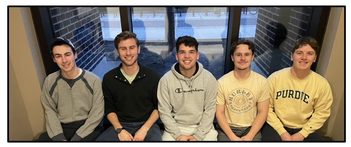
PURDUE UNIVERSITY
Mechanical Engineering

Concussion Detection Technology

Capstone Senior Design Project • Spring 2023

Flynndustries



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Problem Definition

Concussions in football players often go undetected or are detected too late, which can lead to long-term health consequences.

Mission

Our mission is to improve the safety and well-being of football players by developing innovative technology solutions that detect concussions in real-time. We aim to provide coaches and trainers with the tools they need to quickly identify and respond to potential concussions, and ultimately reduce the risk of long-term health consequences for players.

Why? To prevent the potentially life-threatening condition of second impact syndrome and other long-term health consequences resulting from undetected or untreated concussions in football players.

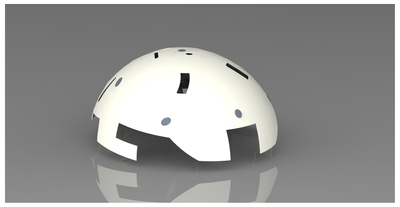
How? Through the development of innovative technology solutions, including an array of flexible force sensors that detect force to the head from football collisions to detect concussions, and send the data via Bluetooth to a computer which processes the information immediately and alerts coaches and trainers when a concussion level hit has occurred.

Benchmarks

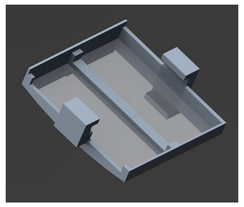
High School	Collegiate	Professional
• Low Cost • Ease of Use • Reliability	• Durability • Ease of Use • Reliability	• Durability • Accuracy • Comfortability

Benchmark	Target	Shockbox	Tozuda Impact Detector	Flynndustries' Design
Distance	185m	100m	∞	>200m
Price	$100	$179.99	$49.99	$75
Immediate response	✅	✅	❌	✅
Tracks multiple hits	✅	✅	❌	✅
Force Sensing	900lbs	200lbs	-	1200lbs/sensor

Shell and Casing

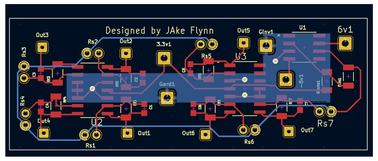


Ultra-thin plastic shell to nest sensors and power supply

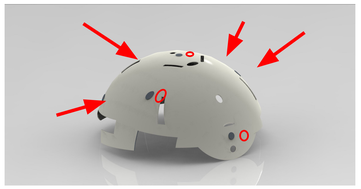


Protective high impact casing for PCB board and Arduino

Wiring and Data Transmission

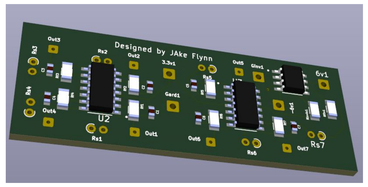


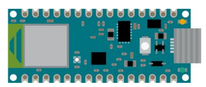
3D CAD model of PCB board, 2.25 x 0.85 x 0.075 in



7 Force sensors rated for >4000N placed at critical locations around head

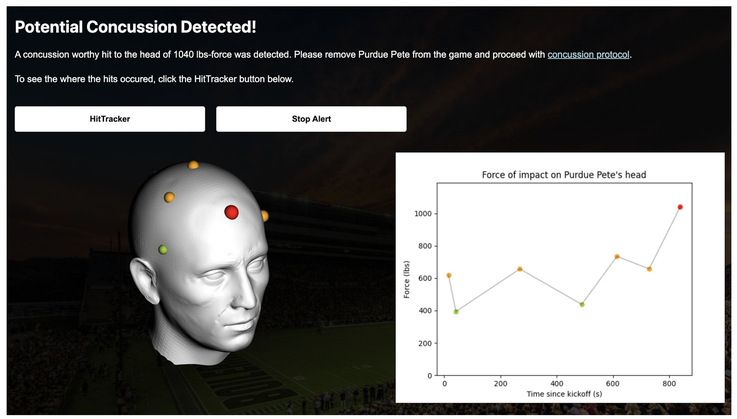
2D wiring schematic of custom-made voltage amplifying PCB board





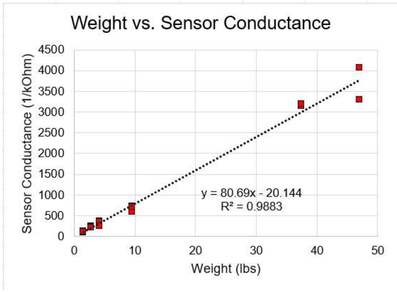
Arduino Nano 33 BLE to send the data from the sensors to the sideline wirelessly

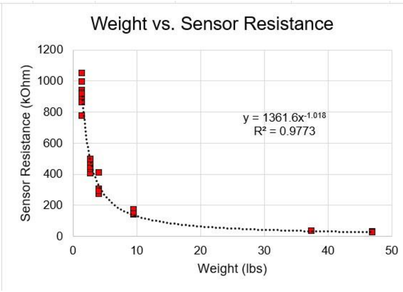
Data Visualization



Easy to use custom made website that displays both visual and audio warnings when a concussion has been detected.

Validation Tests





- **System can withstand hits above 1000 lbs-force**
- **Accurate force readings within 10% of actual force delivered**
- **Product weight is only 10.8% of entire helmet**
- **Alerts sideline of concussion <1 second of hit occurring**
- **Able to send data > 150 yards away**
- **Displays exact calculated location of hit on model of head**

Manufacturing

Total Cost of Purchased Parts	$158.20
Units in Year 1	30,000
Volumized Percent of Retail Value	70%
Purchased Part Cost	$48.55
Anticipated Labor Time (Hours)	.25
Labor Cost ($/hr)	60
Total Manufacturing Cost	$63.55

Product	Mass Production Cost	Quantity	Cost
Arduino	$ 20.00	1	$ 20.00
Sensor	$ 2.60	7	$ 18.20
Capacitors	$ .50	7	$ 3.50
Battery Case	$ 1.56	2	$ 3.12
MCP6004	$ .45	2	$ .90
Batteries	$ .21	4	$ .85
Shell	$ .50	1	$ .50
Wires	$ .50	1	$ .50
UA7401CD	$ .47	1	$ .47
Resistors	$ .05	9	$ .41
PCB Board	$ .10	1	$ .10

Improvements

- Combine Arduino and custom PCB board to 1 flexible board
- Further testing on different portions of helmet protecting the brain more
- Model that generates injury time diagnosis from location and severity of hit
- Expand product past the sport of football
- More reliable, rechargeable power source