Soldier Status Monitoring Project

ECE 445 Project Proposal

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Table of Contents

I. Introduction

As a soldier while it is important to know what is happening surrounding you, it is equally important to know what is happening internally. In the field a soldier needs to be at his best in order to assess and tackle difficult situations. Having a vital monitor would let the soldier know if he is at his best or not and what he can do to improve.

We chose this project because it involves sensors, wireless communication and power systems. Each of us has had theoretical knowledge on the subject but haven't had any practical experience. In addition to gaining practical experience this project also has an immediate practical application. When we complete our project hopefully a soldier out in the field would be able to use our vital monitoring harness to his benefit.

i. Goals

- Be able to gather heart rate and body temperature data reliably.
- Have the data transmitted to a central location where it can be stored and analyzed
- Be able to operate the sensors and transmitter reliably
- Have a power supply that can operate both transmitter and sensors efficiently.

ii. Functions

- LED display that will let the user know when he has reached a critical threshold in his vitals
- Wireless communication of the sensor data to a location at least 100 meters away
- Lightweight batteries to supply power the soldier's device.

iii. Benefits

- The soldier will be able to see check his health
- Continuous monitoring of the soldiers vitals
- Remote monitoring of soldier's health to gain information on what is happening on the field
- Non-invasive monitoring of soldier

iv. Features

- A small and compact device that is comfortable to wear and not encumbersome
- Real time analysis of the data gathered
- Battery lasts for at least 24 hours of use

II. Block Diagram:

The block diagrams are split up into the transmitter circuitry, which is responsible for monitoring the soldier's body vitals, and the receiver circuitry, which is responsible for receiving the data for further analysis and storage.

RED arrows indicate Information Communication Flow while BLACK arrows indicate Power Flow.

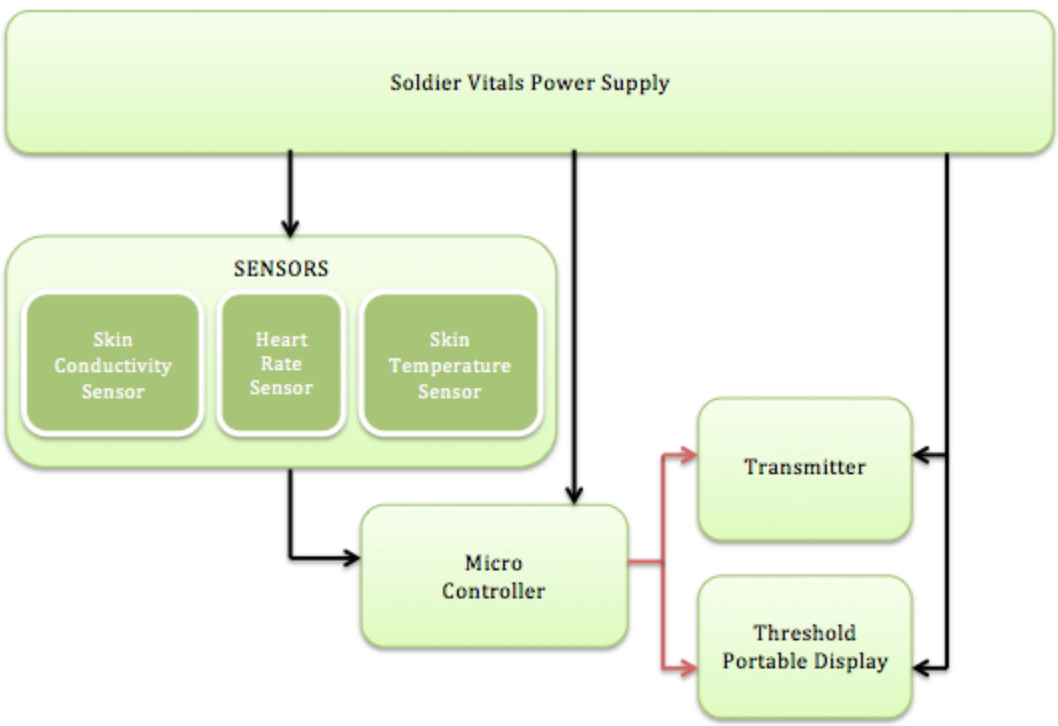

Figure 2.1: TRANSMITTER CIRCUITRY BLOCK DIAGRAM

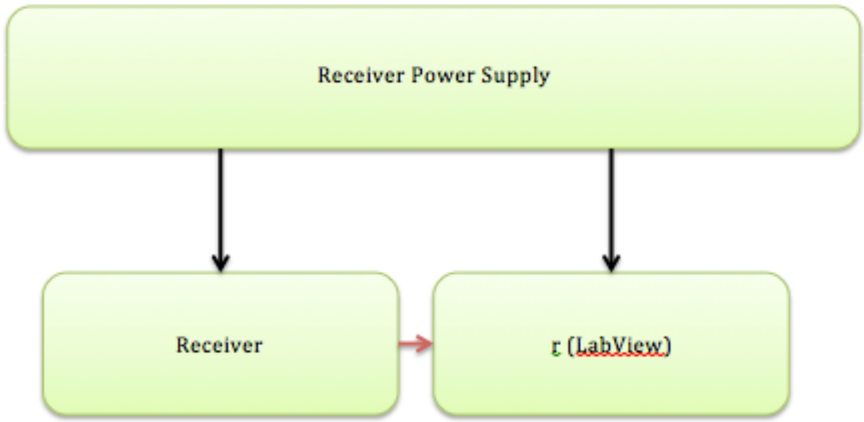

Figure 2.2: RECEIVER CIRCUITRY BLOCK DIAGRAM

i. Block Description

Soldier Vitals Power Supply:

This module needs to be able to power the sensors, the microcontroller, the transmitter, and the display. This power supply will need to last for at least 24 hours.

Sensors:

This block diagram consists of three sensors that will monitor soldier body vitals:

- Skin Temperature Sensor
- Heart Rate Sensor
- Skin Conductivity Sensor(measures sweat)

The sensors will be commercial off-the shelf sensors that give us an output voltage. We will build an interface that will interpret this voltage accordingly and send it to the microcontroller for further analysis.

Microcontroller:

We will make use of the Arduino microcontroller board for receiving data from sensors, packaging them and providing it to the transmitter for wireless communication. The arduino microcontroller will do an analysis on the vitals to see if they pass critical thresholds for each sensor

Portable Display:

This display will also be present on the soldier and will use to indicate when body vitals are crossing a preset threshold values. It will be on the soldiers his arm for easy visibility if thresholds are crossed. We will be using two different colored leds to show the soldier when the heart rate and body temperature thresholds are crossed.

Transmitter:
This block diagram is responsible for wireless transmission of body vitals data from the soldier to a remote centralized receiver over 100m. It will gather the data from the microcontroller to send to the receiver. The microcontroller will send the data over to the transmitter and then the transmitter will package the data into packets which will be sent over and ISM band.

Receiver Power Supply:
This power supply will be a wall power supply and probably be connected to a computer.

Receiver:
This module will receive the data from the transmitter and unpackage the data. It will then send the data to a laptop or a computer to be displayed.

Computer Display: We will make use of a computer running LabView to further analyze the data received and display a continuous monitoring of body vitals.

III. Requirements and Verification

i. Requirements and Verification Table

Block Title	**Requirement**	**Verification**
Sensors	• Heart Rate Sensor circuitry must measure in “beats per minute” (bpm) to be (+-)2% of actual heart bpm • temperature sensor probe must measure skin temperature in “kelvin units” to be (+-) 1% of actual temperature. • Should provide real time data	• We will use a calibrated off the shelf heart rate monitor to see if we get accurate results from our heart rate sensor. • We will use similar off the shelf commercial thermometer to ensure that our temperature sensor is working.
Transmitter	The transmitter must be able to communicate with the microcontroller and then package the data received to send to the transmitter at least 100m away.	We can use TI software to monitor the packets sent by the transmitter. We will send a known data set through the transmitter and monitor the packets being transmitted to see signal integrity and ensure the receiver gets it.
Soldier Vitals Power Supply	The battery bank is required to power the transmitter consuming 215mA at 3.3V, and the microcontroller consuming 50mA at 5V. We also require the device to work for 36hours. Therefore assuming 80% power conversion we will require: ((215+50)mA*36hrs)/0.8=11.9AH	Each of the components that are powered by this battery bank will have LED lighting to indicate that they are being powered. We will also verify the battery charge using a multimeter to monitor open circuit voltage.
Portable Display	Respective LEDs must shine when microcontroller received data from sensors is higher than preset threshold value.	We will verify that the LEDs are working by setting input data to microcontroller as values higher than threshold values and check to see if LED light shines.

Microcontroller	Microcontroller is required to: • receive data from individual sensors • perform signal processing and package the data for transmitter • check individual vitals and control portable display block	The LED light on the arduino board will verify the board is working. While monitoring the packets using TI software during Transmitter Verification, we can also verify that arduino has merged data properly. Portable Display Verification method below, can also be used to ensure that the sensors are transmitting known data properly to microcontroller which in turn in processing properly to indicate data higher than threshold limit, thereby verifying the code ran by microcontroller.
Receiver	The receiver must unpackage the data and send it to the computer.	The receiver should get the known data we sent through the transmitter to verify its ability to receive and the transmitter's ability to transmit.
Computer Display	We will make use of LabView to analyze the data from the receiver to successfully show body vitals from individual sensors in graphical form on a laptop.	In order to verify that the labview program shows accurate measurements of the vitals we will attach calibrated commercial off the shelf monitors to verify that labview displays the correct values

ii. Tolerance Analysis

The potential success of this project mainly rests on the wireless transmission of data of the soldier's heart rate, body temperature and stress level. Wireless signals travel through atmosphere meaning they are susceptible to any forms of interference. There are many factors affecting wireless transmission. These factors will make the wireless transmission difficult , which will cause critical errors while in usage. Thus, we will give our transmission component an extreme condition to ensure its functionality in any circumstance. First, most common interference is physical objects such as trees, buildings while the density of these objects determines whether or not RF can pass through them. We will first try to choose a place where there are a considerable amount of objects that might interfere the transmission. Second, another notable interference would be RF interference from another device. Most common wireless technologies use a RF range of 2.4GHz. The devices that share this channel will not only weaken the signals but also will cause noise. Thus, we will try to use devices that would share the same channel as our wireless transmission. This tolerance testing will be effective in that we also can consider any kinds of electrical interference as well. Lastly, weather condition affects wireless communication. For example, fog and rain make the signal hard to pass through in the atmosphere and lightning can cause electrical interference. Therefore, we will test our transmission under one of those extreme weather conditions. Overall, enabling a firm wireless transmission under these conditions will guarantee our success in the end.

IV. Cost Analysis

i. Labor

Member	$/hour	Hours/week	Total of hours	Subtotal($)
Sanghee Seo	40	20	320	12800
Santhosh Vairavan	40	20	320	12800
Yash Kulkarni	40	20	320	12800
Grand Total (x 2.5)				96000

ii. Parts

Parts	Parts Number	Quantity	Unit Price	Total
XBee Pro 60mW PCB Antenna - Series 1 (802.15.4) (Transmitter)	WRL-11216	1	37.95$	37.95$
XBee Pro 60mW PCB Antenna - Series 1 (802.15.4) (Receiver)	WRL-11216	1	37.95$	37.95$
Pulse Sensor Amped Probe	not applicable	1	$25.00	$25.00

Philips Skin Surface Temperature Probe - 28	21091-A	1	$10.00	$10.00
Polymer Lithion Ion Battery (6Ah)	PRT 08484	4	$40.00	$160.00
Miscellaneous Components (resistors, capacitors)			$30.00	$30.00
Grand Total				$300.90

V. Schedule

Week	Task Assgined	Member
Feb. 4th	Submit the proposal Start ordering parts Researching into each module Conference call with MIT staff Sign up for Mock interview Start learning Eagle and Labview.	Sanghee Seo Santhosh Vairavan Yash Kulkarni
Feb. 11st	Design interfaces using microcontroller for the sensor module. Test the proper acquisition of data and signal processing.	Sanghee Seo Santhosh Vairavan Yash Kulkarni
Feb. 18th	Design review sign-up. Program microcontroller to set up an interface for transmitter and receiver. Design all the necessary wireless components. Keep making correction for upcoming design reviews.	Sanghee Seo Santhosh Vairavan Yash Kulkarni
Feb. 25th	Design Review. Keep working on revising interface and debug errors from previous steps. Prepare Labview layout and display and analyze data using Labview. Work on Individual progress report.	Sanghee Seo Santhosh Vairavan Yash Kulkarni
Mar. 4th	Create PCB and start actualizing the circuit using Eagle. Work on Individual progress report.	Sanghee Seo Santhosh Vairavan Yash Kulkarni
Mar. 11st	Individual Progress Report DUE Finish all the wireless requirement. Revise each module and test the entire design.	Sanghee Seo Santhosh Vairavan Yash Kulkarni
Mar. 18th	SPRING BREAK Prepare for demo and presentation	Sanghee Seo Santhosh

	Debugging	Vairavan Yash Kulkarni
Mar. 25th	Mock-up demo. Mock Presentation sign-up Debug all the necessary modules	Sanghee Seo Santhosh Vairavan Yash Kulkarni
Apr. 1st	Start integrating all the necessary module. Test and revise the functionality of the IC.	Sanghee Seo Santhosh Vairavan Yash Kulkarni
Apr. 8th	Test and Debug. Prepare for demo and presentation Try finalizing the whole IC.	Sanghee Seo Santhosh Vairavan Yash Kulkarni
Apr. 15th	Demo and Presentation sign-up Finalize	Sanghee Seo Santhosh Vairavan Yash Kulkarni
Apr. 22nd	Demo and Presentation Work on the final paper	Sanghee Seo Santhosh Vairavan Yash Kulkarni
Apr. 29th	Final paper DUE Presentation	Sanghee Seo Santhosh Vairavan Yash Kulkarni