Head Bangerz: Concussion Sensor

Design Review 0

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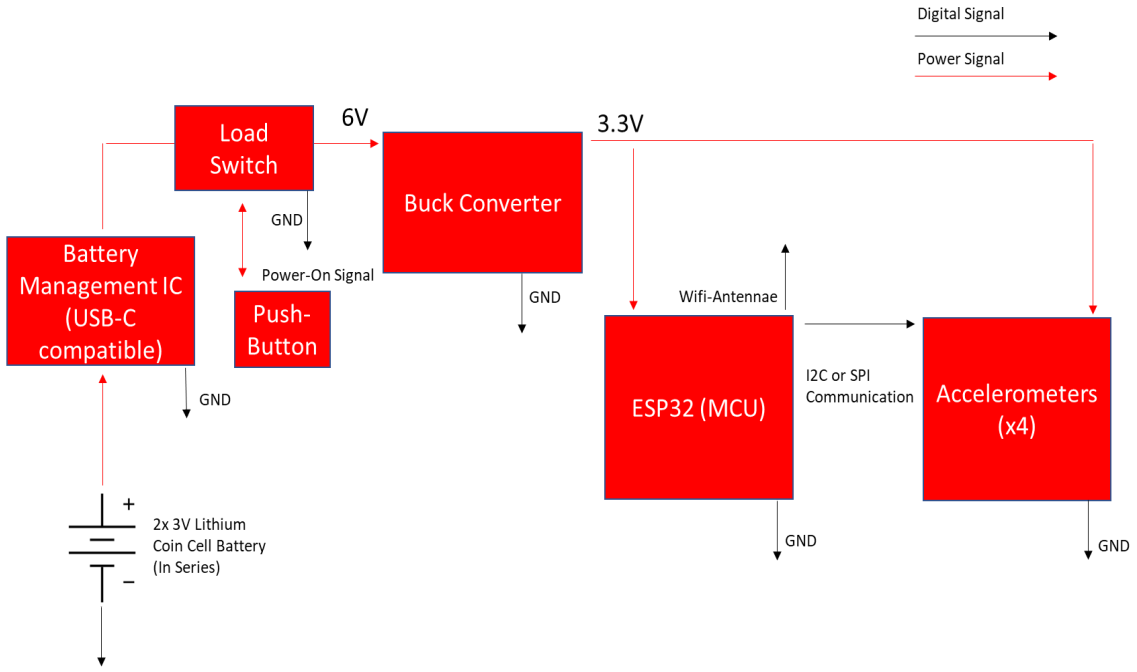
1 Introduction

The Head Bangerz: Concussion Sensor has begun the process of creating a functioning and well designed final product. This product should be small enough to not impact a helmet in such a way that a player could be injured. It must also have the ability to communicate to an off field coach or doctor. As well as have the capacity to stay on through the duration of a multi hour game with a battery that also will not impact or injure the player. Through the process of designing this device, steps to ensure each subsystem and component work properly will guide us to creating the final device. Other concussion sensors on the market utilize chemical reactions to impacts and EEG's implemented in helmets. We would like to stay within a minimum financial threshold to ensure availability to lower level athletes i.e. high school. As well as we prioritize sticking to electrical components rather than chemicals.

2 System Block Diagram



2.1 Subsystem 1 Requirements

- Deliver power to the device
- Minimum 6V delivered through 2 x 3V lithium coin cell batteries in series in order to provide a flexible higher voltage at the low cost of lithium coin cells
- 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

2.2 Subsystem 2 Requirements

- Measurement and communication system for the accelerometer data (likely I2C or SPI)
- Must measure the acceleration of the head from different angles
- Communicate with a server on the sideline using the wifi module so that trained medical staff can monitor the signals
- Accelerometers must have capability for threshold interrupts in order to put the MCU into active mode for transmission only when a high enough value is measured - this will be done to save battery power
- Alternatively, the MCU can be set to an automatic cycle of active to rest mode and transmit data at specific intervals to save power - this is the less desirable option however

3 Availability of 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
Accelerometer (4)	$10.48
Headband Battery Management IC	$11.99
Buck-Converter	$6.99
Load Switch	$3.30
3V Coin-Cell Batteries	$9.99
Total:	$47.99

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. Further, an accelerometer is free to use from the professors' collection.

4 Potential Obstacles

There are obstacles to building our device to work as intended to unknowns and barriers to our own understanding of how to design such devices. The following are questions about our system that we either do not know yet or do not know how to go about answering the questions yet:

1. How do we decrease the size of our board without losing the necessary components to make our system work?
2. What would the threshold for a concussion or a traumatic brain injury (TBI) be? Further, how does the individual's physicalities affect their disposition to get a concussion?
3. Would potential hits break the system? If so, what is the threshold?
4. Would environmental factors such as The tolerance for sweat and water of the system affect how it will perform when faced with these obstacles.
5. Will there be any communication interference with the helmet?
6. Will the setup have to be changed to work with the helmet and make sure the helmet is still effective?
7. Another concern is that it is unclear how to make the system compatible with different helmets while at the same time ensuring the helmet is still as effective as previously and not posing any additional danger.

5 Design Plan

Goals for Review 1 (Feb 13)

- Discuss possibility of making board smaller
- Connect the accelerometer to the board
- Test accelerometer data on a moving object
- Ensure that the converter for 3.3 V from a coin cell works
- Test battery connections on coin cells and how many are necessary to support the device for extended periods of time.

Goals for Review 2 (Mar 6)

- Connect to a remote on/off button
- Ensure server is connected to device and receiving data from it
- Ensure acceleration is measured in multiple directions and readings are correct and taken regularly

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

Action Items

Goal: Make board smaller
Notes: The board needs to be small enough so that it fits comfortably in the back of the neck. There may be unnecessary components or layouts in our current board design that can be removed.

Goal: Place board on helmet in a comfortable manner
Notes: We can use a styrofoam stick on to cover the board so the user feels comfortable. These styrofoam stick on's are typically easy to apply and remove.

Goal: Set up accelerometer to board
Notes: If there is not a space already on the board, we need to add a plug-in for the accelerometer.

Goal: Ensure board is receiving data from accelerometer
Notes: We need to create a program that receives the data from the accelerometer. We are also unsure how the data is presented from the accelerometer, so we need to check that in order to receive useful information. Then, we can also test how the data changes based on the accelerometer's movement.

Goal: Repeat process for 3-4 accelerometers and test
Notes: We are using multiple accelerometers to detect different locations of the head since we are unaware of where a concussion can occur. We also need to check if the data is different between accelerometers.

Goal: Determine what would be considered a concussion from the data
Notes: Since the goal is to use the accelerometers' data to determine concussions, we need to test what the data threshold is for a potential concussion. This would require a prototype and a fake head.

Goal: Send and receive information from board to application
Notes: The board and application will be separate entities, as in there is no wire connecting them. This means that the board has to communicate with the application. Thus, we are assuming there is wifi in these locations and so we will use wifi as communication.

Goal: Create a basic application
Notes: Part of the design is allowing coaches to get alerts for when potential concussions have occurred for their players. This means that the coach has to be able to download the application and have the application connected to the board—probably through bluetooth.

Goal: Receive data from board to application
Notes: The board is picking up the data from the accelerometers, but we need the application to receive the data as well. This can be done through a program.

Goal: Display data in application
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 1st headband/helmet prototype (system does not need to be operational)

Notes: We will be using a hockey helmet to test how the wires, boards, and accelerometers will be placed. We are hoping that the system will be covered with some kind of material to protect the system and provide more comfort for the player. Since the hockey helmet is Brennah's, she will be testing how comfortable the system is.

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 a power button
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.