

# Soldier Status Monitoring Project

SPRING 2013 ECE445 Sang Hee Seo Santhosh Vairavan Yash Kurkani TA : Lydia Majure



## Introduction

- Soldier Status Monitoring
- portable device capable of monitoring body vitals
- The sponsors were interested in using this device to monitor soldiers out in the field



### Goals

- Gather heart rate, body temperature and movement data reliably
- Wireless communication of the sensor data over 100m
- Continuous monitoring of the soldiers vitals for at least 12 hours.

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#### **Features**

- Portable and lightweight device
- LED lighting to display when user vitals reach critical threshold
- Non-invasive monitoring of soldier vitals
- Onsite storage of data on external SD/MMC card



### Main focus area

- Identifying required sensors and its connections with the Arduino microcontroller chip
- Designing custom PCB to incorporate microcontroller and sensors
- Data Packaging and Wireless
   Communication over 100 to 500m
- Software Coding for analyzing and displaying received sensor data.

# Intermediate project goals

- Create a prototype device using identified individual components connecting to the Arduino Uno board using a breadboard.
- Create a completely customized board for the device thereby making it even more compact and portable.



# **Protype A**





## **Prototype B**





### **Final Product**



# **Overall Block Diagram**





# **Threshold Display Module**





## **Sensor Display Module**





# Skin Temperature Sensor (MLX90614)

- Average temperature of all objects in its Field of View.
- I<sup>2</sup>C device, outputs literal information of temperature
- 17bit resolution instead of voltage reading

- **INPUT**: 3.3V through Li-Poly battery. Clock input (SCL) from digital 21
- OUTPUT: Single ended digital communication. Output Data(SDA) on digital 20



## **Comparison of IR sensor**

- Infrared
   Thermometer
   from Home
   Depot to test
   accuracy.
- Holding it same distance, it was 100% accurate.





# **Pulse Sensor Amped**

- Monitor heart rate data in "beats per minute"
- Optical Heart Rate Sensor
- The device will be connected to the ear lobe

- INPUT: 3-5V (requires Aref)
- **OUTPUT:** Single wire output is an analog fluctuation in voltage.







#### **Pulse Sensor Simulation**



#### HR = 60000 / IBI ;

when IBI is calculated in milliseconds



### Pulse Sensor Simulation with oscilloscope

#### **Regular Pulse Reading**

#### Superimposed Regular Pulse



# Pulse Sensor Simulation with oscilloscope

# Pulse reading under constant ambient light

# Pulse reading in dark room with no ambient light



# **Comparison of Pulse Sensor**

- OxyWatch premium Fingertip Pulse
   Oximeter from
   Home Depot
- Pulse Sensor Amped was off by approx 2beats





# Motion Sensor (ADXL 335)

- triple axis accelerometer
- Full scale range of ±3g
- Measures static acceleration due to gravity.
- ADC gives 10bit resolution

- **INPUT:** Input voltage can be between 1.8V to 3.7VDC.
- **OUTPUT:** Accelerometer outputs analog voltage depending on sensed value in each axis.



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# ADXL335 Simulations with oscilloscope

# +Z axis in direction of gravity

# -Z axis in direction of gravity

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# ADXL335 Simulations with oscilloscope

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# ADXL335 Simulations with oscilloscope

# +X axis in direction of gravity

# -X axis in direction of gravity

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# **Power Supply Module**

- This module powers the entire device.
- 2000mAh Lithium
   Polymer battery
- battery includes built-in protection against over voltage, over current, and minimum voltage
- Weight: 36g



# **SD/MMC Storage Module**

- This module stores all the data acquired from the sensors.
- Packaged sensor data from microcontroller is stored in microSD card before transmitting
- Required voltage of 1.8 to 3.6V





#### Wireless Transmission via Xbee module



- Allows a very reliable simple wireless communication.
- The two modules act as a transmitter and a receiver accordingly.
- Able to send data from Wright & Green to Wright & Springfield.
- Configured via X-CTU



## Data Transmission via X-CTU

#### Characters

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 Heart rate, body temperature, motion Speed (Main Goal)

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## **LED Battery Status Indicator**



This circuit is responsible • for indicating a low status of battery. A full battery is around 3.7v. When the battery goes below 3.0v, the red LED lights as an indication of the low status of the battery.

### LED Battery Status Indicator Simulation





## Phase 2 connections:

- For the purpose of phase 2 we remove the arduinoUno board and the breadboard, and replace it with a custom PCB incorporating the following features:
- <u>ATmega 328 microcontroller chip connection</u>
- ADXL335 accelerometer chip
- Footprint for MLX90614 Infrared Temperature Sensor
- Lithium polymer battery socket port.
- MAX1555 with microUSB port for Lithium polymer battery charging.
- SD/MMC card holder
- External 16MHz crystal clocking device
- Headers for pulse sensor and expansion ports



# **Battery Charging (MAX1555)**

- IC for USB charging of Lithium Polymer battery
- Quick charging
- Current automatically reduced to trickle when charging is complete.





# Making of PCB at EVRT 50N

- Step1: Print PCB layout on glossy paper using laser printer
- Step2: Using clothes iron heat transfer design onto copper board.
- Step3: Use PCB etching solution to etch out all copper except transferred ink traces.
- Wash board completely to remove ink and have copper traces left.





### **Future Work**

- We could add a gyroscope, magnetometer, and GPS to improve motion detection
- We could add multiple temperature sensors to improve skin temperature data collected
- We could add electrode ECG measurement in addition to pulse oximetry
- Atmega328 has limited ports with no room for expansion. Could upgrade to Atmega2560



## Conclusion

- Tested with arduino with sensors and are able to communicate reliable data
- Tested the xbees with arduino. Able to transmit at least 100m
- Prototyped a working device
- Made a pcb version of the prototyped board
- Need to design a case that is wearable