Dwight Look College of
ENGINEERING
TEXAS A&M UNIVERSITY

Team 22: Smart Cricket Bat
Bi-Weekly Update 5

Team members: Pablo Barron
Gavin Dahl
Jiakai Hu
Nolapat Pipitvitayakul
TA: Fardeen Hasib Mozumder
Sponsor: Pranav Dhulipala

Dwight Look College of ENGINEERING TEXAS A&M UNIVERSITY

Project description

- Problem: “Cricket practice equipment lacks effectiveness without the assistance and guidance of a coach”

- Solution proposal: “Create a device that will mount on the cricket bat and, through a user friendly app, gives real time feedback on the user’s cricket swing i.e. efficiency and swing angle. Must be easy to use and set up”

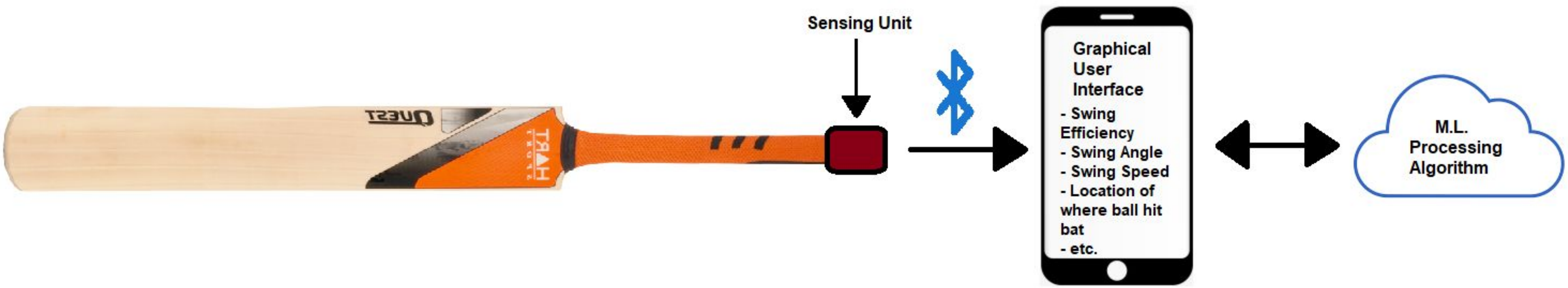
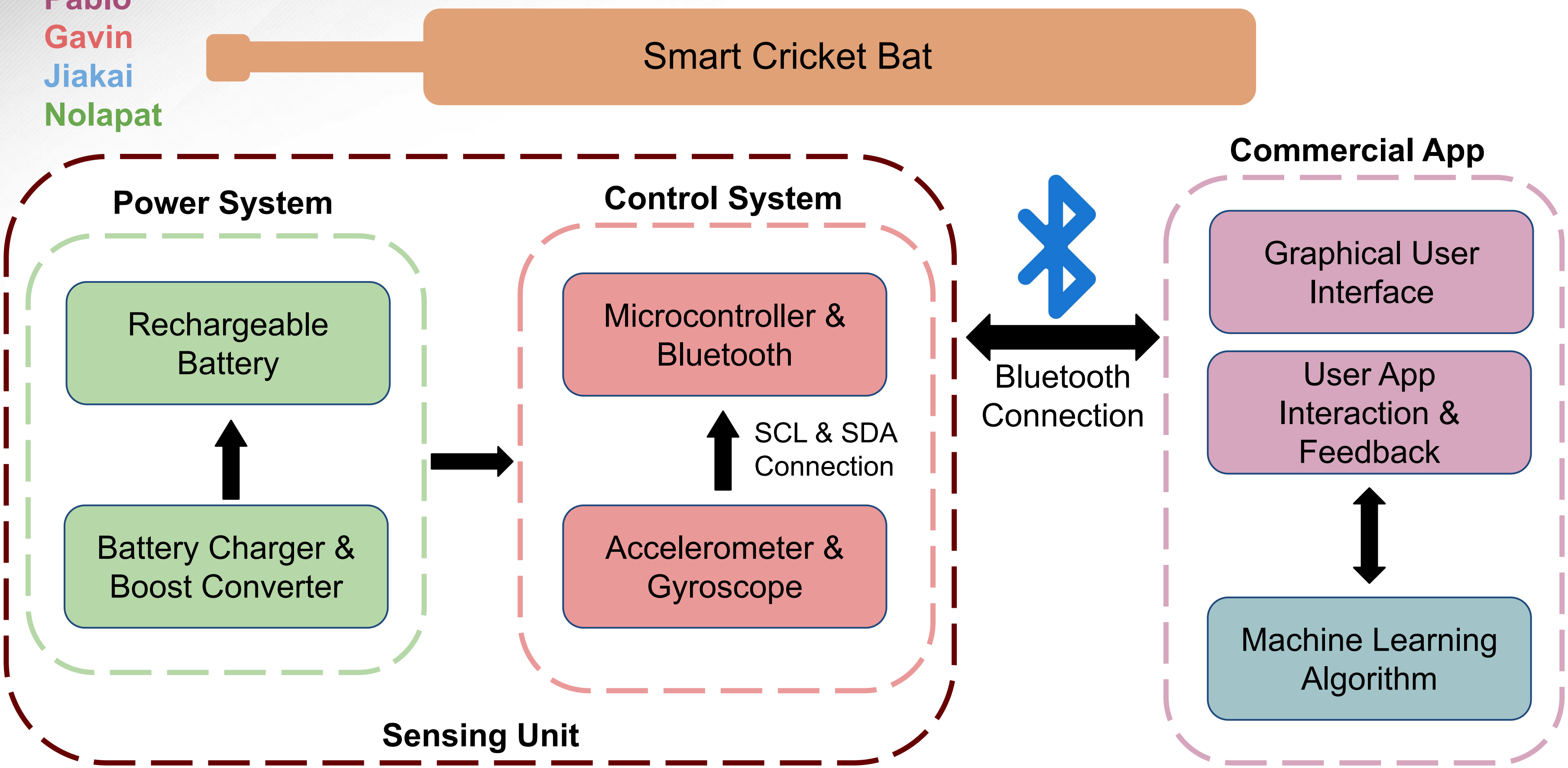
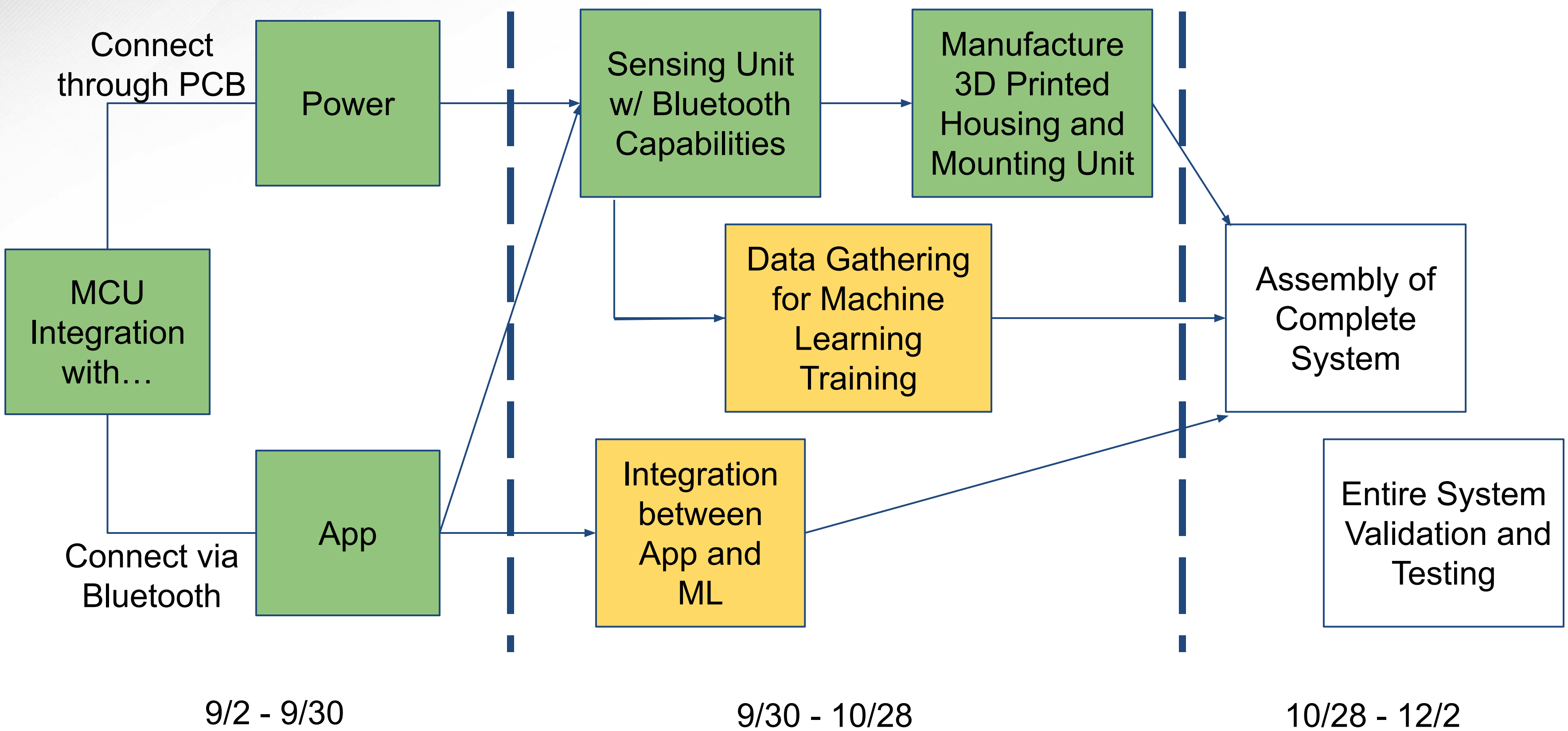


Diagram of subsystems and interface

Pablo
Gavin
Jiakai
Nolapat



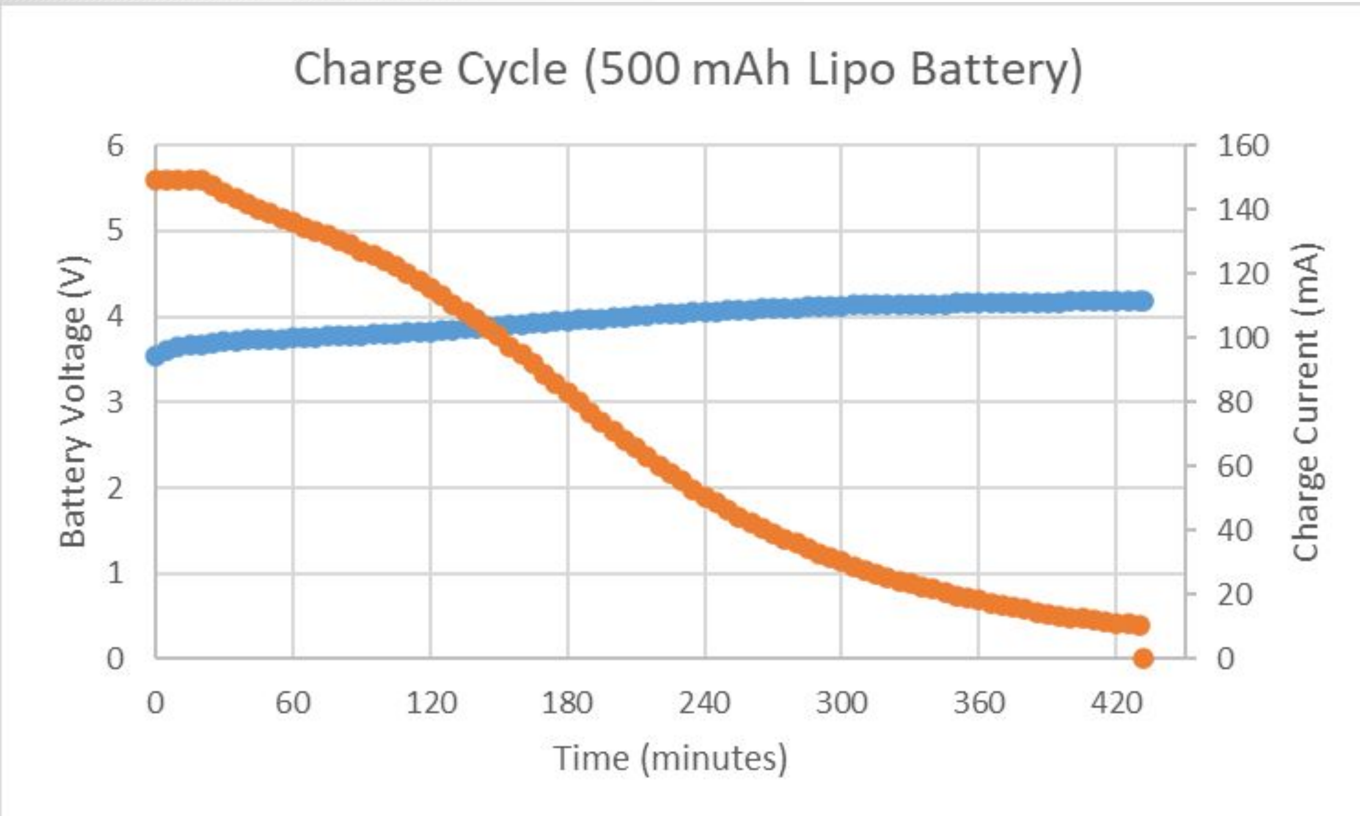
Project Timeline



Power System

Accomplishments since last presentation 10 hr of effort	Ongoing progress/problems and plans until the next presentation
• Finished assemble final PCB • Tested the battery charging circuit	• ML data collection

Power System

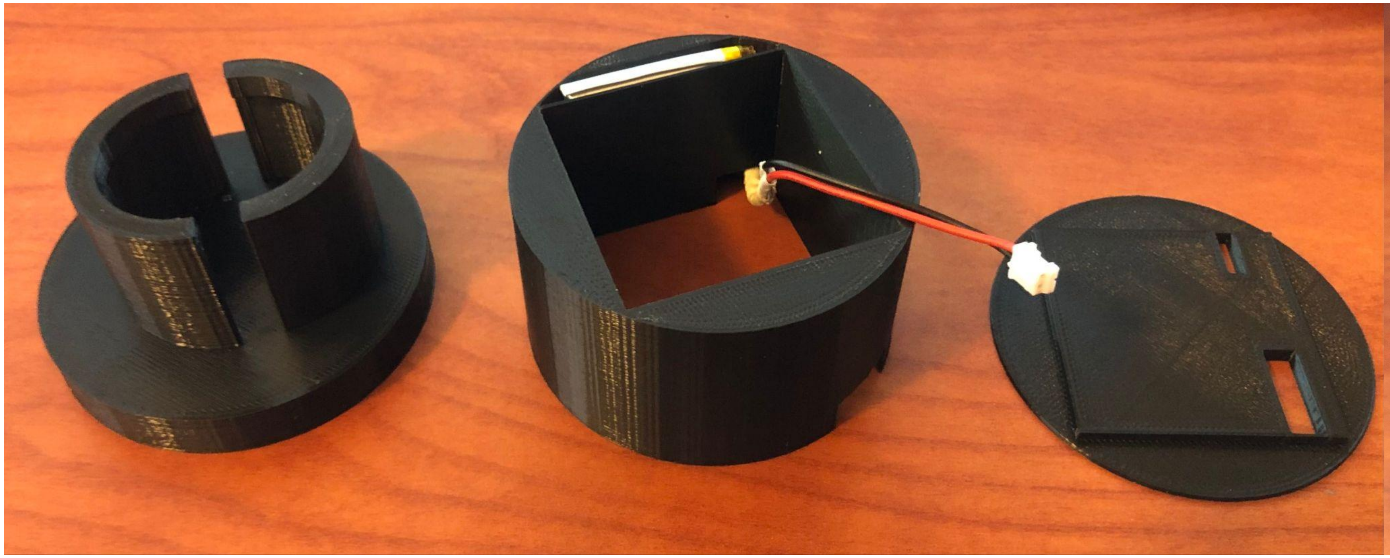


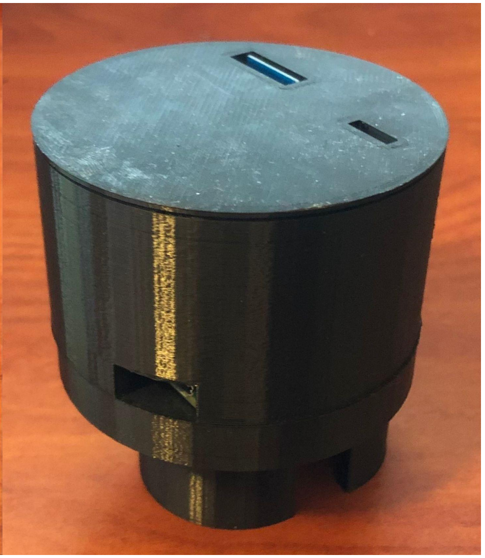
Charge current: 150 mA
Charge voltage: 4.2 V

Control System

Gavin Dahl

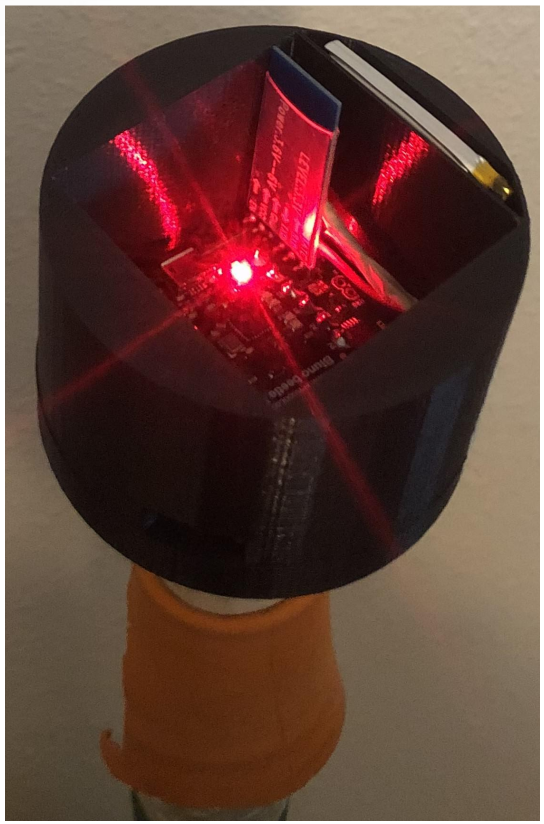
Accomplishments since last presentation 18 hr of effort	Ongoing progress/problems and plans until the next presentation
• Housing and Mounting Unit printed, designs changed as needed, Final Design printed • Bluetooth Range Validated	• Finish final PCB assembly and re-validation • ML data collection • Try to “polish” bluetooth

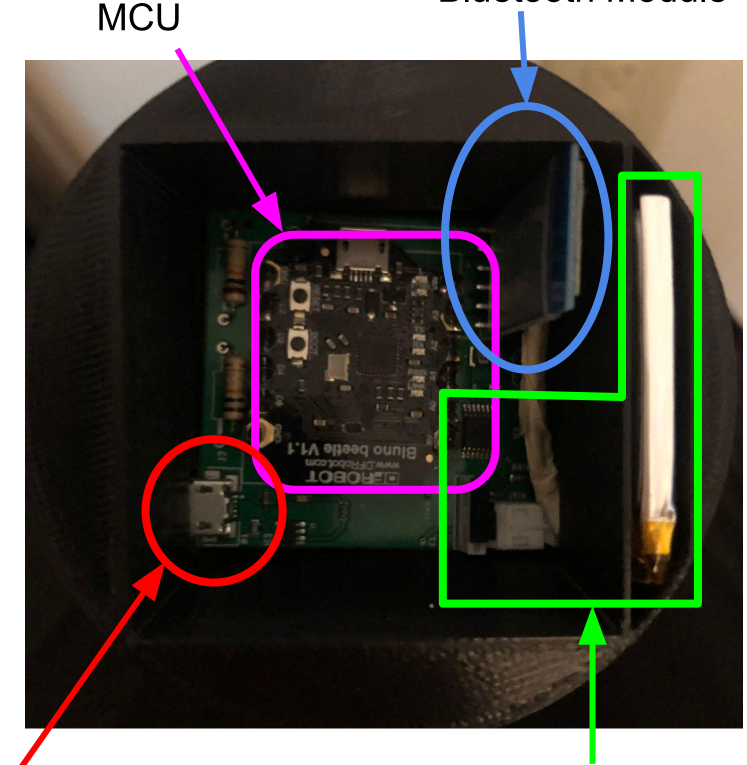




Control System

Gavin Dahl





MCU

Bluetooth Module

Charging Port

Boost Converter +
Battery and Switch

*IMU on bottom layer/side of PCB

Control System

Gavin Dahl

```
COM6

14:45:28.211 -> BT connection at: 10 ft
14:45:59.332 -> BT connection at: 20 ft
14:46:32.348 -> BT connection at: 30 ft
14:48:49.184 -> BT connect ft
14:49:28.085 -> Btion at: 50 ft
14:50:18.726 -> BT connection at: 60 ft
14:52:31.356 -> BT connection at: 70 ft
14:53:30.461 -> BT connection at: 80 ft
14:54:43.617 -> BT connection at: 90 ft
14:56:12.299 -> Bion at: 100 ft
14:58:25.228 -> BT connection at: 110 ft
14:59:28.717 -> BT connection at: 120 ft
15:01:02.842 -> BT connection at: 130 ft
15:02:11.232 -> BT connection at: 140 ft
15:03:25.615 -> BT connection at: 150 ft
15:05:20.859 -> BT connection at: 160 ft
15:07:03.971 -> BT connection at: 170 ft
15:08:31.987 -> BT connection at: 180 ft
15:10:15.585 -> B90 ft
15:12:56.856 -> BT connection at: 200 ft
15:14:36.078 -> BT connection at: 210 ft
15:15:46.228 -> BT connection at: 220 f
```

(a) Bluetooth Distance Validation

<u>Bluetooth Validation</u>

- Wrote sketch for MCU to send current distance, incremented by 10ft, when prompted by bluetooth-connected device
- Connection stable and able to send data until 220 to 240 ft

<u>Sensing Unit Mass Verification</u>

- Took average mass from 10 weigh-ins:

  85.89 ± 0.01 grams

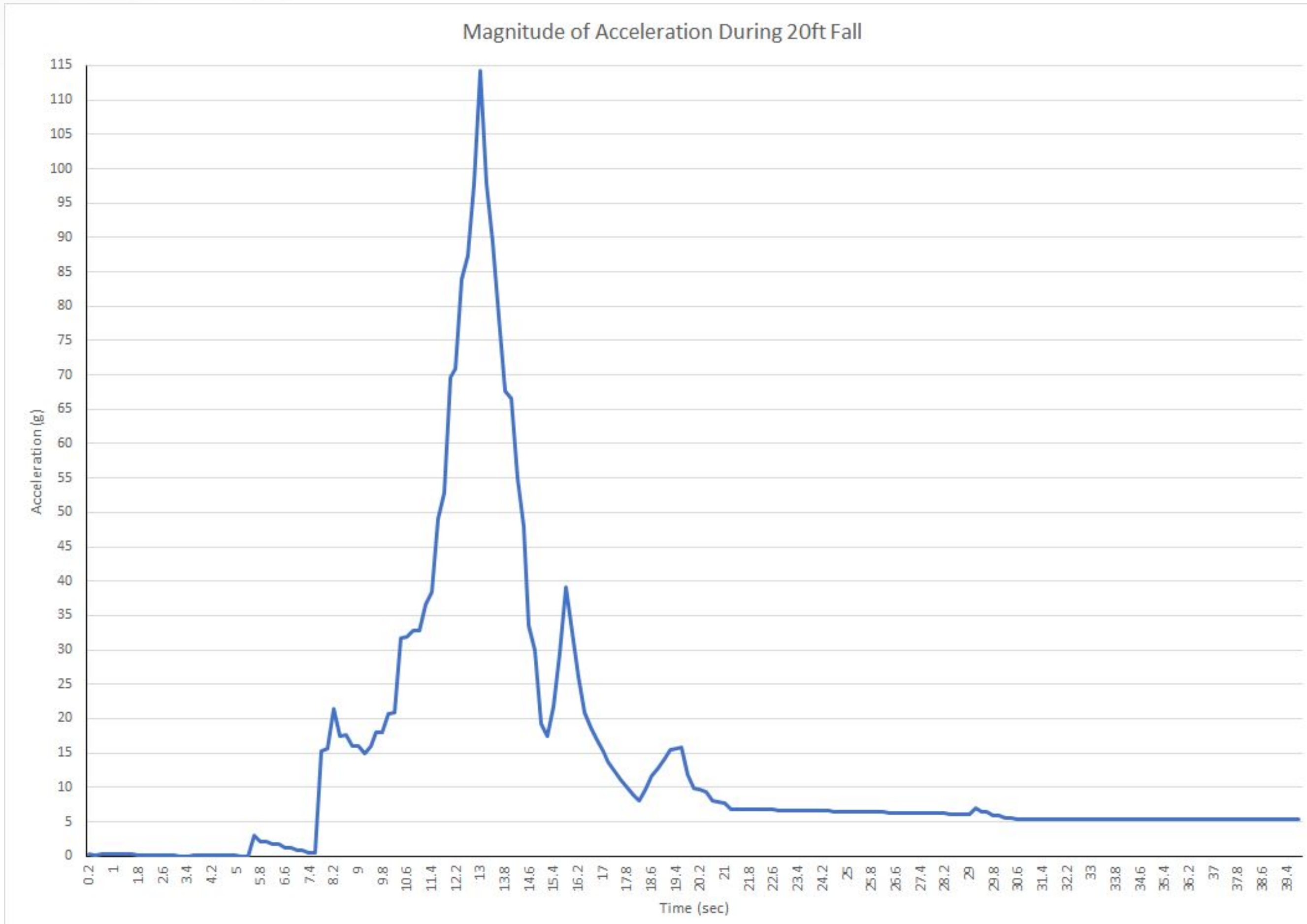
(b) Housing Unit + PCB + Battery Total Mass

Control System

Gavin Dahl

- Calculated Expected Acceleration at Impact:
  139.4 g's

- Measured Acceleration at Impact:
  114.188 g's



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Android App

Pablo Barron

Accomplishments and changes since last presentation: 13 Hrs	Ongoing progress/problems and plans until the next presentation
• Validated Range of Bluetooth with Gavin: 240 ft • Switched ML to run on the cloud instead of locally: Firebase	• Currently still integrating with ML and creating Firebase server to host pre-processing and ML

Android App

```
I/FirebaseApp: Device unlocked: initializing all Firebase APIs for app [DEFAULT]
I/FirebaseInitProvider: FirebaseApp initialization successful
I/DynamiteModule: Considering local module com.google.android.gms.measurement.dynamite:
I/DynamiteModule: Selected local version of com.google.android.gms.measurement.dynamite
D/NetworkSecurityConfig: No Network Security Config specified, using platform default
V/FA: onActivityCreated
```

Machine Learning

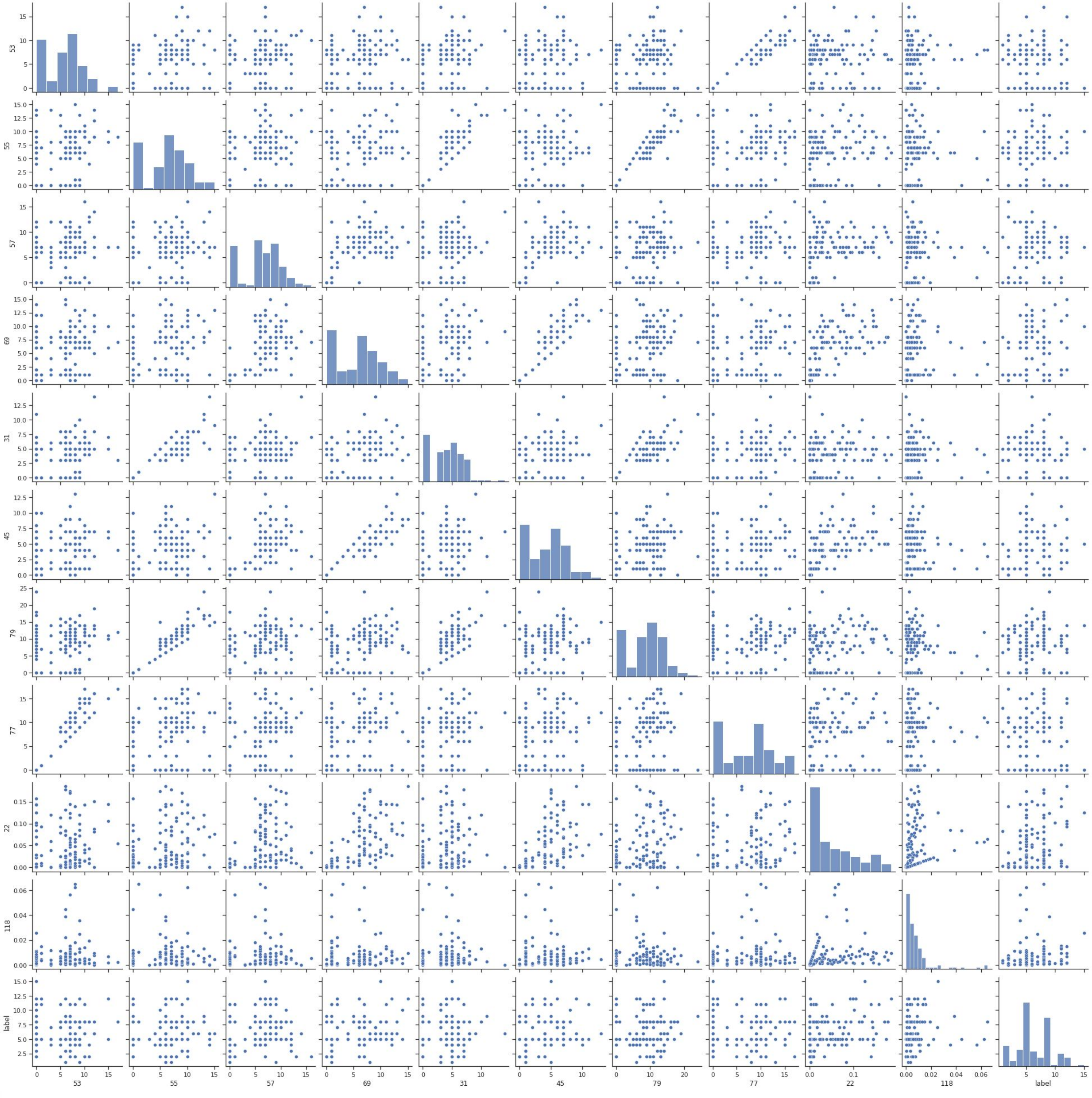
Accomplishments since last presentation:

- Preprocessed and trained newly gathered data

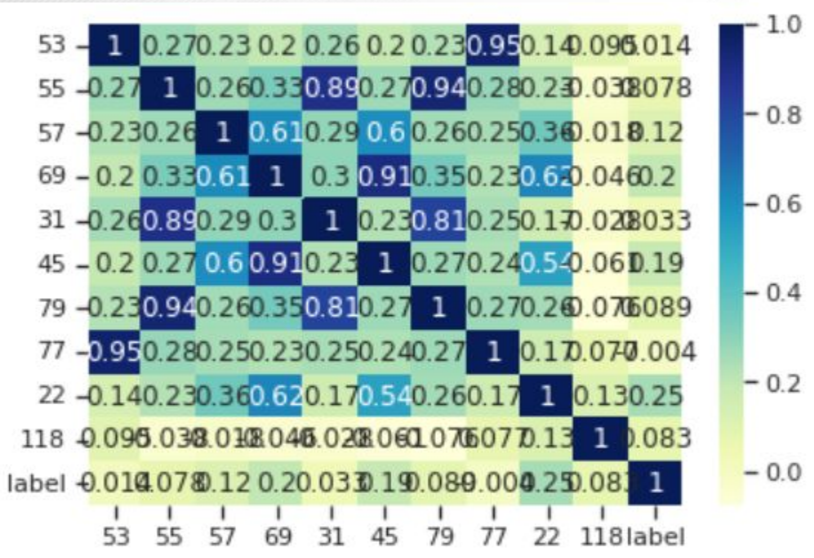
Plans until next presentation:

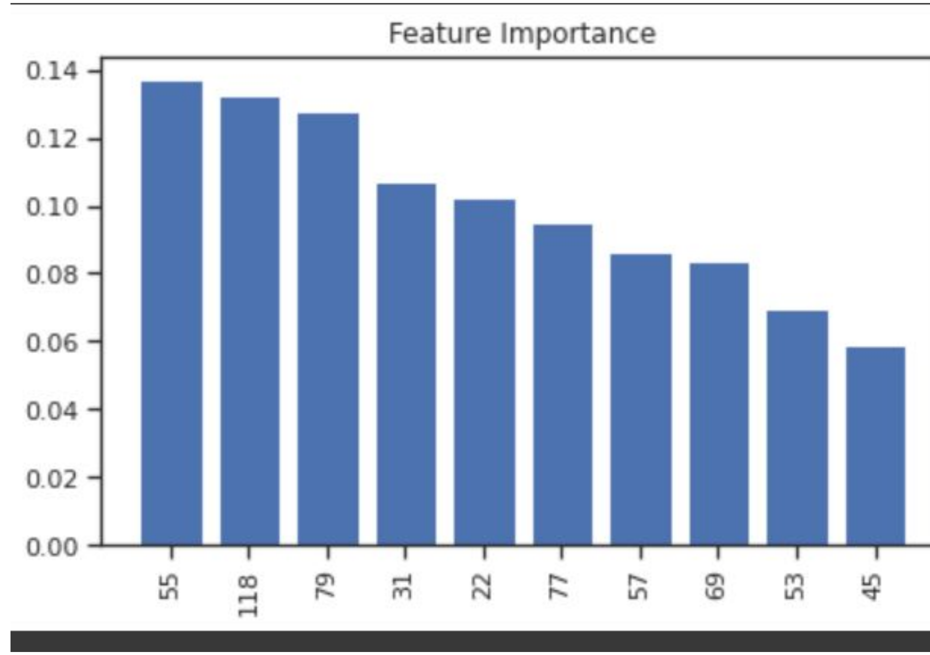
- More data gathering to increase accuracy

Pairplot



Heatmap, feature importance, and result






```
Accuracy on training set is : 0.5844155844155844
Accuracy on test set is : 0.30303030303030304
              precision    recall  f1-score   support

           1       0.00      0.00      0.00         1
           2       1.00      0.33      0.50         3
           3       0.00      0.00      0.00         2
           4       0.00      0.00      0.00         3
           5       0.30      0.78      0.44         9
           6       0.00      0.00      0.00         1
           7       0.00      0.00      0.00         2
           8       0.50      0.20      0.29        10
          10       0.00      0.00      0.00         1
          12       0.00      0.00      0.00         1

    accuracy                           0.30        33
   macro avg       0.18      0.13      0.12        33
weighted avg       0.33      0.30      0.25        33

[6 8 2 5 5 5 5 5 5 5 5 8 5 4 5 5 5 5 6 5 5 4 5 5 5 8 5 5 5 5 5 8 6]
[ 8  2  2  8  6  7  5  5 10  3  8  8  1  8  4  8  5  8 12  5  3  5  7  5
  4  5  5  8  4  5  8  8  2]
```

Execution plan

Execution Plan														
	9/2/2022	9/9/2022	9/16/2022	9/23/2022	9/30/2022	10/7/2022	10/14/2022	10/21/2022	10/28/2022	11/4/2022	11/11/2022	11/18/2022	11/25/2022	12/2/2022
Status Update 1														
Control System PCB														
Control System and App Communication														
Power System PCB Design														
App/Control System Itegration via Bluetooth														
Connection and Data sending Validation														
Status Update 2														
PCB Fabrication and Assembly														
ML and App Intergration														
Make App "prettier" by using images and other details														
ML Data Collection														
Data Training with New Data														
Status Update 3														
PCB Testing and Validation														
Sensing Unit Housing Design														
Sensing Unit Handle Mount Design														
Validate ML with Real Time Swings														
Status Update 4														
Final PCB Manufacturing														
Sensing Unit Housing Manufacturing														
Sensing Unit Handle Mount Manufacturing														
Status Update 5														
Complete System Integration														
Final PCB Validation														
System Validation														
Final Design Presentation														
Final Demo														
Final Report														

	Not Started		Jiakai Hu
	In Progress		Nolapat Pipitvitayakul
	Completed		Pablo Barron
	Behind Schedule		Gavin Dahl
			Everyone

Validation plan

Paragraph	Test Name	Success Criteria	Methodology	Status	Responsible Engineer(s)
3.2.1.2	Sending Data via Android device	The app should be able to send data (input for ML Algorithm)	Upload the app to a simulated android phone and test by outputting data to a localized device to test data sending	TESTED: App is able to send real time data to a device via an input stream	Pablo Barron
3.2.1.2	ML Algorithm Precision	The ML algorithm provides precise result of output data within acceptable error range.	Use all data gathered to test the training and testing accuracy.	TESTED: Training accuracy around 98% and Testing accuracy around 13%	Jiakai Hu
3.2.1.3	Communication Range	Communication between the sensing unit and app stays active for a distance of up to 100ft.	Test normal functionality of the smart cricket bat's operations at 10ft intervals ranging from 0ft to 100ft, or until bluetooth cuts off.	TESTED: Bluetooth module and mock phone had strong connection until 230 ft, where the connection would cut off.	Gavin Dahl Pablo Barron
3.2.1.2	System Latency	User swing analysis deliever to user via the app in no greater than 10s after the user's bat has struck the ball.	Take 20 practice swings with the bat, timing the time from the ball's impact on the cricket bat till the analysised swing data is available to user on app.	UNTESTED	Full Team
3.2.1.4	Wireless Connection Stabilty	Connection between sensing unit and smartphone app does not drop.	Sensing unit connected to smartphone app via bluetooth, set to default mode, and left to run for 1 hour. Connection is monitored via smart phone app.	IN PROGRESS	Gavin Dahl Pablo Barron
3.2.1.4	Full Range of Motion	Sensing unit can measure the angle of the bat at a full 360°.	Sensing unit is attached to pivoting arm on a protracter, the angle is tracked on both a piece of paper and in a text file, and then compared.	TESTED: Sensing unit tracks accurate degree of turn for all 3 axes	Gavin Dahl
3.2.1.5	Easy to Use GUI	The app is easily naviagble to allow any person, regardless of technical skills, to use our device	Upload the app to a simulated andriod phone to view the clarity of the app	TESTED: App is able to run on physical device and does not crash	Pablo Barron
3.2.1.5	Operation Time	System operates continously on battery power for a minimum of 2 hours.	Sensing unit is turned on, set to defualt mode, and left to run for 2 hours. Power is monitored via a digital multimeter.	TESTED: Fully charged 500 mAh lipo battery can run for about 6 hours	Nolapat Pipitvitayakul
3.2.1.6	Detection Range	Sensing unit can detect vibrations from at least 38in away when mounted on a bat.	Mount sensing unit on end of the cricket bat handle and hit the top of the bat 10 times to ensure full range.	TESTED	Gavin Dahl
3.2.1.7	Detection Accuracy	Sensing unit is able to detect a collison between ball and bat on any area of the cricket bat.	Mount sensing unit on cricket bat, measure data from hits in a variety of areas on the bat (at least 15) until it is confirmed there are no dead areas.	TESTED	Gavin Dahl
3.2.1.8	Detection Sensitivity	Sensors are able to detect degree's of motion within 1deg of change and is able to give changes in speed to 1 decimal places.	Mount sensing unit to cricket bat, connect to PC via microUSB, and watch realtime data output of angle of bat and speed and compare to movements made in real life.	TESTED	Gavin Dahl
3.2.1.9	Ease of Use	System is easily attached to end of handle of the cricket bat, is easily connected to the app via bluetooth, and is easy to calibrated during first time start up calibrations. Whole process should take no more than 5 minutes.	Use stopwatch to measure how long it takes te user to mount device, pair to phone, and do the calibration setup.	IN PROGRESS	Full Team
3.2.2.1	Mass	Mass of combined control system (MCU and IMU sensors), power system (Li-Po Battery and boost converter), and our housing unit, will weigh no more than 100g.	Use digital scale to measure weight of combined unit.	TESTED: Took average of 10 weigh-ins of sensing unit in its entirety, averaged out to 85.89 ± 0.01 g.	Nolapat Pipitvitayakul Gavin Dahl
3.2.2.2	Volume Envelope	The housing unit for the sensing device should a cylindrical shape, be no more than 60mm in diameter, with an intereior diamteter of 56mm, and a height of 35mm.	Measure inner and outer diameters and height of created housing unit for sensors.	UNTESTED	Nolapat Pipitvitayakul Gavin Dahl
3.2.2.3	Mounting	The sensing unit is able to be mounted to the handle of any cricket bat and can lock securly into place.	Use the developed mounting device to mount the sensing unit onto end of the handle of the bat, and do varoius shack and shock test to confirm secure fit.	UNTESTED	Nolapat Pipitvitayakul Gavin Dahl
3.2.3.1.1	Input Voltage (MCU)	The input voltage for our Beetle BLE board shall be between 5V - 8V.	Use multimeter to validate input voltage level.	TESTED: Boost Converter Output is 5V +- 0.1	Nolapat Pipitvitayakul
3.2.3.1.3	Battery Charging Voltage and Current	The sensing unit has a 3.7V 150mAh Lo-Pi batteries as its power supply. These can be charged through a microUSB cable that can supply maximum 150mA of charge current with a 4.2V charge voltage.	Use multimeter to validate voltage levels and charge current levels.	TESTED: Charge voltage is 4.2 V and maximum charge current is 150 mA	Nolapat Pipitvitayakul
3.2.3.2.1	App Data Gathering via Bluetooth	The Android device should be able to recieve data from our MCU via bluetooth	Upload the app to a simulated android phone and input different "dummy" data to see if the android device recieved the data	TESTED: Random Reading errors, but we are able to read data sent from the mcu	Pablo Barron
3.2.4.1	Thermal Resistance	The system should be able to operate in environments with tempatures ranging from 0°C to 85°C.	Use heating mechanism to raise tempature to 85°C and test systems functionalitly. Place system in cooling mechanism to lower tempature to 0°C and test systems.	UNTESTED	Gavin Dahl
3.2.4.2	Shock Tolerance	The IMU should be able to handle g shocks up to a max of 10,000g.	Test dropping IMU at differing heights and then use systems normal functionality to try to validate that IMU will still function after taking shocks more than 10,000	IN PROGRESS	Gavin Dahl

Parts List

Part Description	Order Status
3 x Bluno Ble Microcontroller	Part Received
2 x HC-05 Bluetooth Module	Part Received
3 x gy-521 IMU	Part Received
1 x LiPo Battery 3.7V 150mah	Part Received
12 x Capacitor	Part Received
8 x Resistor	Part Received
3 x Inductor	Part Received
1 x Switching Voltage Regulators	Part Received
1 x JST Right-Angle Connector TH 2-Pin	Part Received

Questions?