

Smart Vibe

Student Initiatives Fund
Emerson Walsh



Background

- BS Mechanical Engineering
- Class of 2017
- Member of JHU Men's Tennis Team
- Reason for applying to SIF:
Passionate about the application of innovative technology in sport



Idea

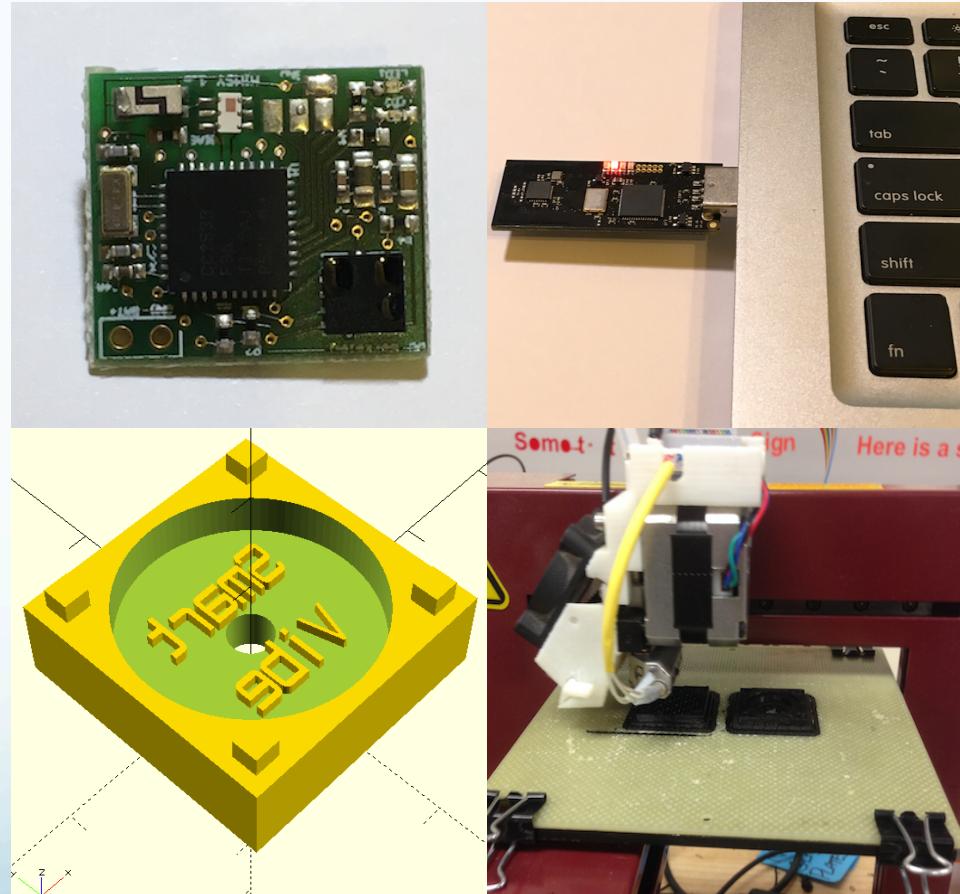


- Develop a “smart” vibration dampener that can provide the player with stats about his/her game
- Design Requirements:
 - Dampen vibration
 - Removable
 - Lightweight
 - Unobtrusive
 - Durable
 - Under \$100



Development

- Components
 - 9-axis IMU
 - Accelerometer
 - Gyroscope
 - Magnetometer
 - Radio & USB dongle
 - rates up to 450 Hz
 - 40 mAh battery
- Mold
 - 3D-printed
 - injection molding



Progress



Oscilloscope



Wireless

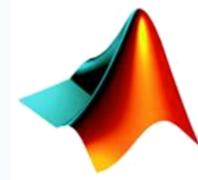


Battery

First Generation Prototype



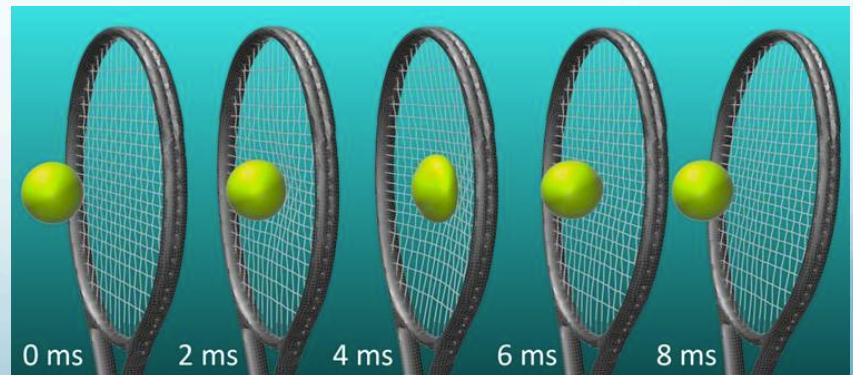
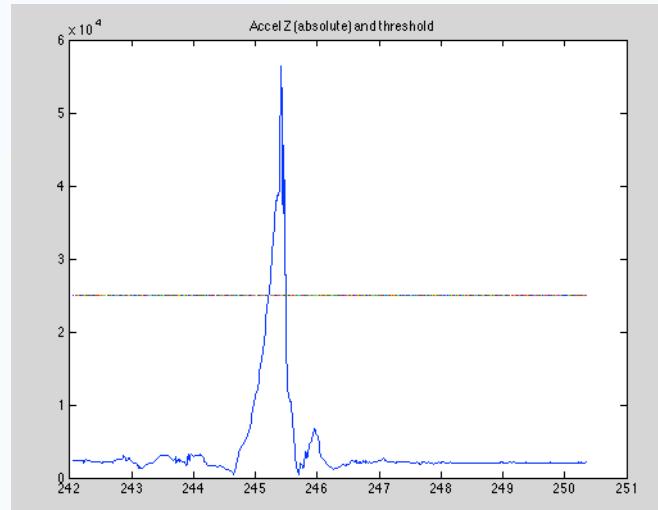
- Total cost of device
 - chip 70.00
 - battery 4.50
 - + silicon 2.50
 - total = \$77.00
- Dimensions:
 $2 \times 2 \times 1 \text{ cm}$
- Battery Life ~ 2.5 hours
(rechargeable)



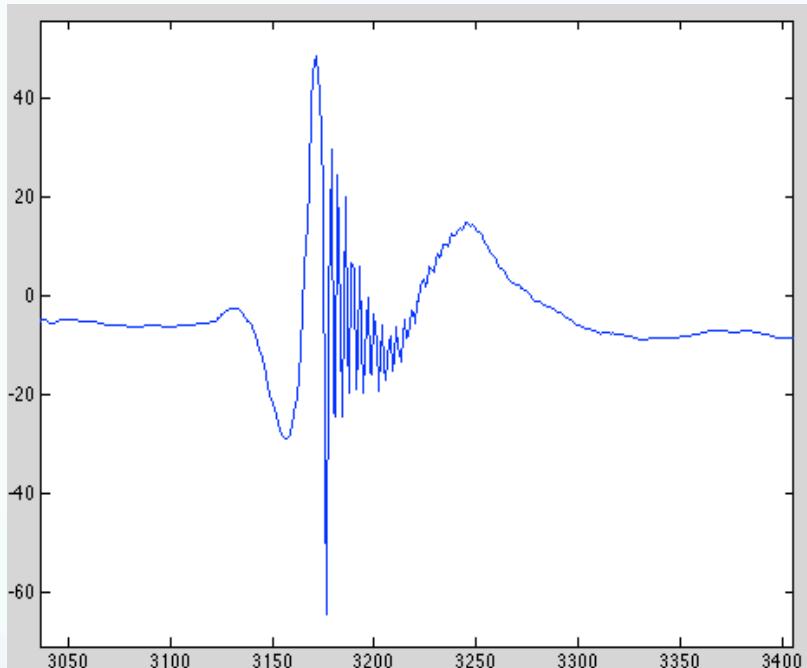
MATLAB®

Data Analysis

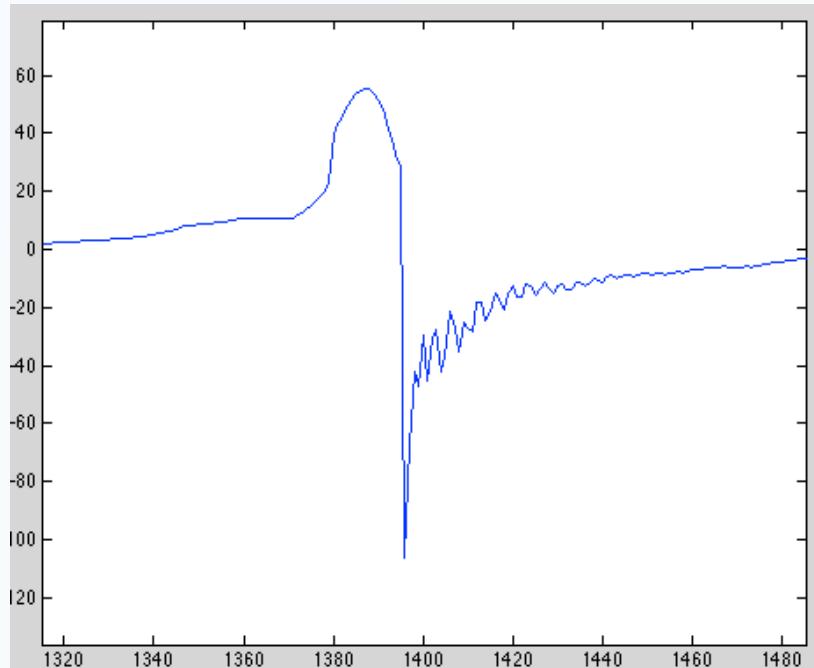
- ✓ # of hits
 - Threshold Detection
- ✓ Swing speed → Serve speed
 - Numerical Integration
 - Max, Average, and Individual
- ✓ Shot Recognition
 - Serve vs. Groundstroke
 - Topsin vs. Slice
 - Cross-court vs. Down-the-line
- ✓ Time between shots
 - Relate to tracking points
- ✓ Duration of Play



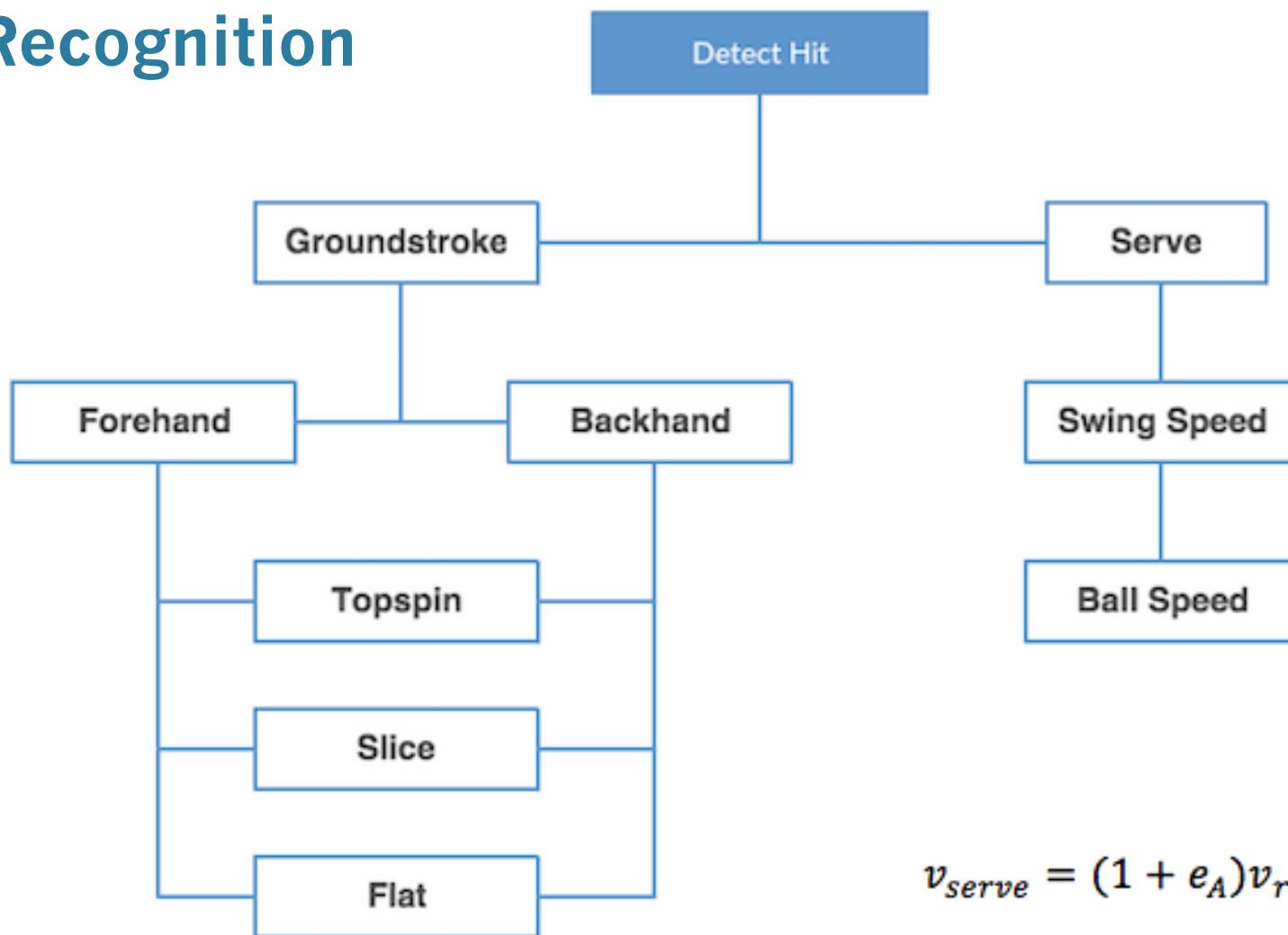
Forehand Topspin z-acceleration



Forehand Slice z-acceleration



Shot Recognition



$$v_{serve} = (1 + e_A)v_{racquet}$$

What makes this unique?



Extra Attachment:

Obtrusive to player



Too Expensive:

Not the right approach
to replace the racquet
with technology

Spending

Item	Cost
Buttons	7.00
Switches	15.00
Syringe for injection mold	3.34
OOMOO 30 silicon	35.00
LED, counter, buttons, and resistors (for counter)	18.00
Ball coach radar gun, tripod stand, rechargeable batteries pack, cloth	299.95
SORTA Clear® 40 - Trial Size	54.70
Slide switches and buttons	14.63
QLIPP Tennis Sensor (used for reverse engineering)	99.00
Getting Started with Bluetooth Low Energy Book	39.41

total = \$586.03

Future Work

- Data Transmission
 - Radio → BLE
 - Phone application
- Onboard Processing
 - Combining data collection and analysis
- More testing relating swing speed to ball speed
- Reduce cost



Student Initiatives Fund:

Thank you for this opportunity!

Emerson Walsh

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Appendix

- Material Properties (40)

	<i>Mixed Viscosity</i> (ASTM D-2393)	<i>Specific Gravity</i> (g/cc) (ASTM D-1475)	<i>Mix Ratio</i>	<i>Pot Life</i> (ASTM D-2471)	<i>Cure Time</i>	<i>Shore A Hardness</i> (ASTM D-2240)	<i>Tensile Strength</i> (ASTM D-412)	<i>100% Modulus</i> (ASTM D-412)	<i>Elongation at Break %</i> (ASTM D-412)	<i>Die B Tear Strength</i> (ASTM D-624)
SORTA-Clear® 18	21,000 cps	1.08	100A:10B by weight	60 min.	24 hrs	18A	425 psi	35 psi	545%	80 pli
SORTA-Clear® 37	35,000 cps	1.08	1A:1B by volume	25 min.	4 hrs	37A	600 psi	90 psi	400%	105 pli
SORTA-Clear® 40	35,000 cps	1.08	100A:10B by weight	60 min.	16 hrs	40A	800 psi	90 psi	400%	120 pli