), \dots, x_n - E(y_n) \tag{2}$$

3. Calculate the square of subtracted values as in above equations

$$(x_1 - E(x_1))^2, (x_2 - E(x_2))^2, \dots, (x_n - E(x_n))^2 \tag{3}$$

$$(y_1 - E(y_1))^2, (y_2 - E(y_2))^2, \dots, (y_n - E(y_n))^2 \tag{4}$$

4. Multiply the subtracted mean of each variable

$$\begin{aligned} &(x_1 - E(x_1)) \times (y_1 - E(y_1)) \\ &(x_2 - E(x_2)) \times (y_2 - E(y_2)) \\ &\vdots \\ &(x_n - E(x_n)) \times (y_n - E(y_n)) \end{aligned} \tag{5}$$

5. Now finally the value of R is found by putting all the determined values in the formula as we have derived earlier

$$r = \frac{\sum_{i=1}^n (x_i - E(x_i)) \times (y_i - E(y_i))}{\sqrt{\sum_{i=1}^n (x_i - E(x_i))^2 \times (y_i - E(y_i))^2}} \tag{6}$$

Write the value of R

6. Exit

**7. Results**

Using the experimental data, it was known that for 1°C rise in temperature, there is an increase in 10 bpm(pulse). Analyzing these values, we predicted the condition of the soldier. We examined 50 people in different health conditions. Like, few were in good health, while a few were with some minor diseases and few are admitted in the hospital. We conclude a sample space from our readings which are given below in the tables.

Temp(X)	Pulse(Y)	Value of r	Condition
9.6	60	0.111	Normal
97.5	65	0.2221	Normal
98	72	0.3332	Normal
99	82	0.4443	Tired
100	92	0.5554	Tired
101	102	0.6665	Harm
102	112	0.7776	Near Death
103	122	0.8887	Death
104	132	0.9998	Death

Table 1. Observations table

Table (1) clearly shows the implementation of the algorithm based on R, where we can estimate the condition of the soldier; either he/she is safe or has some injury and the value of R gives the probability of serious injury or death of the soldier in warfare. The result is described in the graph which is given below.

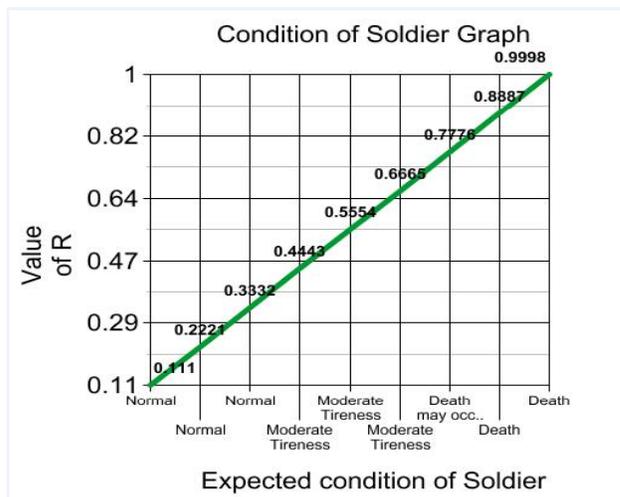


Figure 8. Soldier's health approximation graph

The soldier can send a secret code in the form of some digits or some combination of digits which will be decoded in the base station and inform the officials on the base station that what is the message either he/she is injured or they want some help in form of troops or ammunition and at the same time when the soldier is not responding and health condition shows harmful to the officials and can send the secret code to verify that either the soldier is responding or expired.

### 8. Conclusions

Our proposed system is for the operative security purpose and safety system which is created by integrating the modern advancements in wireless and embedded technology. It is a lightweight with a weight of not more than 1.5 kilos, and the battery timing is good for at least 72 hours, which the soldier can easily carry it in a smart bag. By the use of this system, the soldiers can condense the losses of battle. It assists to give top secret information and cautions to the soldiers so that they can survive for long and aim of war or secret operation can be obtained. This system gives strength to the defense system of country. So, we can accomplish that these types of strategies are very supportive for certifying security of the soldiers.

### 9. Proposed Future work

The system can be enhanced for making it device-to-device communication, in this way a soldier can communicate with other soldier without any dependency of the base station and also using IOT technologies it can be more flexible in collecting nearby information automatically in warfare. The basic idea of the system can be enhanced for the serious patient health care which is supposed to be alone or some out of town and the system may generate useful information to its hospital and insurance agency or some of his/her relative.

### Bio Graphy



Zeeshan Raza is teaching at the NFC Institute of Engineering and Technology in Multan, Pakistan. He has varied research interests in the computing and has published several peer reviewed research papers.

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