

Objective

Concussions are a major concern in contact sports, particularly in American football. It is well known that an improperly fit helmet can drastically increase a player's risk of sustaining a concussion. Our company, Football Informatic Technology or FIT, has developed a solution to the current suboptimal helmet fitting protocols in a device that utilizes force-sensing resistor technology to quantitatively assess the fit of a football helmet.

Clinical Problem

- Every year, 160,000 to 200,000 football players nationwide receive a concussion¹
- Research suggests that sport-related head trauma may lead to neurodegeneration known as Chronic Traumatic Encephalopathy (CTE)
- There are many challenges associated with addressing sports-related concussions
- Difficult to diagnose
- Lack of effective treatment options
- Therefore, prevention is highly emphasized

Needs Criterion

The football helmet is the primary prevention measure against head injuries in the sport of football. However, football helmets are currently fit using very qualitative metrics, which can result in a wide range of potential fittings. Additionally these fittings can change significantly over the course of the season and often these changes go unnoticed.

Below are needs for a device to address this problem:

- Accurately, quantitatively assesses fit
- Non-bulky to not interfere with fit of helmet
- Easy to use - little set up time and rapid readings as to not interfere with normal fitting protocol
- Removable and reusable – 1 unit per team
- Low-cost so accessible to a larger demographic

Novelty

- Only device on the market that quantitatively assesses the fit of a helmet
- Other products on the market look at accelerometer forces to determine whether a concussion has been sustained

Design Overview

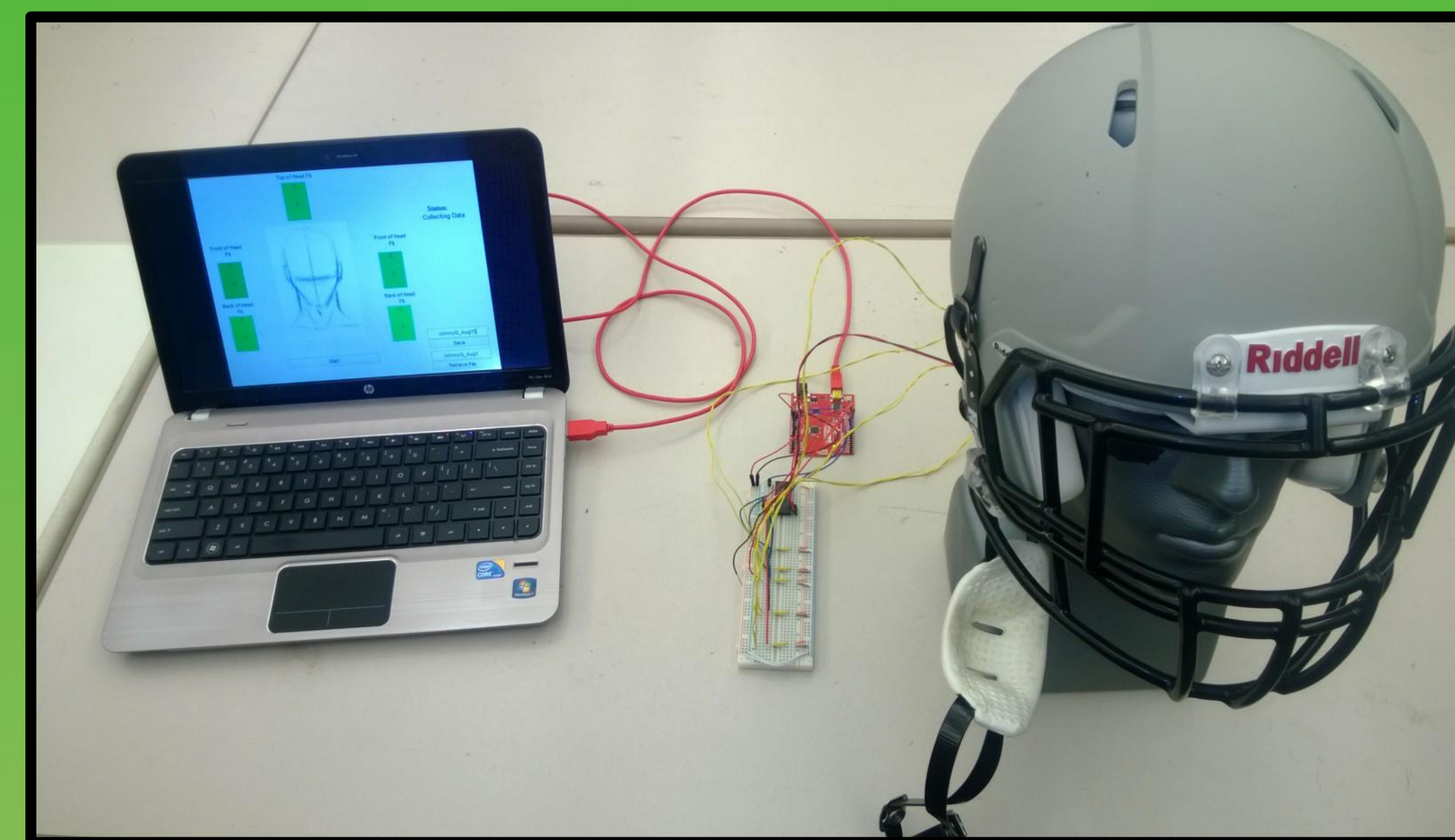


Figure 1: Image of FIT Helmet System

Our design is composed of an Under Armour skull cap, five force sensing resistors connected to a breadboard, and a multiplexer. The multiplexer sends an analog signal with sensor data to the Arduino Uno. The Arduino displays all readings within a MATLAB graphical user interface (GUI).

Protocol

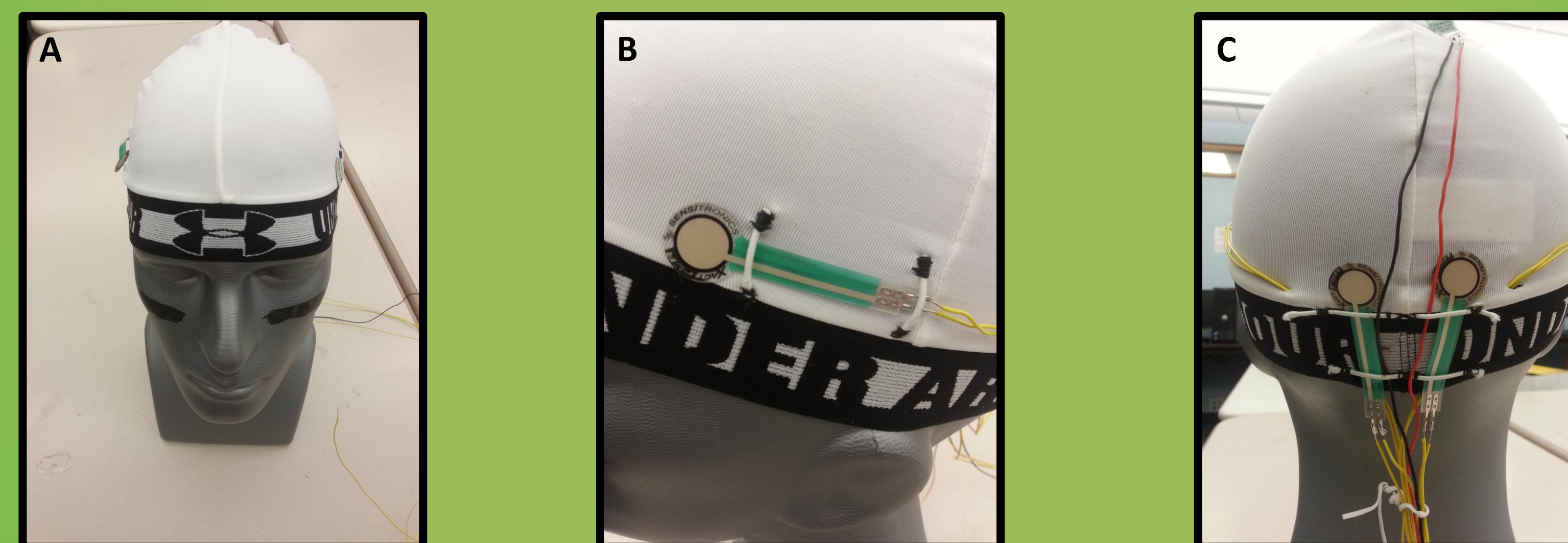


Figure 2: Front (A), side (B), and back (C) view of FIT Helmet System Sensor Cap

1. Wear cap without sensors
2. Place sensors into labeled supports on cap
3. Deflate football helmet bladders
4. Wear football helmet
5. Introduce air via bladder until desired fit is reached via user interface

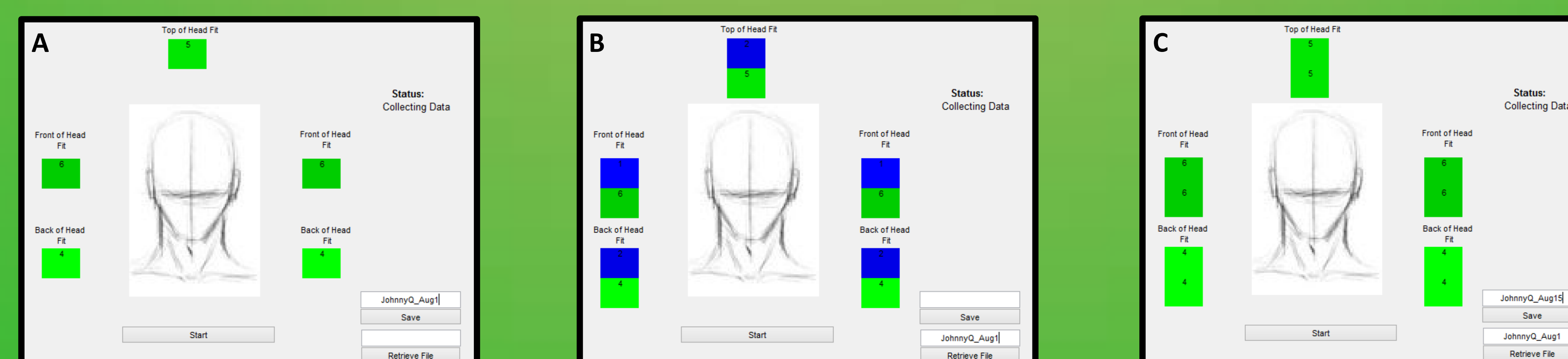


Figure 3: FIT Helmet System MATLAB GUI from an initial fitting (A), subsequent fitting with loaded data (B), and successful refitting (C)

Initial Reading:

1. Following hardware protocol, press start on data collection
2. Observe color changes in sensor display boxes
3. Add/remove air to achieve green display boxes
4. Write file name and save as .csv

Subsequent Reading:

1. Load old save file to restore prior display boxes
2. Compare active display boxes to loaded display boxes
3. Save as new file in .csv

Description of Market

Youth Football:

- Approximately 3.0 million athletes between 7 and 14 participate in youth football programs²
- Recent 10% decrease due to fear of concussions
- Technology would be supported by parents, coaches, and NFL to encourage football participation

High School Football:

- 1,068,627 player nationwide³
- Product would have funding from schools and parents

College football:

- Participation in football is two times the amount of participation in the next popular sport (baseball)⁴
- Extensive funding from universities
- Target market

Manufacturing Costs

Item	Quantity	Cost per Unit	Total Cost
Under Armour Cap	1	\$15.00	\$15.00
Sensors	5	\$5.00	\$25.00
Solder	-	\$0.05	\$0.05
10kΩ resistors	5	\$0.05	\$0.25
Wire	-	\$0.10	\$0.10
Breadboard	1	\$8.00	\$8.00
Arduino Uno	1	\$25.00	\$25.00
Electrical Tape	1	\$0.79	\$0.79
Engineering Labor	0.5	\$25.00/hr	\$12.50
Total			\$86.69

Future Plans

Future work will focus on integrating materials directly with the football helmet. These iterations will look to decrease the time with which these sensors can be easily removed and place back in between football fittings.

Acknowledgements

We would like to thank Dr. Zapanta, all the TA's for BME Design (in particular, Melissa Delgado and Trent Wells), and the CMU Physics Department, and the CMU Football team for their support.

References

- (1) U. S. Consumer Product Safety Commission, "Estimate Report of Annual Injuries Associated with Football Activity, Apparel or Equipment", National Electronic Injury Surveillance System, National Injury Information Clearinghouse, 1995.
- (2) Football Concussion Fallout Extends to Youth Programs. Star Tribune Sports.
- (3) High School Sports Participation Increases for 24th Consecutive Year. National Federation of State High School Associations.
- (4) College sports participation rates continue upward trend. National Collegiate Athletic Association.