Block Diagram

Power circuit schematic
Data transfer rate calculation

The Bluetooth LE module we will be using has a data transfer rate of up to 2 Mbps. The I2C Master from the IMU can be configured to read up to 24 bytes per package from up to 4 auxiliary sensors. The data out rate for the IMU is 100Hz which means that 24*100 = 2.4 Kilobytes can be transmitted per second. This corresponds to 2.4*8 = approx. 20Kbps which is well within the bluetooth transfer rate, and shows that Bluetooth LE will be sufficient.
Battery charger plot

Lithium ion battery use
Lithium ion batteries have high energy density, do not need prolonged priming when new, have relatively low self-discharge -- self-discharge is less than half that of nickel-based batteries-- and low maintenance because no periodic discharge is needed. Lithium polymer batteries have lower energy density and decreased cycle count compared to lithium ion and are expensive to manufacture.

Block Description - Microcontroller
1. Inputs:
   a. 3.3V from power supply
   b. IMU sensor data (I2C interface)
   c. Bluetooth module data (SPI interface)
   d. Push button switch
2. Outputs:
   a. IMU control signals (I2C interface)
   b. Bluetooth control signals (SPI interface)
   c. Acceleration and rotational data to bluetooth module
   d. LED indicator
3. Purpose
   a. The microcontroller is the hub of the device. It will control the state of the IMU sensors and will determine the frequency of acceleration and rotation data collection. The microcontroller will control the state of the bluetooth module, and transmit data from the IMU to the bluetooth module. It will also receive input from the push button for powering on, powering off, and resetting the system. It will provide device status through a LED, which will show if the device is functioning or if there is an error. The microcontroller will implement a state machine for device control.
## Requirements and Verification table for power module

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Verification</th>
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</table>
| **3.7 V DC to 3.3 V DC Buck Converter**  
1. Vout = 3.3 V ± 0.3 V at 30 mA | **3.7V DC to 3.3 V DC Buck Converter**  
1. Verification Process for Item 1:  
   a. Attach 35 ohm resistor as load  
   b. Attach oscilloscope across load  
   c. Set NMOS gate voltage to 31.25 kHz square wave with 59.375% duty cycle  
   d. Buck converter with 3.3 V DC  
   e. Ensure output voltage remains 3.0 V and 3.6 V |
| **3.7 V LiPo Battery and Charger**  
1. Each of two batteries must store 5500 mAh, -500 mAh tolerance, of charge  
2. Battery must be unable to discharge if left plugged into charger without power | **3.7 V LiPo Battery and Charger**  
1. Verification Process for Item 1:  
   a. Attach 5.5 ohm resistor bank as load  
   b. Measure I and V at 5 minute intervals  
   c. Terminate test when any Vcell 3.3 V  
   d. Perform midpoint Riemann summation  
   e. Ensure at least 5000 mAh extracted  
2. Verification Process for Item 2:  
   a. Fully charge battery  
   b. Unplug charger from wall outlet  
   c. Allow to sit for 5 days  
   d. Measure cell voltages  
   e. Ensure battery has not discharged beyond typical self discharge |
<table>
<thead>
<tr>
<th>Total Power Consumption</th>
<th>Total Power Consumption</th>
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<tbody>
<tr>
<td>1. Functions for 6 hours</td>
<td>1. Verification Process for Item 1:</td>
</tr>
<tr>
<td></td>
<td>a. Turn device on</td>
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<td>b. Set device still simulate no motion</td>
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<td>c. Request bluetooth RF broadcast (slave) to send data to computer (master)</td>
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<td></td>
<td>d. Ensure value obtained is consistent and on for 6 hours</td>
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Safety Statement

In engaging in this project over the course of the semester, we are taking all precautions necessary to ensure the safety of all persons, equipment, and facilities used. This includes the completion of 2 online safety training courses by each member of this project. Since this product contain high voltage part up to 110v in the power unit, we will build and connect any electrical components with cautions. We will ensure not to take any unnecessary risks for our project. We will ensure that we only utilize the components and parts as they are meant to be used. We will also ensure that our circuit design is simulated and safe to be use before building the physical prototype.

Citations:
Battery University, "Is Lithium-ion the Ideal Battery?" Web. 15 Feb 2016 URL: http://batteryuniversity.com/learn/article/is_lithium Ion_the_ideal_battery


Maxim Integrated, “MAX1737 Stand-Alone Switch-Mode Lithium-Ion Battery-Charger Controller” MAX1737 datasheet, September 2007