Head Bangerz: Concussion Sensor

Design Review 1

Group 2
Lauren Stark, Brennah Satterfield,
Mackenzi NierDuffy, Sofia Main, and Greg Defalco

Prof. Mike Schafer
EE Senior Design

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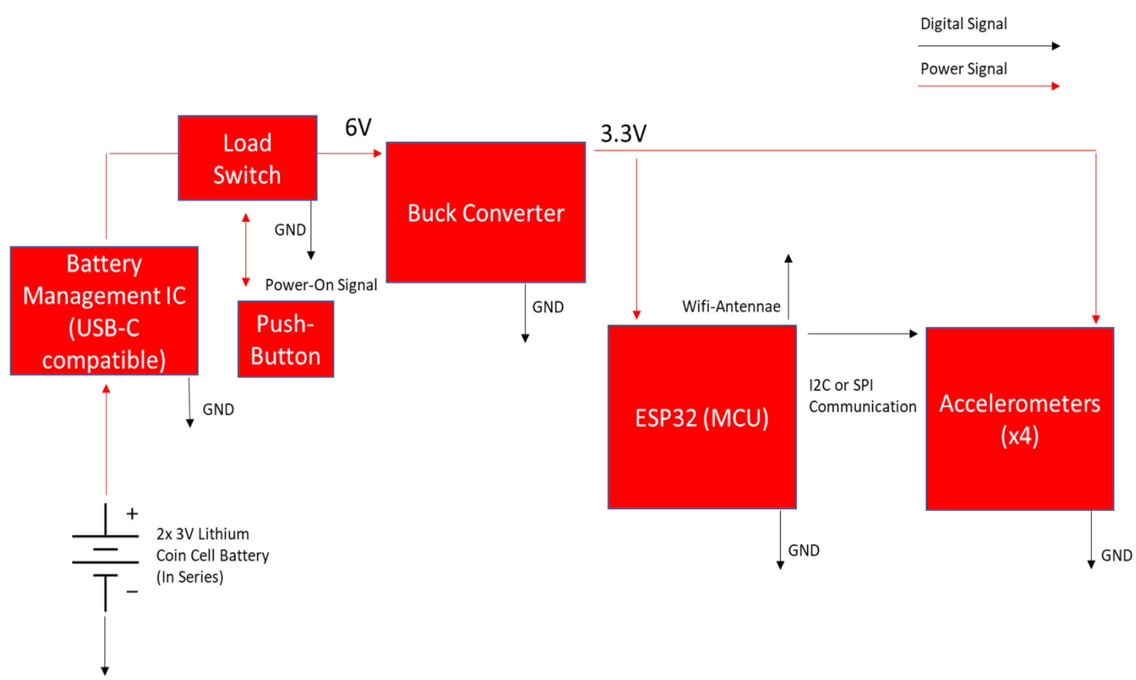
1 Introduction

The Head Bangerz: concussion sensor will be focused towards hockey. Hockey teams on average have about 20 to 30 hits per game. The Head Bangerz: Concussion Sensor will be fitted inside a hockey helmet, generously donated to the group and tested through vigorous tests. The sensor will also have the ability to communicate to an off field coach or doctor via bluetooth to a computer connected to wifi receiving input data from the helmets. The computer hub will be able to receive data from multiple sensors. The sensor will be charged by a lithium battery that can be removed from the helmet and recharged. With an interrupt on the sensor, the sensor will effectively be off during the game and turn on and send data on the event of a hit. This will help save a significant amount of energy so that the sensor can last the entire duration of a game. We have also decided fully on using **ESP32-C3-WROOM** for its bluetooth capabilities.

2 System Block Diagram



2.1 Subsystem 1 Requirements

- Deliver power to the device
- Buck Converter to step down the voltage to 3.3 V for the MCU and accelerometers
- Push button to power on/off the device in order to save charge
- Battery management IC to recharge device
- Load switch to reduce power loss when device is fully powered off

We're creating a new board that will include a battery connector and a better voltage converter. We have updated our Board on Eagle to reflect these changes. The current power to the system is fully the 5V coming straight from the computer port in a USB-c cable.

2.2 Subsystem 2 Design

Subsystem 2 involves the sensing components of the design. Currently two breakout board sensors from Adafruit will be used. The ADXL375 is a high G accelerometer (up to 200Gs) which meets or concussion sensing requirements (someone please put in the actual G number we need to meet). The BNO055 contains a gyroscope which will allow for the measuring of angular acceleration data, which is also an important factor in the diagnosing of concussions (someone put in the fancy curve data we found pls.) Both of these boards are I2C compatible, and will be connected as such to the ESP32.

2.2 Subsystem 3 Requirements

- Build a website that is readable and connects to ESP
- Website displays to the accelerometer data output
- Website is user friendly and can connect outside of the SD network
- Bluetooth connection to the ESP32-C3

The Website currently connects to an ESP32 , using wifi. The ESP32 connected to the website will in the future be bluetooth connected to the sensors in the helmet. Currently, the website relies on SPIFs to run. By Design Review 2, we plan to have full connections to the website every time and make sure that there needs no further changes on the connections.

3 Power Requirements

After running some preliminary calculations for all the major current-sinking devices of the design, it was found that in order to supply power for a worst case scenario of 3 hours (real time of professional hockey game), and transmit BLE major hit once per minute over the course of that entire time - a battery of approximately 200 mAh would be needed. After looking into options online, a 3.7 V - 5 V rechargeable lithium ion battery at either 250 mAh or 500 mAh should provide more than enough margin to power the device.

4 Components and Strange Requirements

4.1 Components

The major components that will need to be purchased are the microcontroller, helmet, and accelerometers. Below is a table of their costs.

Component	Price
High G Accelerometer	\$19.99
Headband	\$11.99

Battery Management IC	
Buck-Converter	$6.99
Load Switch	$3.30
Lithium rechargeable batteries	$9.99
Total:	$52.26

These costs are well within our $500 budget for the project. The components are available for purchase on multiple websites, and we do not anticipate any problems acquiring them. We have decided on a 200 G's accelerometer. Helmet was free because a hockey helmet has been donated to us for free.

4.2 Strange Requirements

The board design will have to be smaller to fit inside a helmet so we will need the different components on the board to be soldered by the manufacturing company.

5 Design Plan

Goals for Review 2

- Have the board and schematic ready to be sent out to be manufactured
- Ensure bluetooth works and properly connects one ESP32 to another
- Ensure acceleration is measured in multiple directions and readings are correct and taken regularly with multiple sensors including one accelerometer and one gyroscope
- Create a shell that holds the battery that can be removed and recharged

For more information on these goals, please refer to action items.

Action Items

Goal: Create new board and make it smaller
Notes: First we must know the new design requirements. Then after all the math has been done, fabricate a new board that can be sent to manufacturing. The new board must be a maximum of 2 inches across, using hockey helmet design requirements that we have specified.

Goal: Display data in website

Notes: The data that is collected has to be displayed in a user-friendly way. The application should also alert the user when a concussion has occurred. This could be done in a Green-Yellow-Red manner where green means the player is fine, yellow means the player sustained a hit but not concussion worthy, and red means the player may have a concussion and should be removed from the field.

Goal: Create other prototype (system must be operational)
Notes: In this instance, we will also be testing the comfortability for the player and the protection of the system. However, in this instance, the system must be working. This way we can test how the accelerometers and application are working properly. Several tests must be done.

Goal: Create and manage interrupt
Notes: Since the board is powered by a battery, we don't want to lose battery if the system isn't being used. A power button would allow for the system to be turned on and off. Once the system is on, the system should be collecting data. If the system is off, the system should not be gathering data. This way the battery can be preserved.

Goal: Connect Lithium Battery
Notes: Find a way to charge the board using a battery that can be detached and recharged.

Goal: Create Battery holder using CAD
Notes: Create an easy holder that will protect the battery from harm and can be removed and recharged easily.