



SmartHelmet

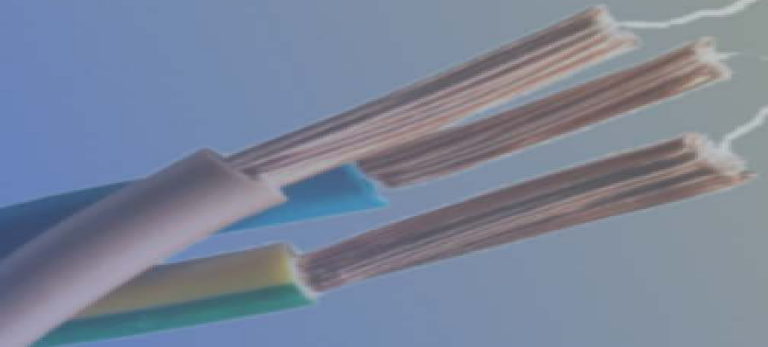


SmartHelmet



# Smart Helmet

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# Project Description

- Client: Dr. Hesam Moghaddam
- Increase the safety of the helmet by reading the g-force's
- System should work for any type of helmet
- Based on Client Requirements Team will use:

- Arduino
- Accelerometer and Gyroscope
- Bluetooth Transmitter, SD card

**Table 1:** Threshold of G-Forces [1]

Max linear acceleration	AIS level	Injury description
<50g	0	No injury
50-100g	1	Minor
100-150g	2	Moderate
150-200g	3	Serious
200-250g	4	Severe
250-300	5	Critical
>300g	6	Non-survivable



# Customer Requirements (CR)

**Table 2: Weighted CR**

<b>Factors</b>	<b>Weight</b>
High Protection	5
Transmit Data	4.5
Similar Size	4
Durable	4
More Comfort	3.5
Small Sensors	3



# Engineering Requirements (ER)

**Table 3: ER Values**

<b>Requirements</b>	<b>Values</b>
Increase G-Forces	200 g
Maintain Volume of Helmet	4100 cm <sup>3</sup> (250 in <sup>3</sup> )
Reliability	80%
Ductility Material	Reduce g-forces on head
Increase Range of Transmitter Sensor	16 m (50 ft)
Decrease Volume of Sensors	100 cm <sup>3</sup> (6 in <sup>3</sup> )

# Arduino System

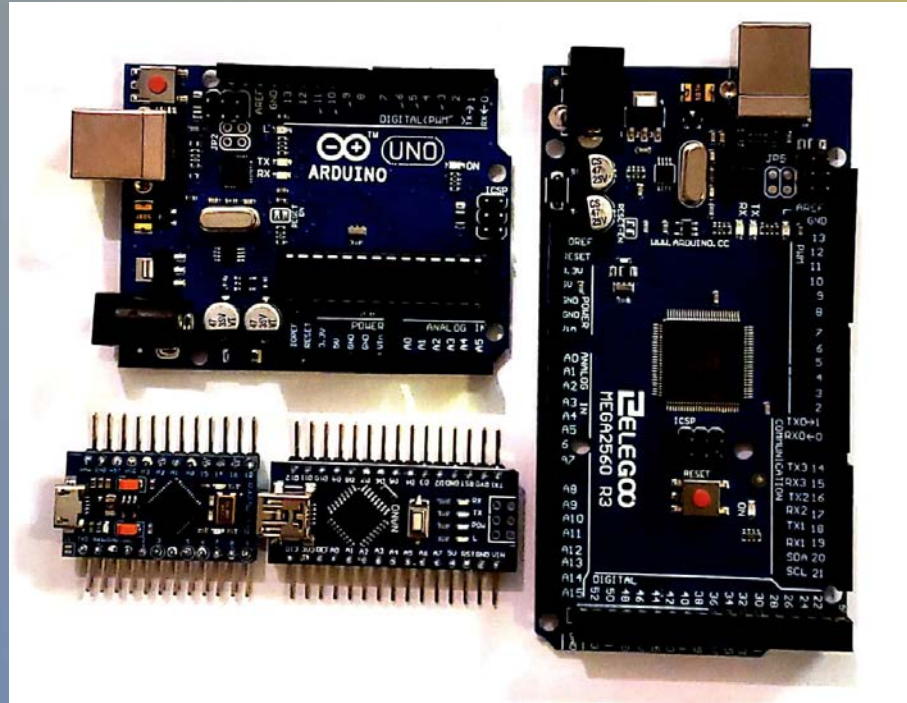
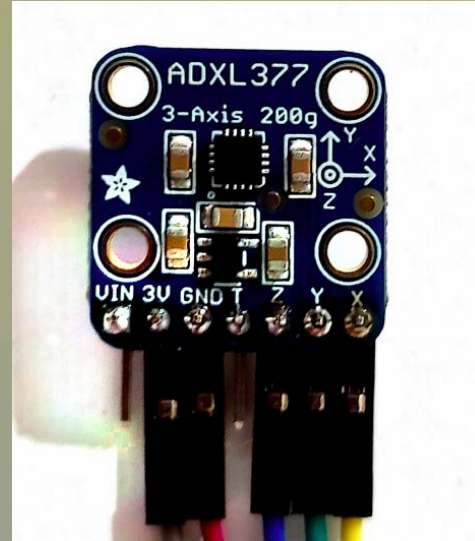


Figure 1: Various sizes of Arduinos



# Accelerometer

- Measures Linear Acceleration
- $\pm 200G$
- Analog Sensor
- Calibrated in code

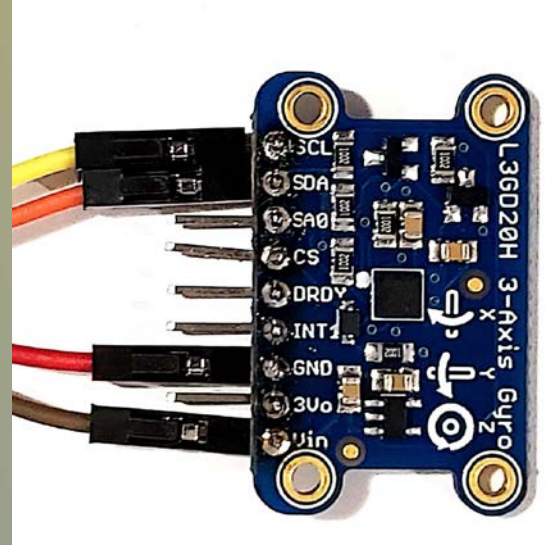


**Figure 2:** Linear Accelerometer



# Gyroscope

- Angular acceleration
- Detect a quick rotation
- Increases the safety for the project



**Figure 3:** Gyroscope

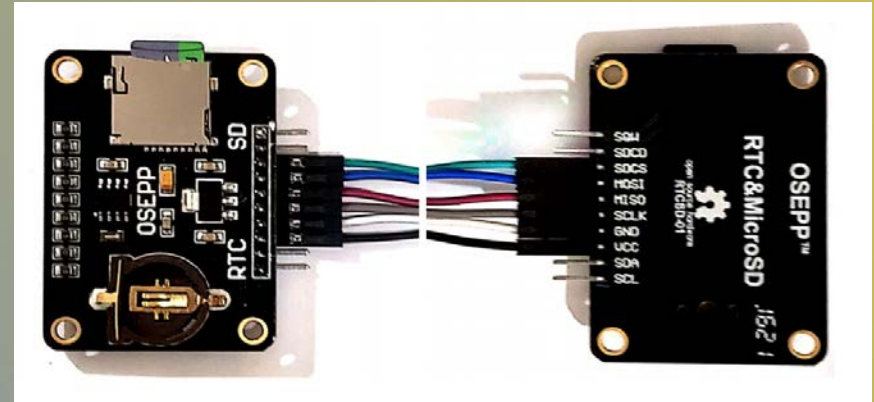
# Bluetooth and SD card



- Transmit data
- Collect Data



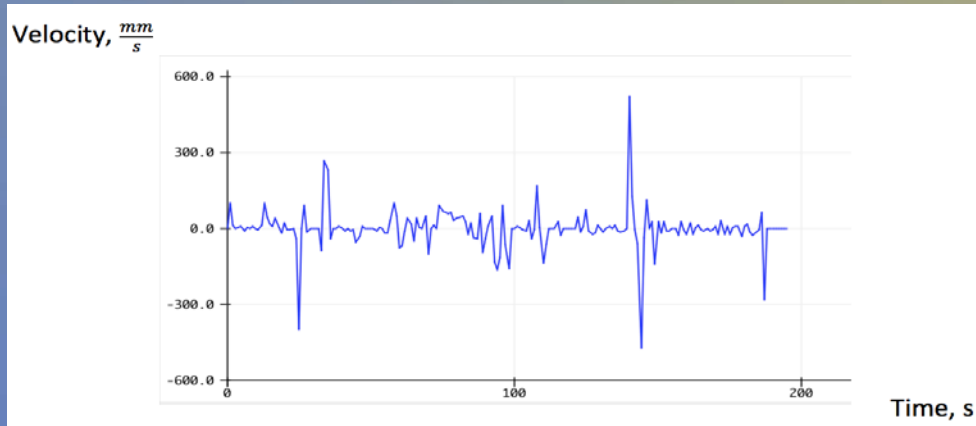
**Figure 4:** Bluetooth



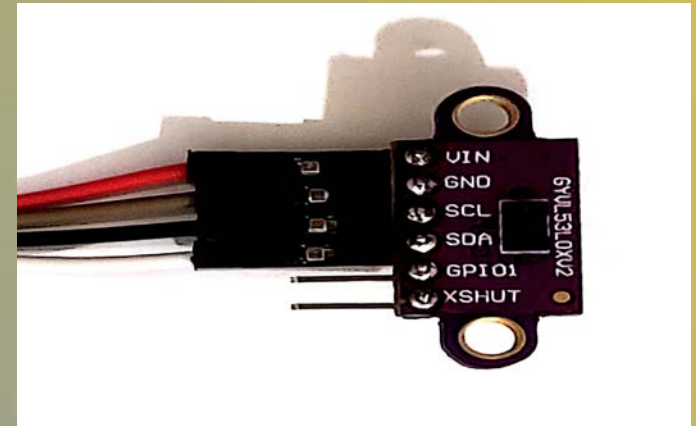
**Figure 5:** SD Card



# Laser Sensor

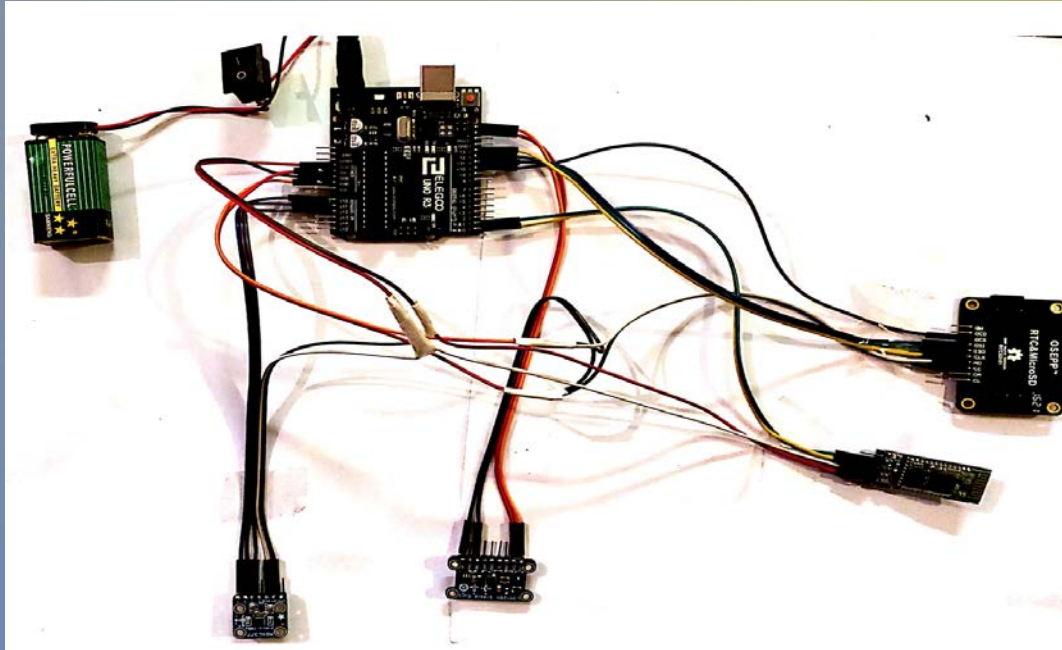


**Figure 6:** Graph results

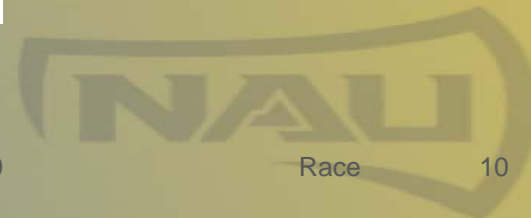


**Figure 7:** Laser Sensor

# Manufacturing of System




**Figure 8:** The system





# D3O material

- D3O material changed due to quality issue [2].
- Materials are made using a combination of advanced polymer chemistry [3].
- Absorbs and dissipates energy during an impact, reducing the amount of force transmitted to your body compared to standard foams [4].



**D3O 2mm Solid Sheet 10"x14.5"**  
(AERO) Skived


D3O uses patented, patent-pending and proprietary technologies to make rate-sensitive, soft, flexible materials with high shock absorbing properties.

D3O foam sheets can be cut to size and applied to the body as an under-wrap to provide added protection to contusions right on the sideline. D3O foam is soft and flexible and can be cut to any shape to match your specific needs.

Add D3O's patented impact protection to existing equipment by cutting your own padding. D3O foams are made from cutting edge smart molecules that remains soft and flexible until force is applied causing the material to seize up and bind together providing uncompromising impact protection.

D3O set solid and mesh sheets reduce up to three time as much force as similar foam padding without the added bulk. Only 2mm of solid D3O AERO out performs 20mm of EVA foam in transmitted force testing by up to 40%.

To learn more about D3O foam sheets and to get a glimpse at the raw testing



**D3O 6mm Mesh 10.5"x15" Sheet (XT)**

D3O uses patented, patent-pending and proprietary technologies to make rate-sensitive, soft, flexible materials with high shock absorbing properties.

D3O foam sheets can be cut to size and applied to the body as an under-wrap to provide added protection to contusions right on the sideline. D3O foam is soft and flexible and can be cut to any shape to match your specific needs.

Add D3O's patented impact protection to existing equipment by cutting your own padding. D3O foams are made from cutting edge smart molecules that remains soft and flexible until force is applied causing the material to seize up and bind together providing uncompromising impact protection.

D3O set solid and mesh sheets reduce up to three time as much force as similar foam padding without the added bulk. Only 6mm of solid D3O XT out performs 20mm of EVA foam in transmitted force testing by up to 70%.

To learn more about D3O foam sheets and to get a glimpse at the raw testing data click the link below.



**D3O 10mm Solid Sheet 10"x14.5"**  
(AERO) Unskived

D3O uses patented, patent-pending and proprietary technologies to make rate-sensitive, soft, flexible materials with shock absorbing properties.

D3O foam sheets can be cut to size and applied to the body as an under-wrap to provide added protection to select body parts or to contusions without leaving the field for more than a few seconds. D3O foam is soft and flexible and can be cut to any shape to match your specific needs.

Add D3O's patented impact protection to existing equipment by cutting your own padding. D3O foams are made from cutting edge smart molecules that remains soft and flexible until force is applied causing the material to react on the molecular level by seizing up and binding together providing uncompromising impact protection.

D3O set solid and mesh sheets reduce up to three time as much force as similar foam padding without the added bulk. Only 4mm of solid D3O AERO out

Figure 9: 2mm Sheet

Figure 10: 6mm Sheet

Figure 11: 10mm Sheet

# Installing D3O Material.



- Remove the original padding of the helmet.
- Replace the padding with D3O.
- Increase the protection of the helmet.
- The weight increase with the D3O.
- The last step for installing the padding is to cut the necessary holes to hold the sensors of the smart system in the helmet.

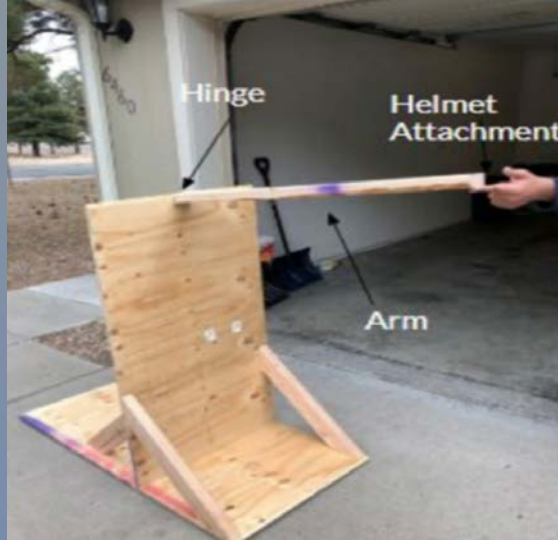


**Figure 12:** Helmet With Original Material



**Figure 13:** Helmet With D3O Material

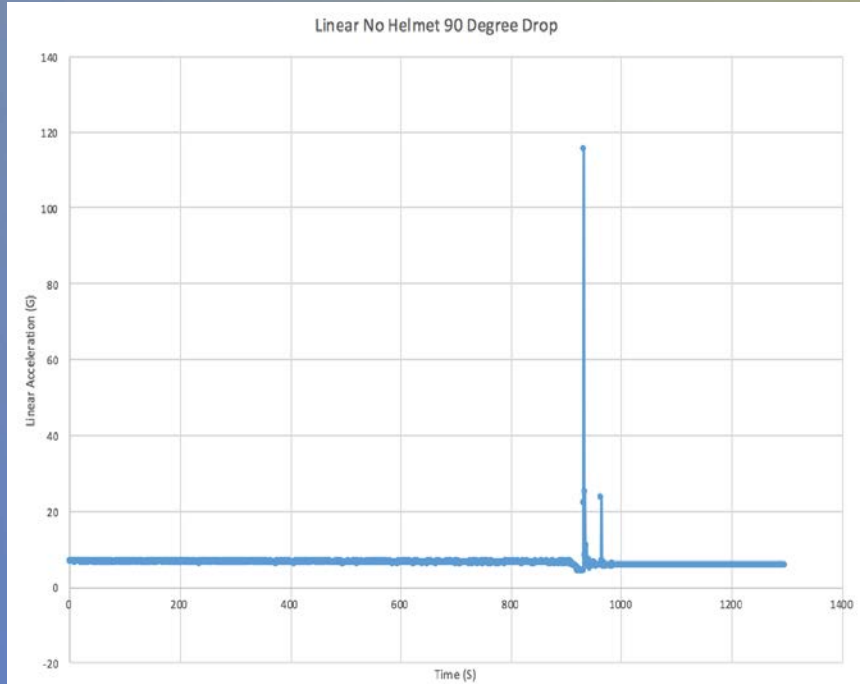
# ASTM Testing Device



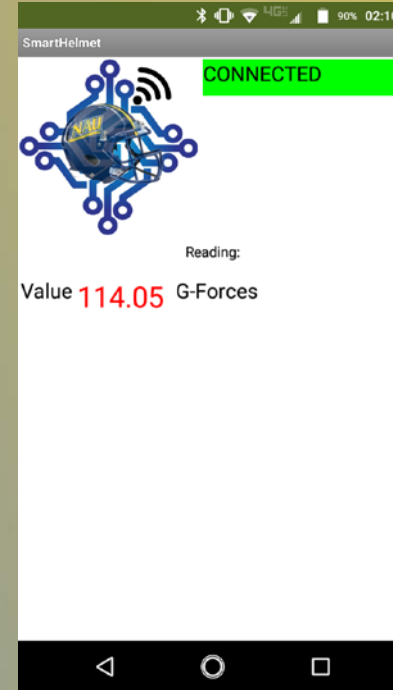
**Figure 14:** Testing device with video



# Project's Result

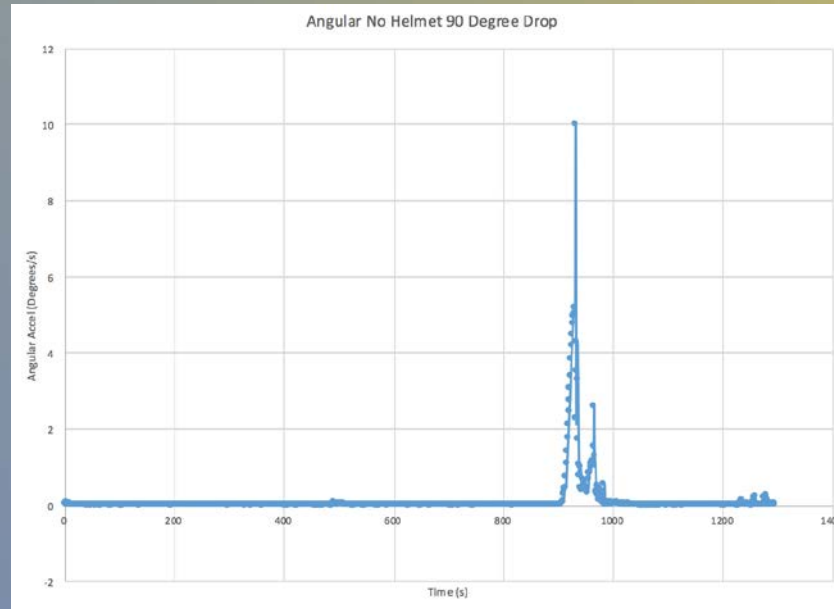


**Figure 15:** Linear Acceleration

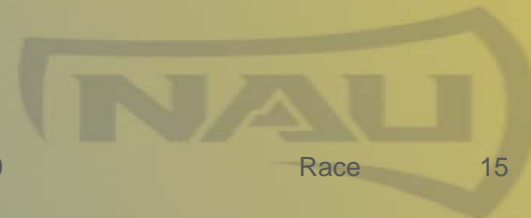


**Figure 16:** Screenshot of Bluetooth App

# Project's Result cont.

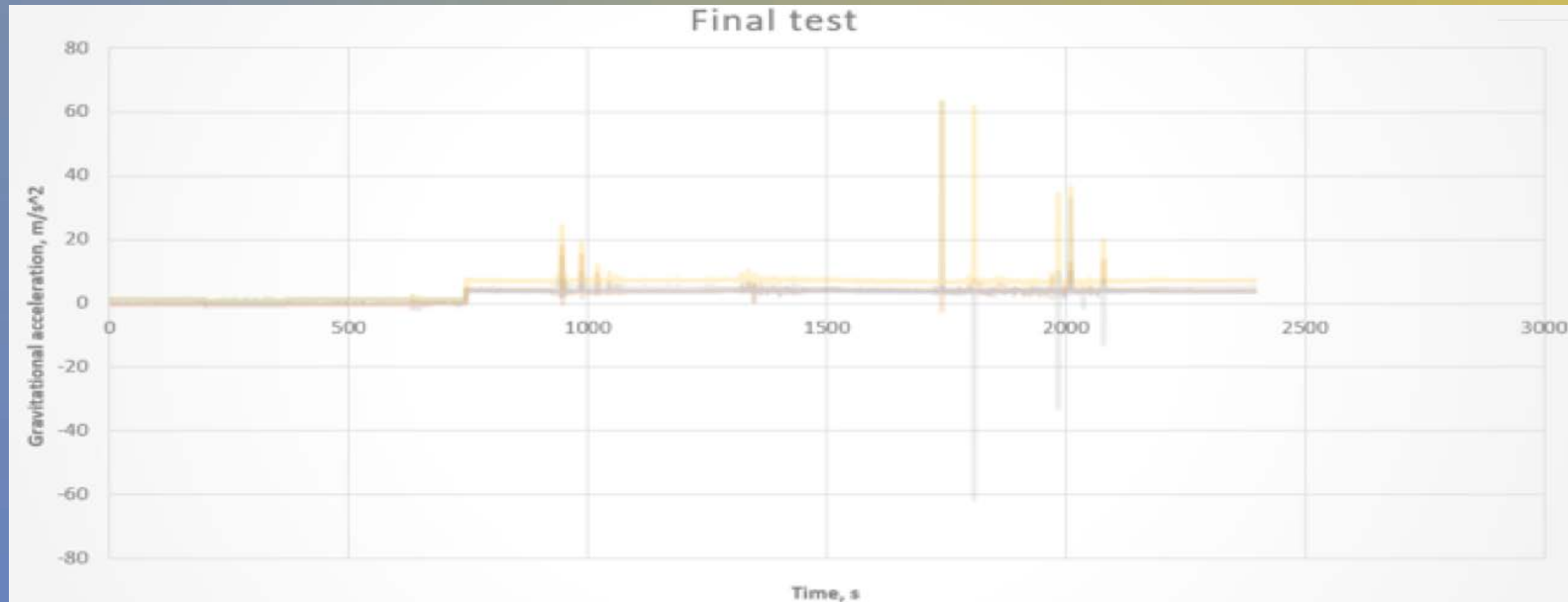


**Figure 17: Angular Acceleration**

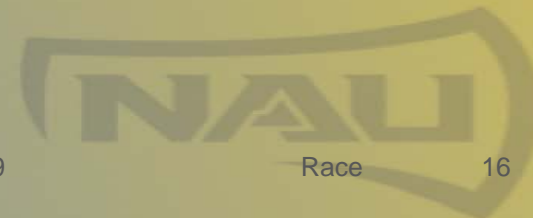




# Final result of the project



**Figure 18:** Final test result







# Project Problems

- Delay in ordering Arduino parts
- Protect the system while testing the device
- Putting all the sensors together as one system
- Ordering multiple bluetooth sensors
- Try to add Magnetorheological Fluid (MR Fluid) into smart helmet



# Process of Solving the Project Problems

- Work with the sensors as soon as they arrive
- Mega board, UNO board, and nano board
- Team made a research about the appropriate sensor
- Future work with MR Fluid



# Experiences



- New programs
- Researching new topics
- Work with electrical components
- Adapting to client's needs
- Teamwork





# References

- [1] “Male Body Image and the Average Athlete,” PsychGuides.com. [Online]. Available: <https://www.psychguides.com/interact/male-body-image-and-the-average-athlete/>. [Accessed: 08-Nov-2018].
- [2] J&P Cycles. (2019). *ICON Men's Viper Stealth D30 Back Armor - 2706-0163*. [online] Available at: [https://www.jpcycles.com/product/973-768/icon-men-s-viper-stealth-d30-back-armor?mrkgcl=444&mrkgadid=3298932708&utm\\_source=google&utm\\_medium=cpc&utm\\_term=462833838426\\_product\\_type\\_motorcycles\\_product\\_type\\_gear\\_product\\_type\\_body\\_armor&utm\\_campaign=Google Shopping Generic - Gear&product\\_id=973-768&utm\\_content=pla&adpos=1o5&creative=278867792399&device=c&matchtype=&network=g&gclid=EAIaIQobChMIIsNzLndTN3QIVDnh -Ch22OA5YEAkYBSABEgIapvD\\_BwE](https://www.jpcycles.com/product/973-768/icon-men-s-viper-stealth-d30-back-armor?mrkgcl=444&mrkgadid=3298932708&utm_source=google&utm_medium=cpc&utm_term=462833838426_product_type_motorcycles_product_type_gear_product_type_body_armor&utm_campaign=Google Shopping Generic - Gear&product_id=973-768&utm_content=pla&adpos=1o5&creative=278867792399&device=c&matchtype=&network=g&gclid=EAIaIQobChMIIsNzLndTN3QIVDnh -Ch22OA5YEAkYBSABEgIapvD_BwE). [Accessed 19 Sep. 2018].
- [3] “D3O 6mm Mesh 10.5‘x15’ Sheet (XT).” *Gamebreaker*, [gamebreaker.com/shop/d3o-6mm-mesh-sheet-xti/](http://gamebreaker.com/shop/d3o-6mm-mesh-sheet-xti/).
- [4] “D3O 10mm Solid Sheet 10‘x14.5’ (AERO) Unskived.” *Gamebreaker*, [gamebreaker.com/shop/d3o-10mm-solid-sheet-10x14-5-aero-unskived/](http://gamebreaker.com/shop/d3o-10mm-solid-sheet-10x14-5-aero-unskived/).





# Questions



**Figure 19:** Smart Helmet