

Athlete Motion Tracking

Senior Design May 2019

Team One

<http://sdmay19-01.sd.ece.iastate.edu/>



Client: Precision Performance Cycling

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SYSTEM DESIGN



PROJECT NEED

The goal is to create an integrated interface between multiple software and hardware systems to decrease the bias when the client is manually analyzing the athlete's performance.

CLIENT GOAL

Optimize Athlete Performance

Prevent Injury

Minimize Fatigue



PROJECT GOAL

Motion Capture

Pressure Sensor System

User Friendly Integration



MARKET SURVEY

Image System

- Dartfish (Competitor)
- Mutually Exclusive
- Subscriptions
- Live Feed for Athlete

Hardware System

- Leomoe (Competitor)
- Mutually Exclusive
- Subscriptions
- Stationary

FUNCTIONAL REQUIREMENTS

Video Capture



Sensors



User Interface



Data Analytics

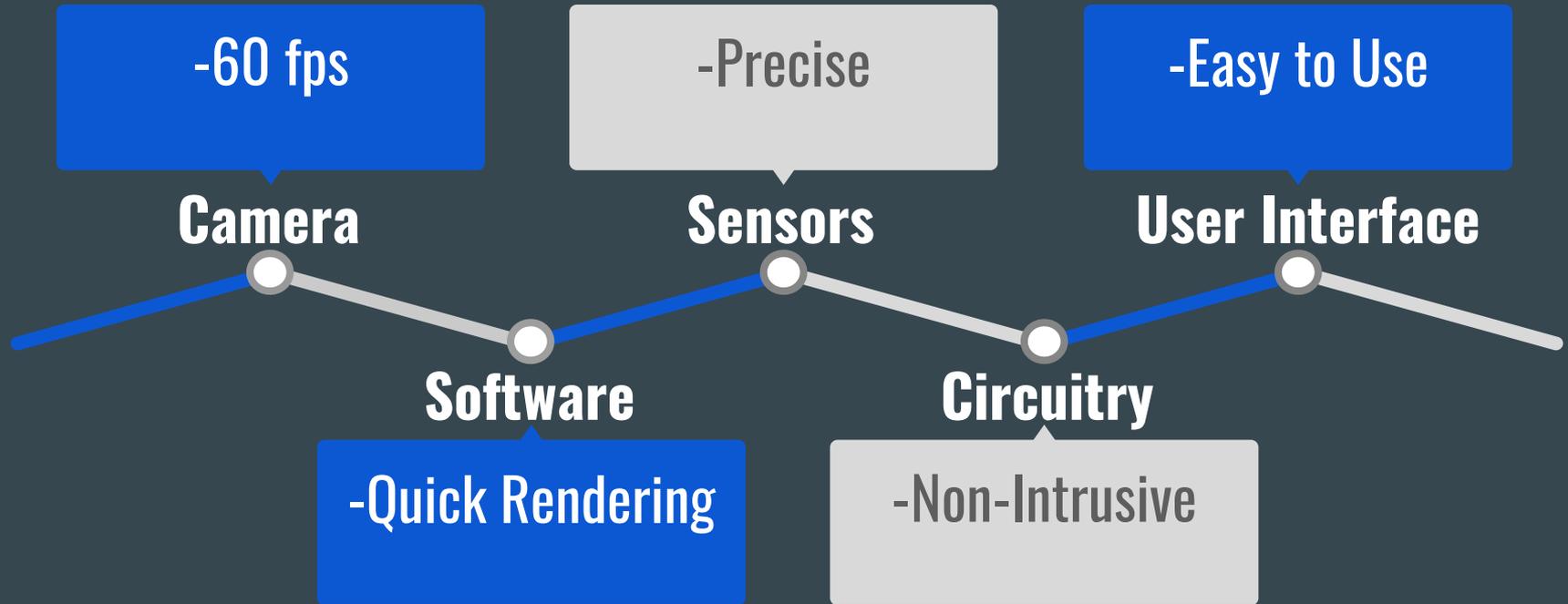


NON-FUNCTIONAL REQUIREMENTS

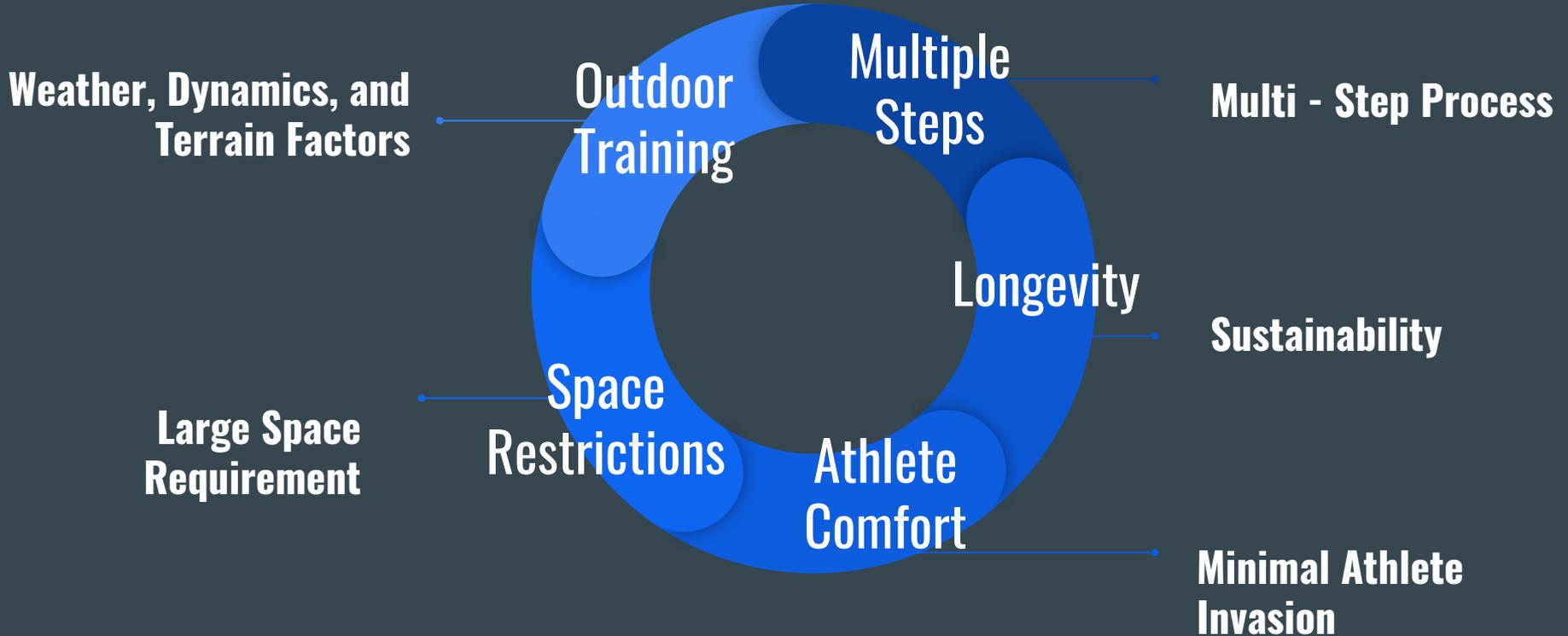
- Precision
- Ease of Use
- Visually Appealing
- Non-Intrusive



RESOURCE REQUIREMENTS



RISK IDENTIFICATION and MITIGATION

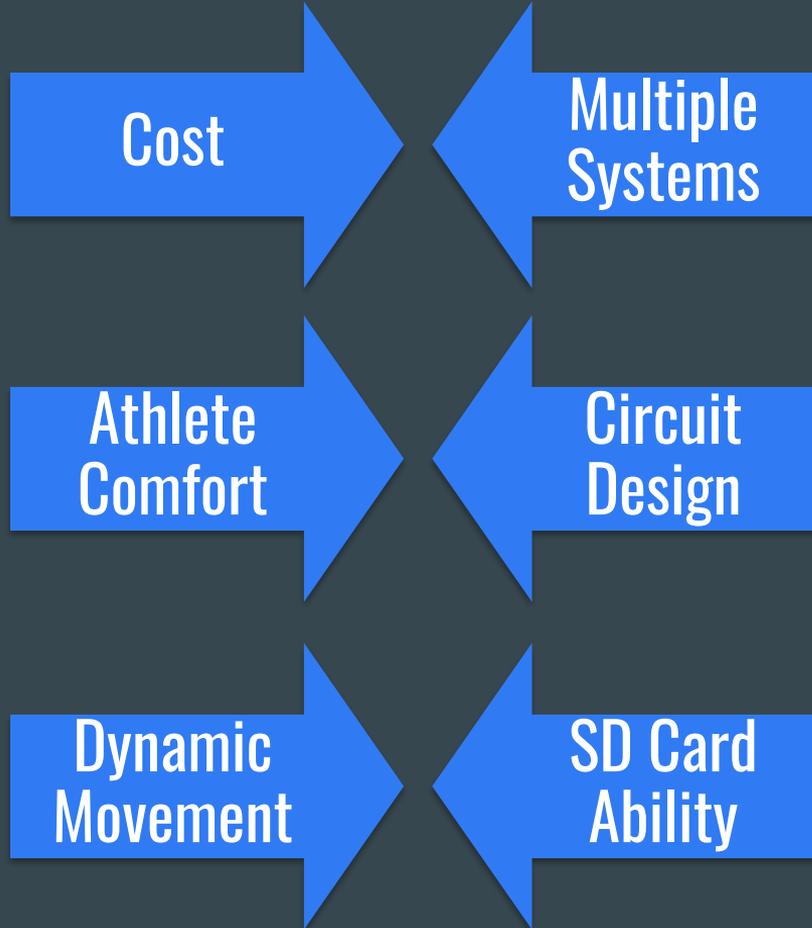


CONSTRAINTS



DESIGN TRADEOFF and INNOVATIVENESS

TRADE OFFS



INNOVATIONS

COMPETITOR ANALYSIS

How is this project different?

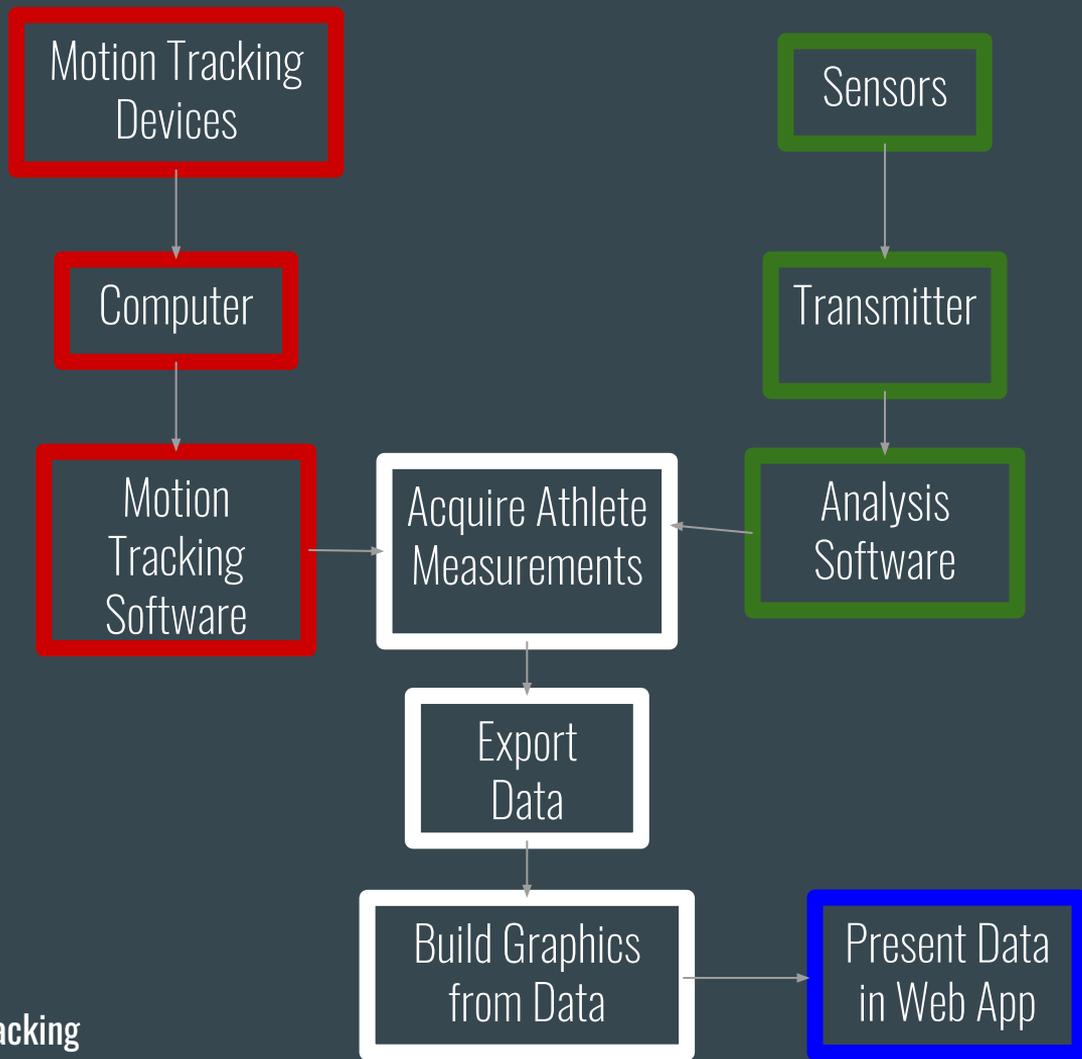
- Capability for multiple athletes
- Client owned and maintained
- Hardware AND software
- One web app

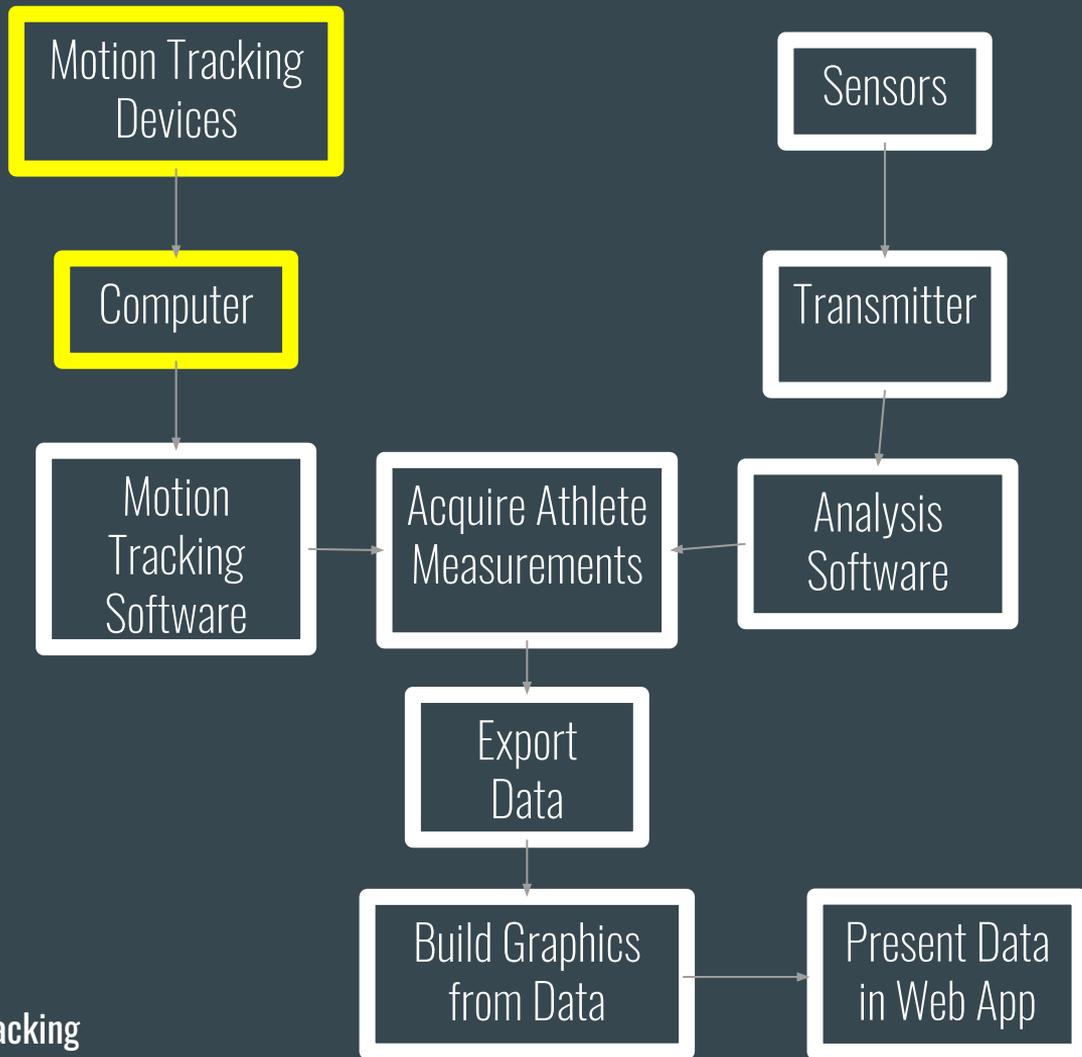


DETAILED DESIGN IMPLEMENTATION



DESIGN BLOCK DIAGRAM



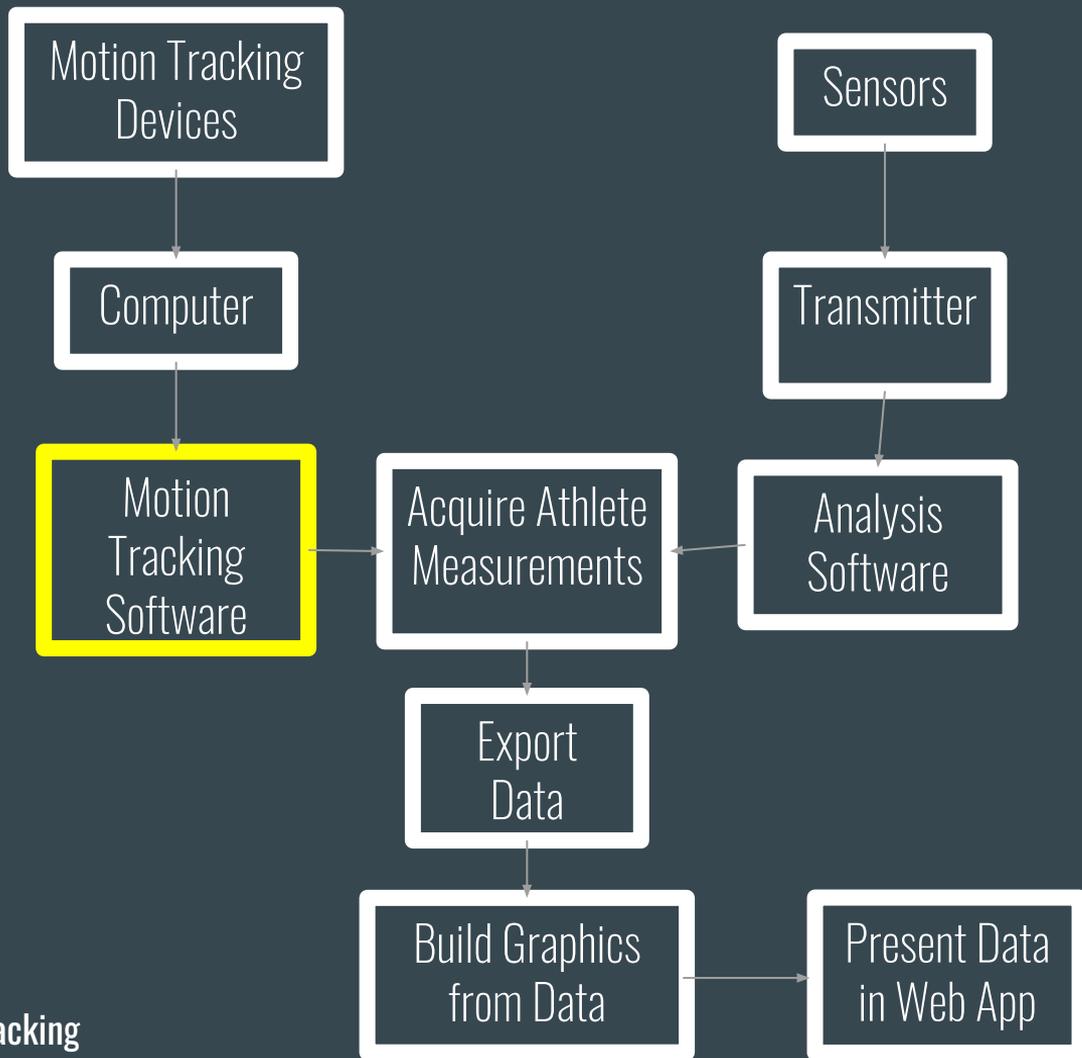


CAMERAS



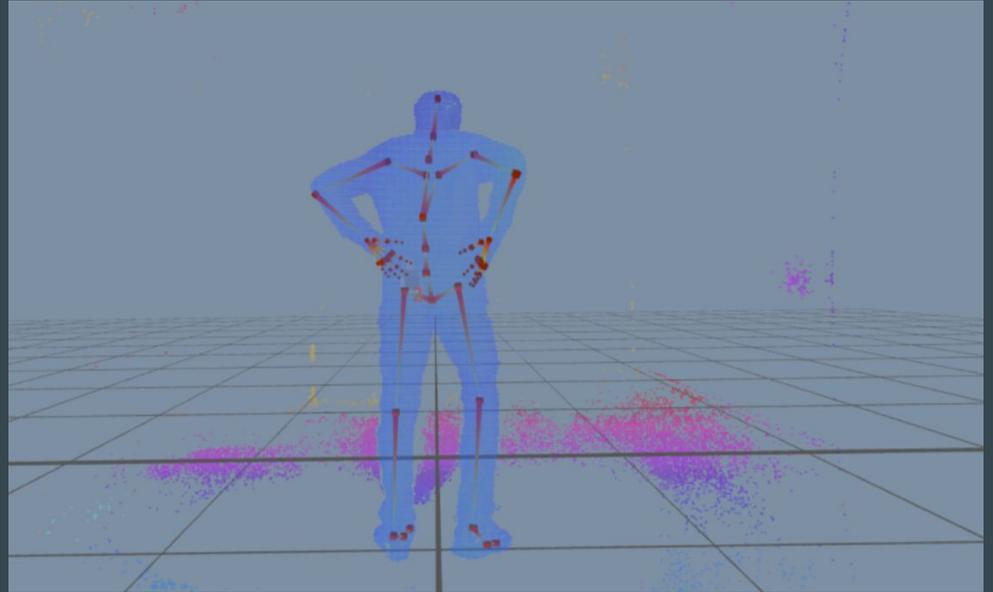
Playstation Eye

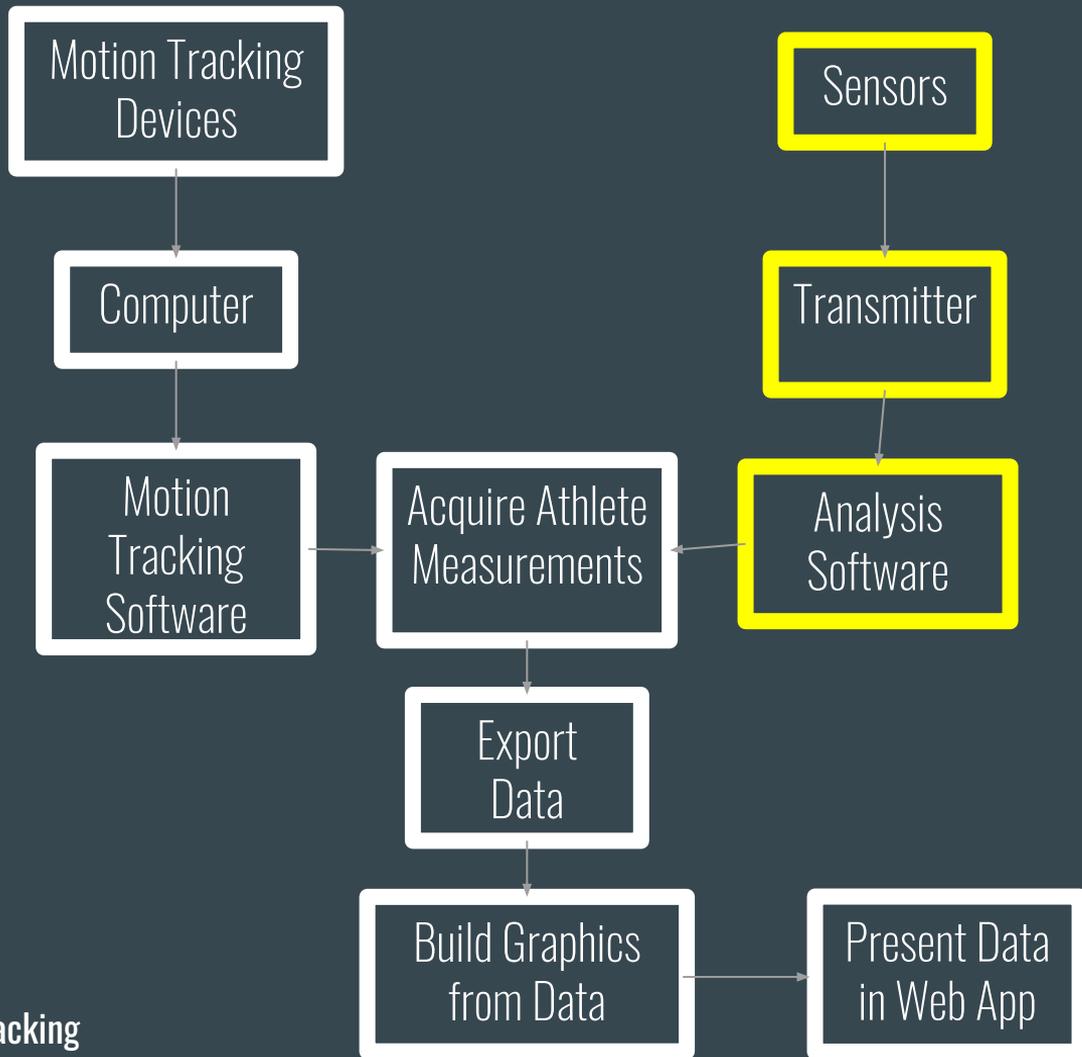
- USB Webcam
- 480p at 60fps
- Inexpensive, but reliable



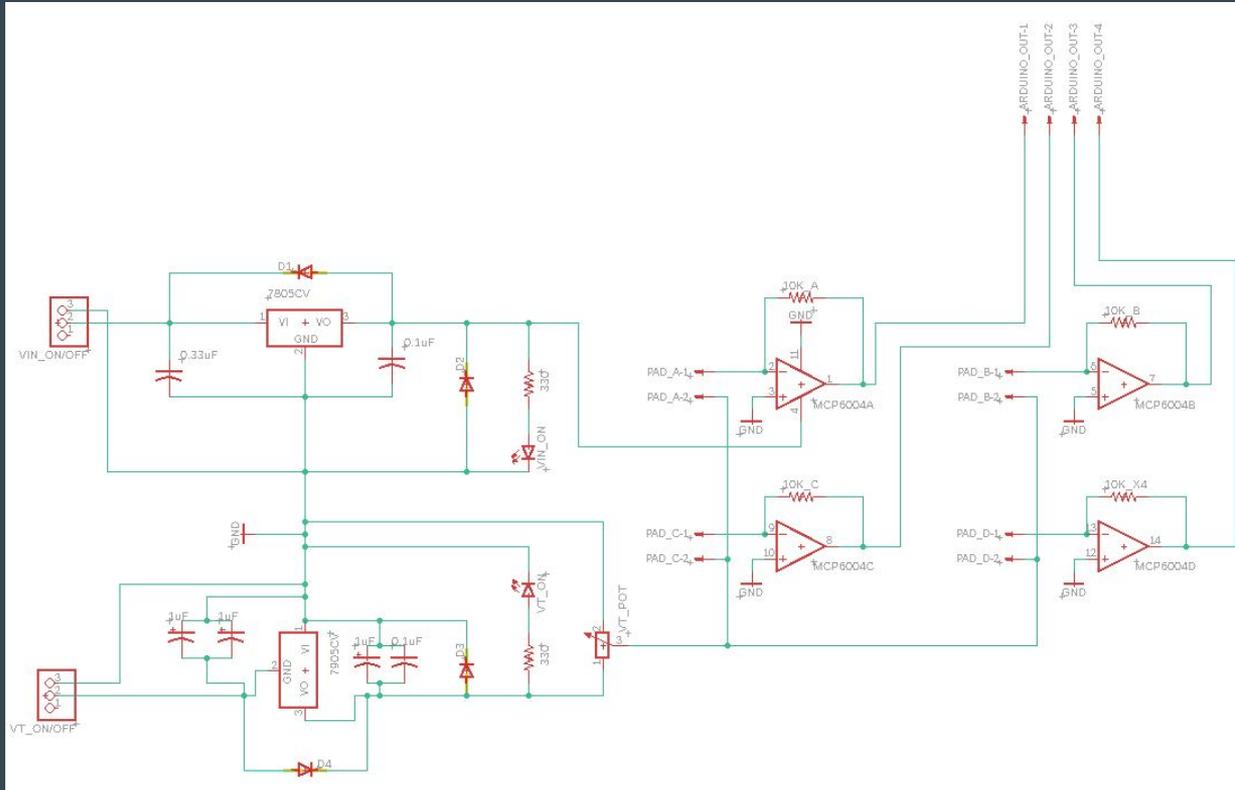
iPi SOFTWARE

- Multi Platform Compatible
- Multiple Camera Inputs
- Exports Data to Excel and Matlab





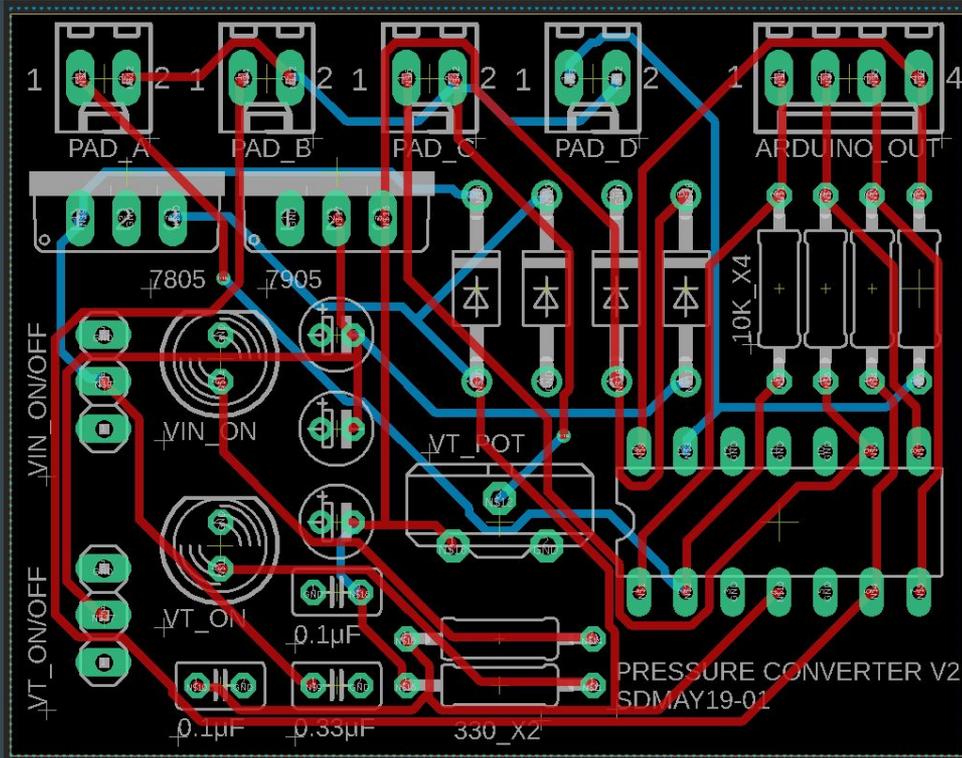
HARDWARE MODULE DESIGN



Key Features:

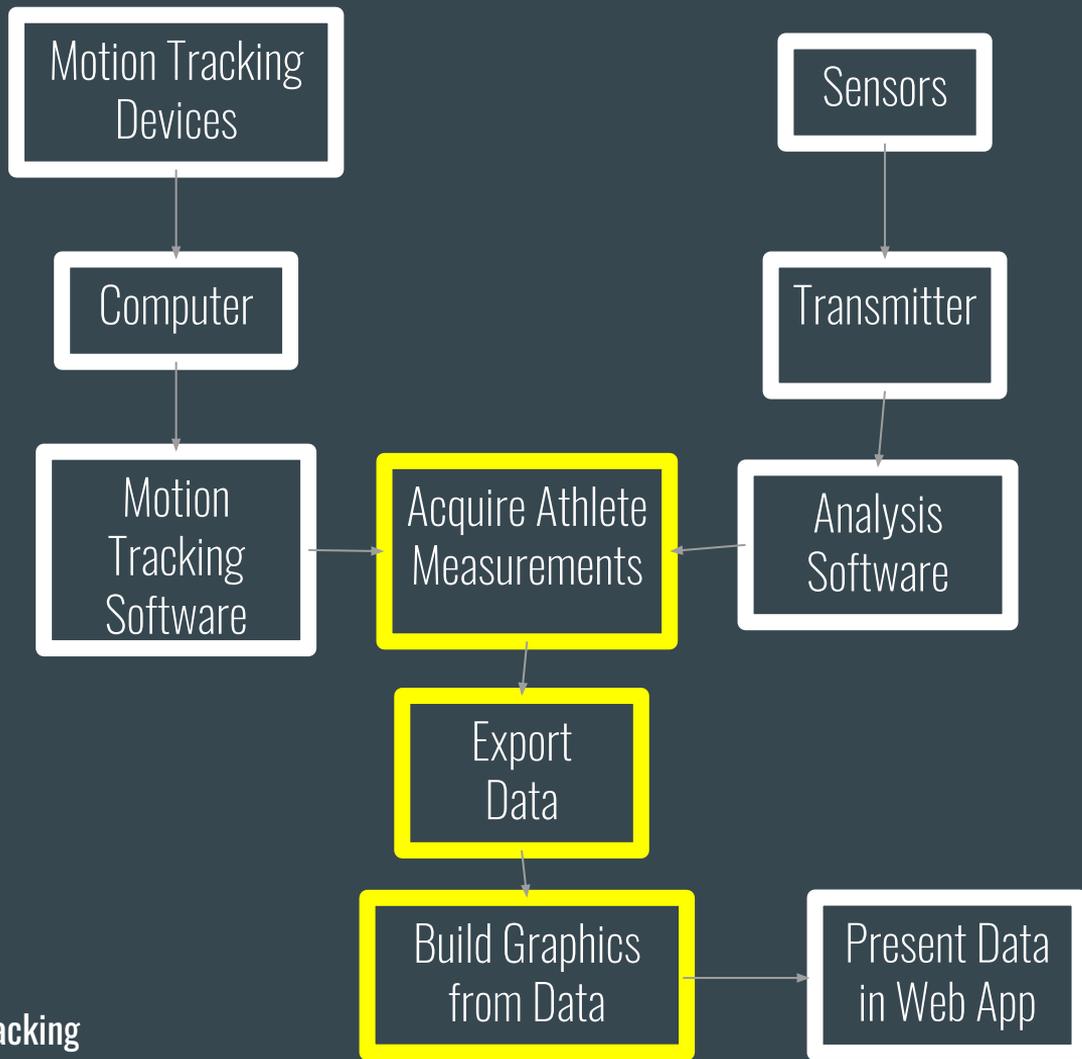
- Dual power source
- Voltage protection
- Power indication
- On board calibration
- Arduino integration

PRESSURE SENSOR CIRCUIT DESIGN

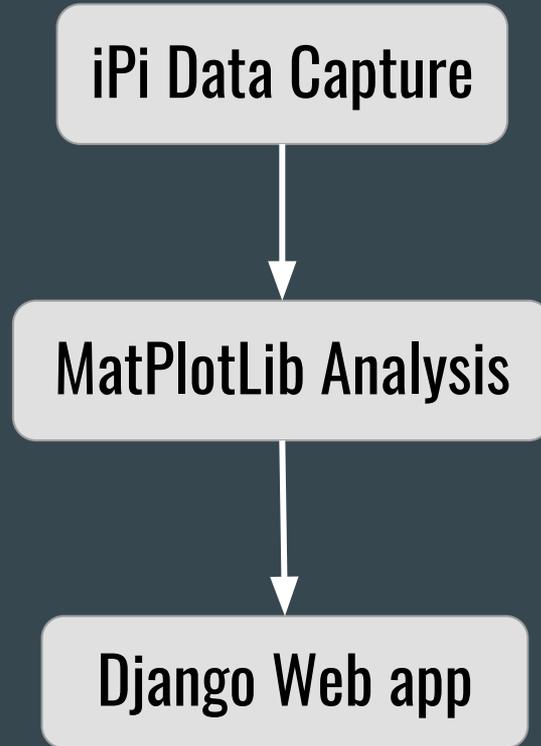


Key Features

- Size
- Reliable
- Organized
- Easy to replicate

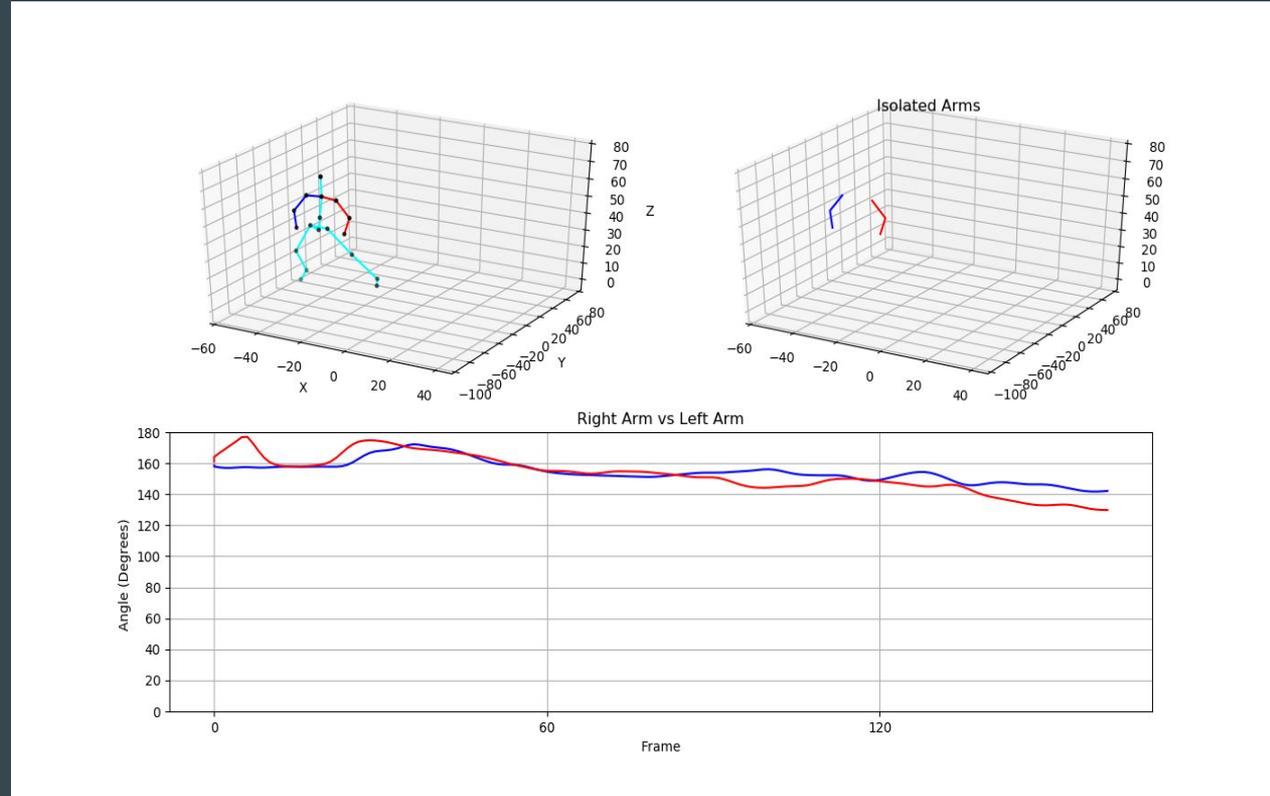


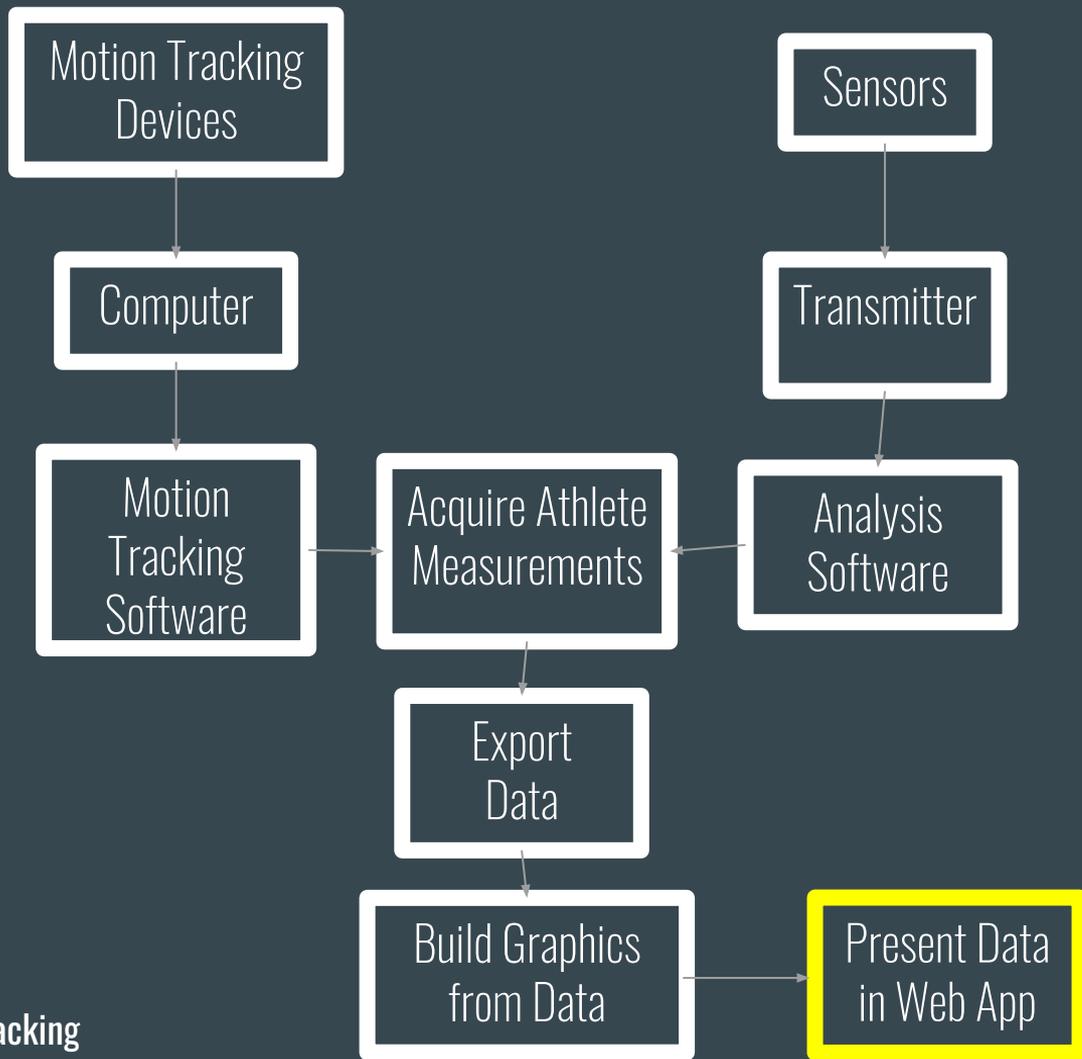
SOFTWARE MODULE DESIGN



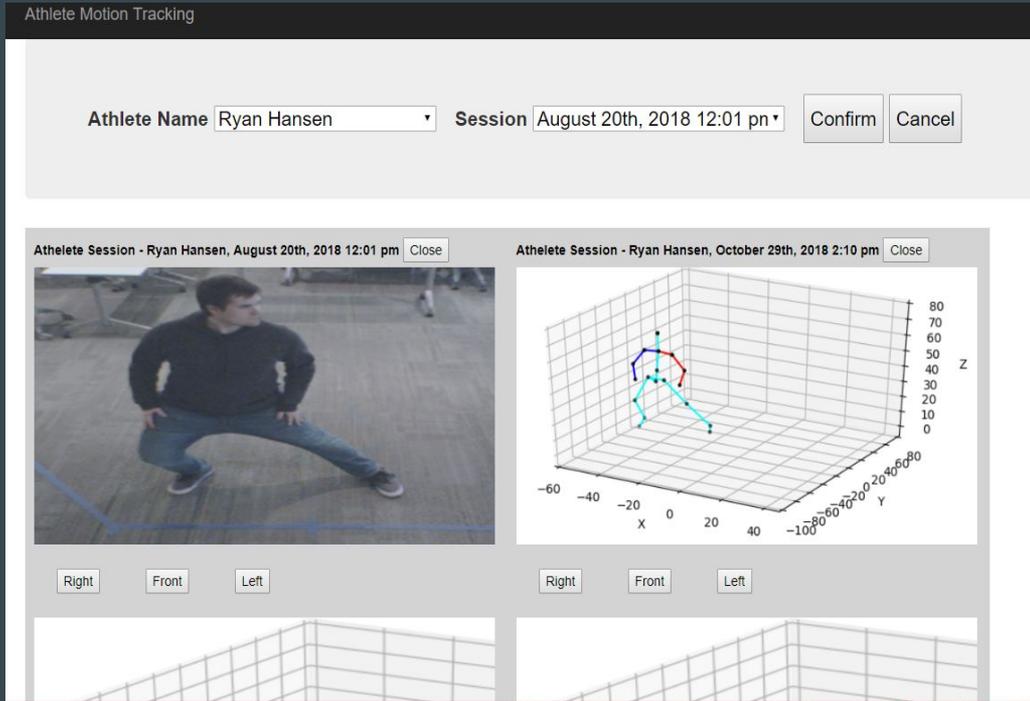
MATPLOTLIB DATA ANALYSIS

- Designed in a meaningful and efficient manner
 - Recreation
 - Isolation
 - Specific tracking





USER INTERFACE DESIGN



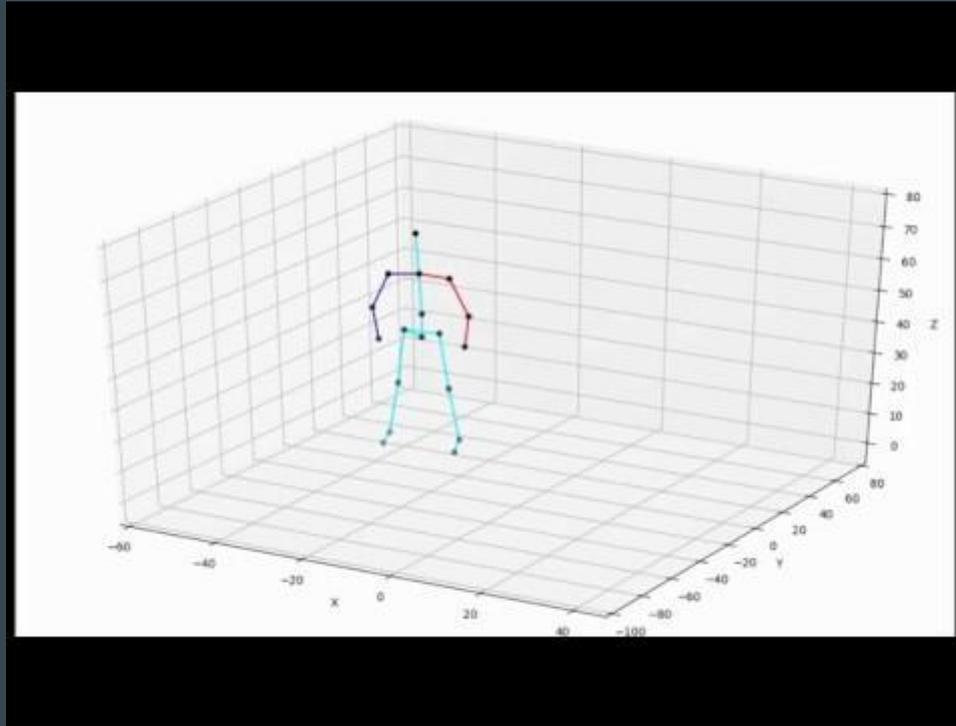
Django Web Application

- Designed for multiple athlete use
- Full system integration
- Modular and Extendable
- User Friendly

CAMERA FOOTAGE



DATA ANALYSIS PROGRAM



CHALLENGES

Problems

- Cameras
- Circuit Design
- Video



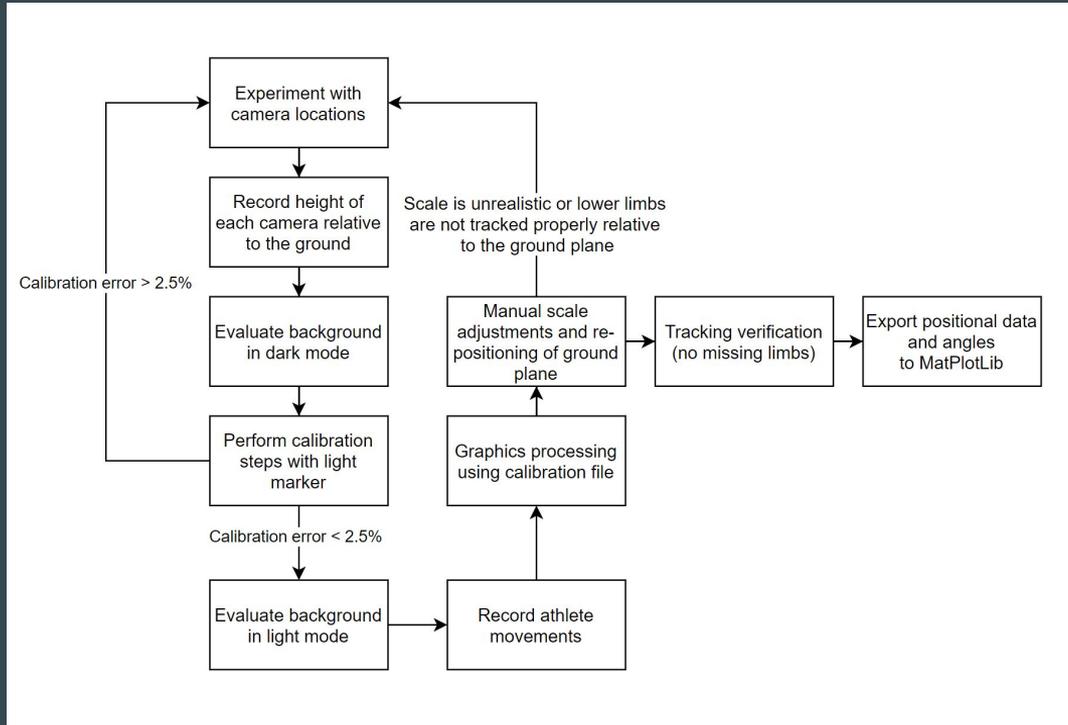
Solutions

- Different Cameras
- Optimization
- Calibration

TESTING



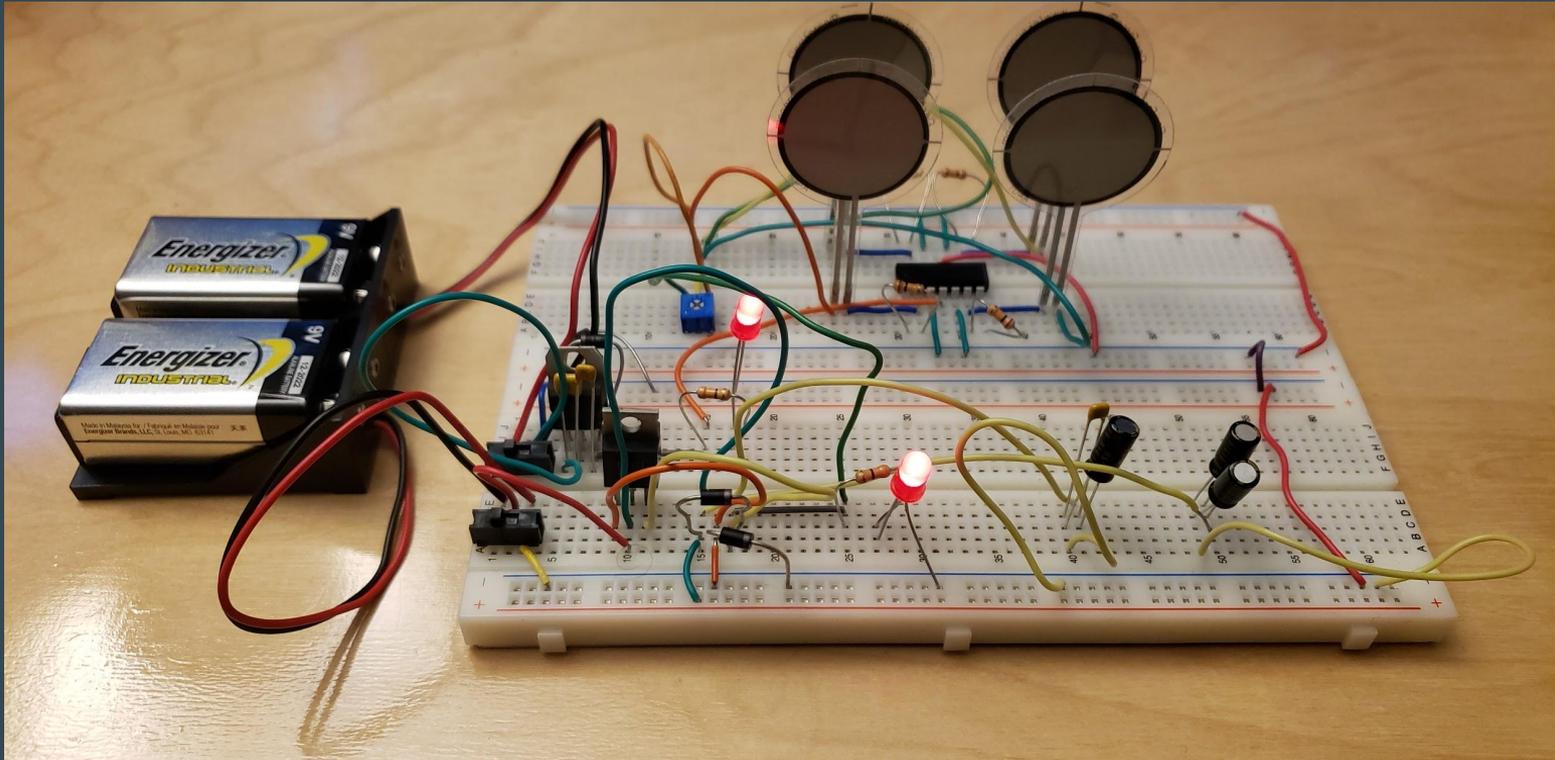
TEST PLAN - MOTION CAPTURE



UNIT TESTING - CAMERAS



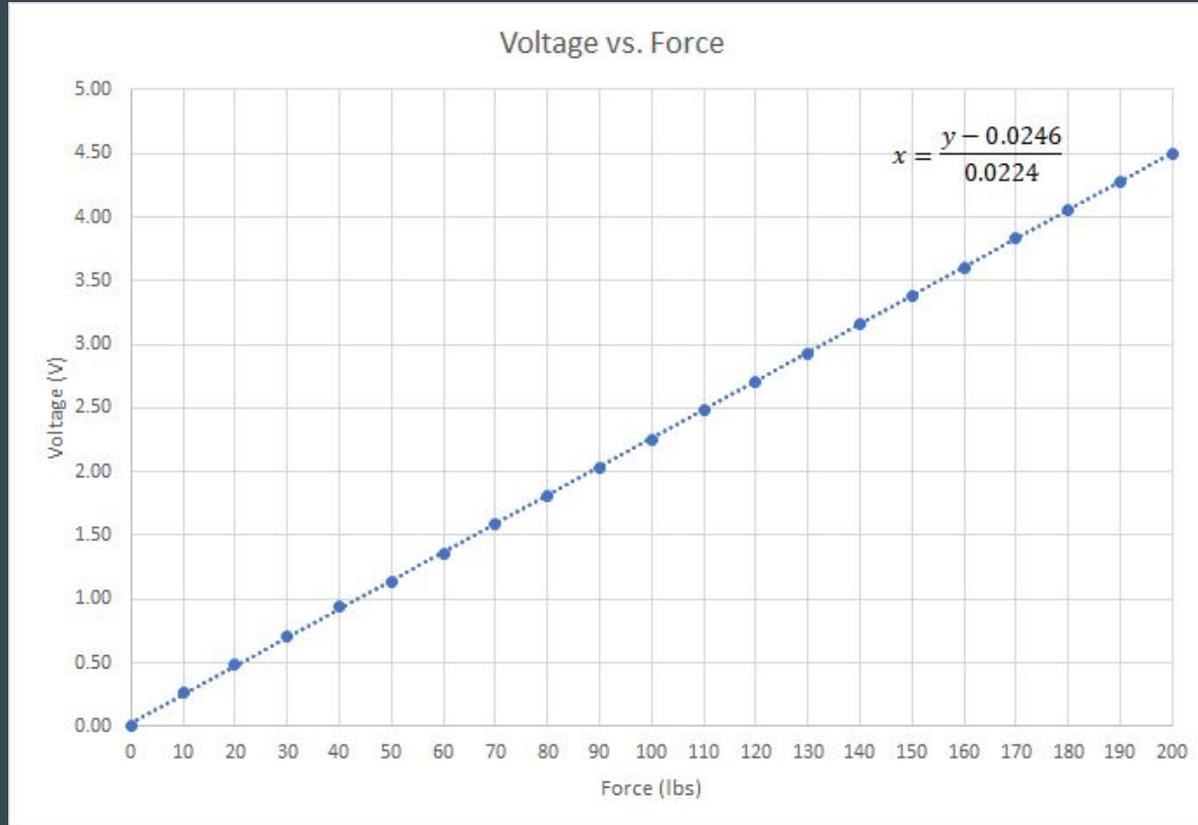
UNIT TESTING - PRESSURE SENSORS



ENVIRONMENT/FIELD TESTING



PRESSURE SENSOR TEST RESULTS



CONCLUDING and MOVING FORWARD

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CONCLUSIONS and LESSONS LEARNED



FUTURE WORK

- Addition of a third sensor system, accelerometers
- Higher level analytics with greater accuracy
- Live streaming capability for each system
- Database for data storage

QUESTIONS

THANK YOU

APPENDIX

RESOURCE REQUIREMENTS

ENVIRONMENT TESTING

COST

COMPETITORS - DARTFISH

COMPETITORS - LEOMO

PRESSURE SENSOR LITERATURE

PRESSURE SENSOR SPECS

PROPOSED GANTT CHART

REVISED GANTT CHART

ARM TRACKING

LEG TRACKING

MOTION CAPTURE TESTING

APPENDIX - RESOURCE REQUIREMENTS

Cameras

- 4 playstation eye webcams
- 480p at 60 fps
- user friendly
- reliable

Software

- iPi software
- multiple inputs
- export data to matlab and excel

Sensors

- TekScan Pressure Sensors
- 1,000 lbs of force accurately
- Light and Portable

Circuitry

- Small form factor
- Arduino integration
- Supports up to 4 pressure sensors
- On-board adjustment for calibration
- Easy to replicate
- Reliable

User Interface

- Allow the review of sessions
- Comparison between sessions
- Storage of sessions
- Flexible

APPENDIX - ENVIRONMENT TESTING



Background

Lighting

Tracking Area

APPENDIX - COST

Part	Digi-Key Part #	Quantity	Unit price	Total price
9V Battery Holder	BH9VW-ND	6	\$2.200	\$13.20
9V Battery Holder (barrel plug)	1568-1406-ND	1	\$2.950	\$2.95
10K resistor	CF14JT10K0CT-ND	12	\$0.041	\$0.49
330ohm resistor	CF14JT330RCT-ND	6	\$0.100	\$0.60
10k potentiometer	3362P-103LF-ND	3	\$1.020	\$3.06
1N4006 diode	1N4006RLGOSCT-ND	12	\$0.165	\$1.98
3mm led	732-5008-ND	6	\$0.160	\$0.96
1uf electrolytic	493-6031-ND	9	\$0.220	\$1.98
0.1uf ceramic	BC1084CT-ND	6	\$0.240	\$1.44
0.33uF ceramic	399-4299-ND	3	\$0.480	\$1.44
slide switch	EG1903-ND	6	\$0.610	\$3.66
7805 vreg	497-1443-5-ND	3	\$0.520	\$1.56
7905 vreg	497-1472-5-ND	3	\$0.590	\$1.77
terminal block connector 1x2	A98333-ND	12	\$0.620	\$7.44
terminal block connector 1x4	A98335-ND	3	\$2.680	\$8.04
heat shrink tubing	A332B-4-ND	1	\$1.310	\$1.31
22 awg parallel wire	https://www.amazon	1	\$7.050	\$7.05
Playstation Eye	https://www.amazon	4	\$5.99	\$23.96
USB extensions	https://www.amazon	4	\$12.99	\$51.96
OSHpark PCBs	https://www.oshpark	3	\$5.35	\$16.05
				Overall price
				\$150.90

APPENDIX - COMPETITORS DARTFISH (Pressure Sensors)



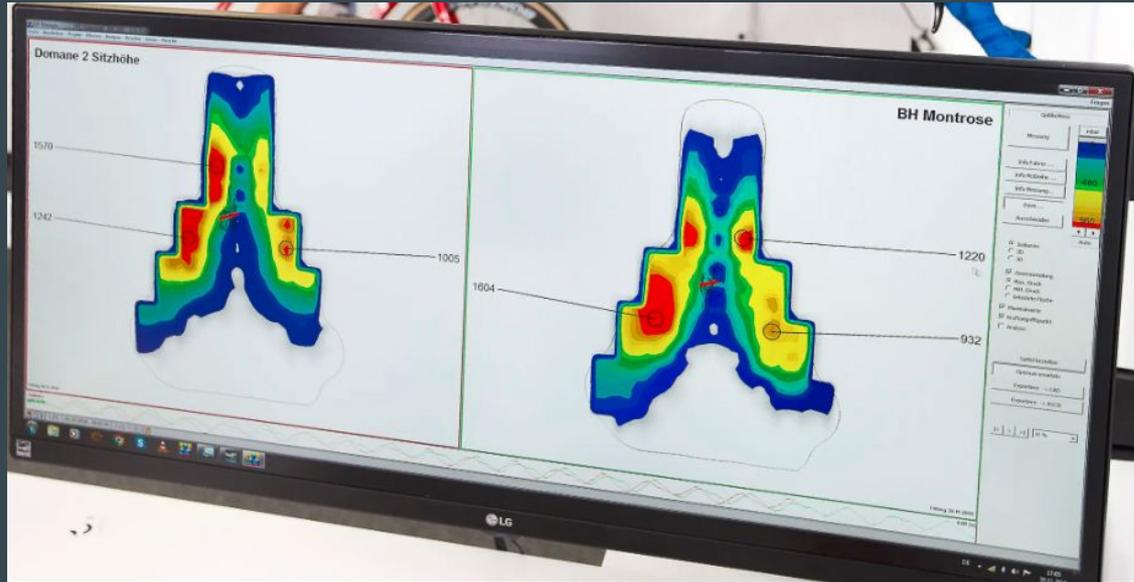
DARTFISH



Dartfish develops and offers cutting-edge video solutions that empower its users to CAPTURE, ANALYZE and SHARE video content. Dartfish is the world leader in video based analysis with in excess of 100,000 active users in sports, universities, stadiums and anywhere that athletes need to understand movement to excel. Dartfish, trusted globally by thousands of elite sport organizations, federations, and corporations, leads the world with technology to create, analyze and distribute video content.

Dartfish has been used by our staff for over a decade and we provide Dartfish education to Cycling Analysis students from all over the world. We also offer complete solutions and hardware consulting to help to create your ultimate motion analysis environment. Cyclogic's has Dartfish Certified Technologists on staff and use Dartfish extensively in Lab and at offsite locations all over the globe. We regularly deploy our performance analysis specialists to help teams, manufacturers, sports NGB's and athletes perform better.

APPENDIX - COMPETITORS LEOMO (Pressure Sensors)



APPENDIX - PRESSURE SENSOR LITERATURE

Saucony Study:
Up to 6 times body weight

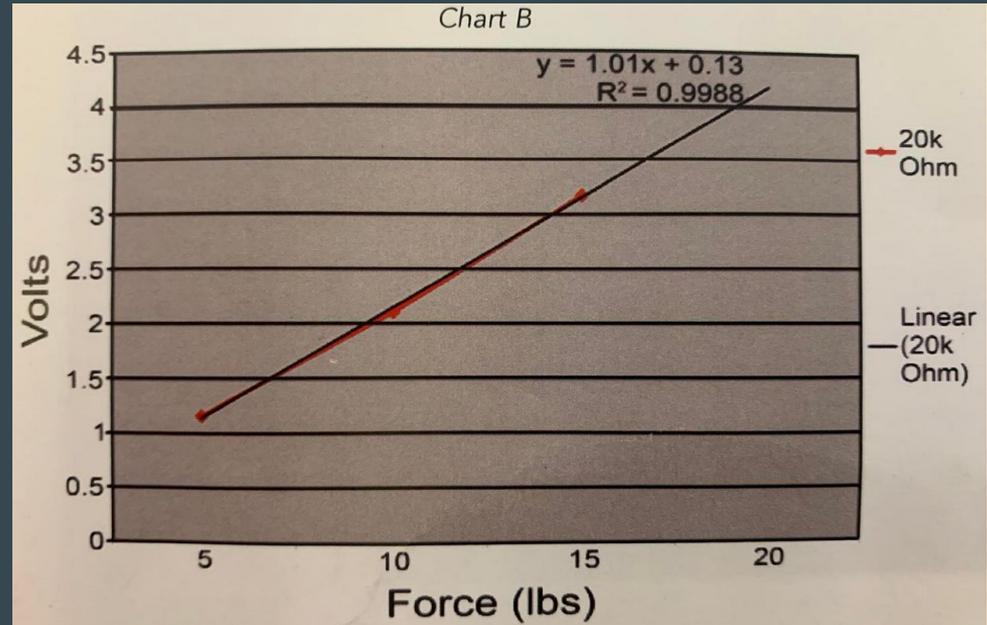
Example: 150 pound person can generate 1000 pounds of force while running

Source: <https://hypertextbook.com/facts/1999/SaraBirnbaum.shtml>

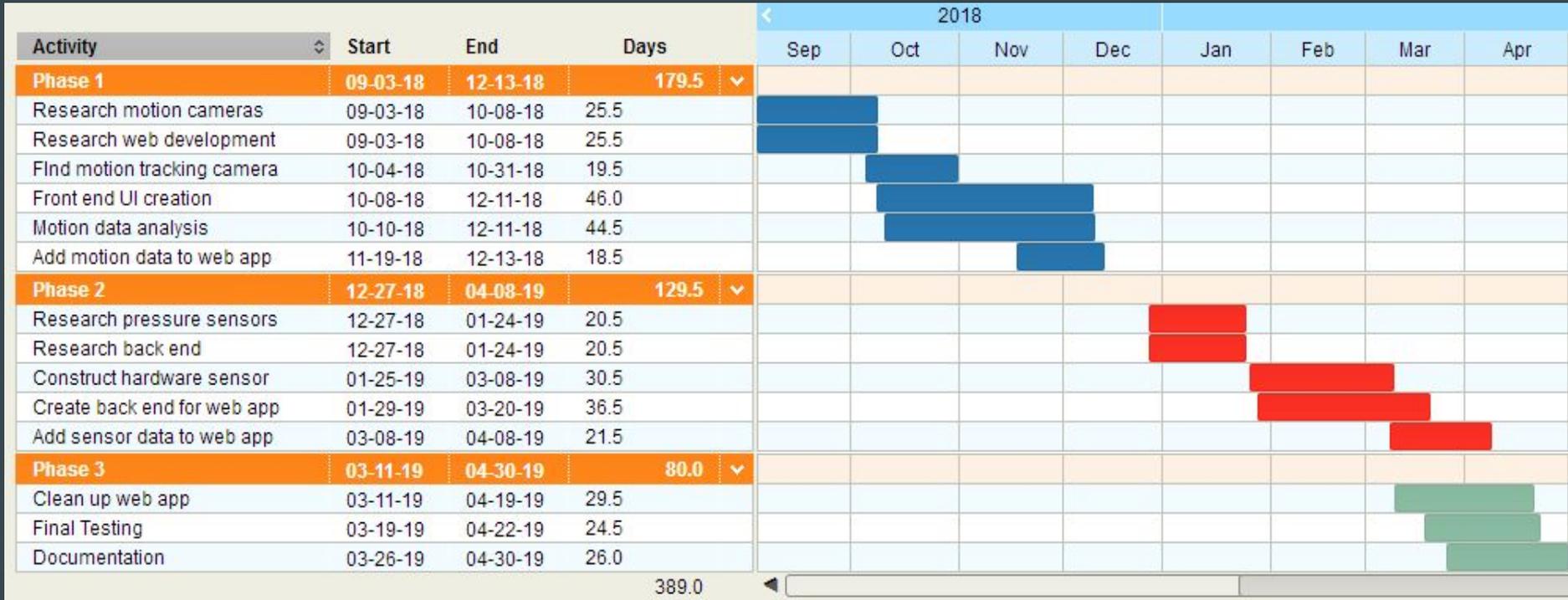
APPENDIX - PRESSURE SENSOR SPECS

Sensors

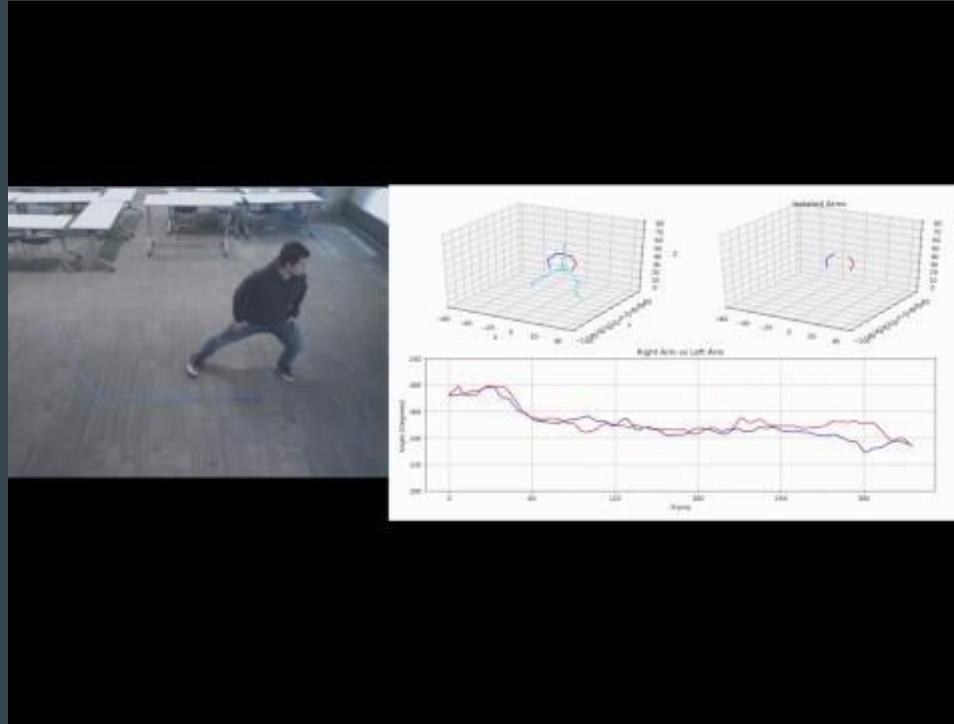
- TekScan thin film variable resistors
- Up to 1,000 lbs of force
- Varying sizes



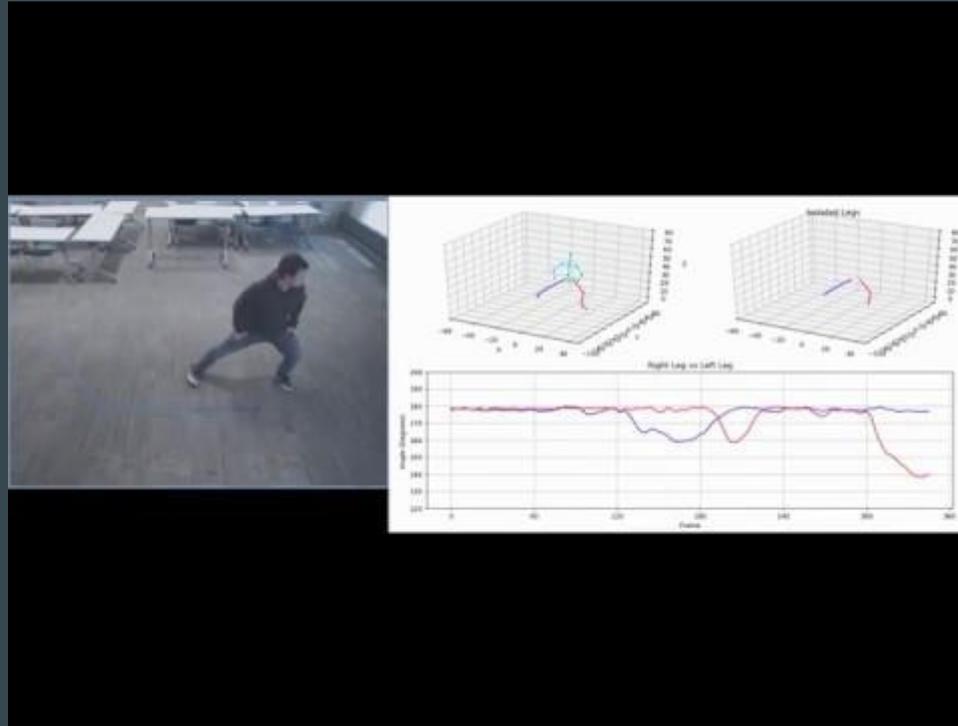
APPENDIX - PROPOSED GANTT CHART



ARM ANGLE TRACKING



LEG ANGLE TRACKING



MOTION CAPTURE TEST RESULTS

