FAMU-FSU College of Engineering

Team 309: Sprinter Data Collection

Members

Adam Breindel, EIT
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Systems Engineer

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Lead Computer Engineer

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Lead Electrical Engineer

Sponsor

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Motivation

- To improve the performance of the sprinter

- Solution - To create an affordable device that can help coaches analyze sprinter data

Lucero Cruz

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Project Scope

Project Description:

- A product that improves data tracking for sprinters/runners.

Goals:

- Create an alternative to devices already established for tracking runner data that is cost effective.
- Capture accurate data points.
- Provides similar or improved data sampling for the sprinters/runners.

Lucero Cruz

Market Competition

Capability	Devices			
	1080 Sprint	Zepp Play	StatSports	Our Vision
Force	✓	✗	✗	✗
Acceleration	✓	✓	✓	✓
Speed	✓	✓	✓	✓
Stride Length	✗	✗	✗	✓
Stride Frequency	✗	✗	✗	✓
Distance	✗	✓	✓	✓
Deceleration	✗	✗	✓	✗
Active Time (Productivity)	✗	✓	✗	✗

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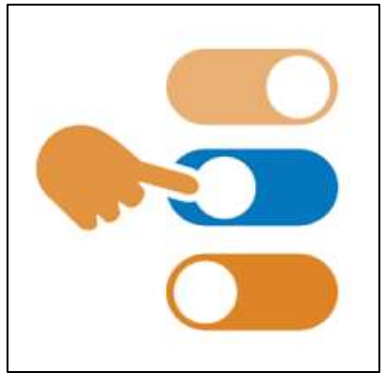
Targets

Data Measurement



Customizable

Water Resistant

User Interface

Affordable

Lightweight

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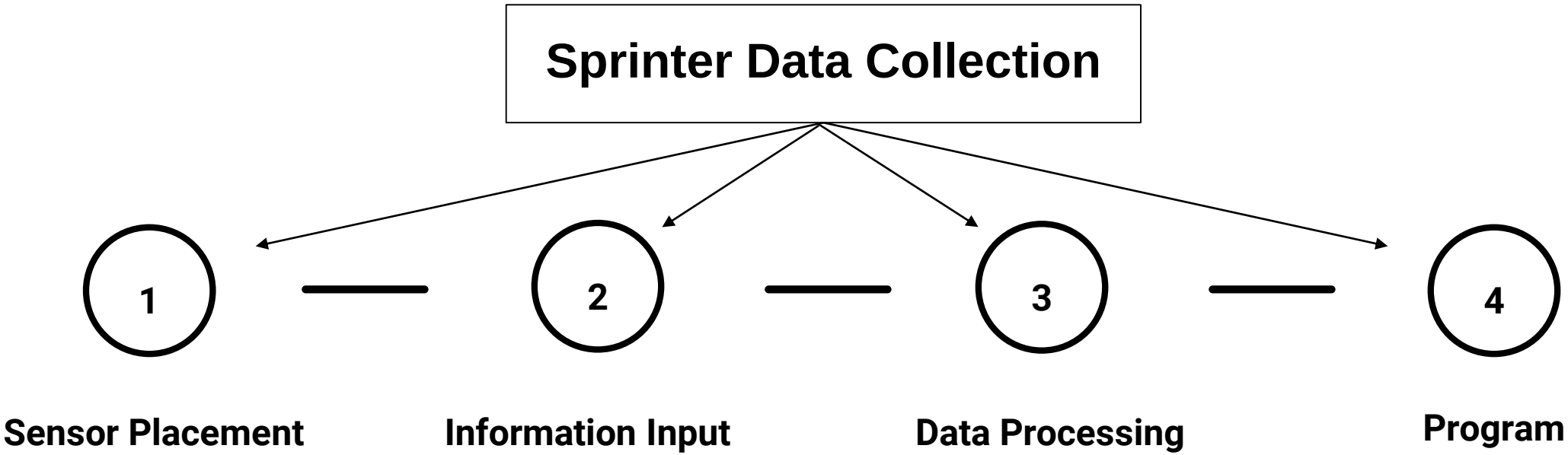
Functional Decomposition



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Functional Decomposition

1

Sensor Placement

- Placement of IMU (Inertial measurement unit)
  - Chest mount on runner

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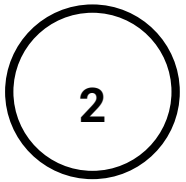
Functional Decomposition



Information Input

- User Information Input
  - Allow for multiple runners
  - Name, Height, Weight
- Camera and IMU Input
  - Camera
    - .MOV file, Manual input
  - IMU
    - .CSV file, Manual input

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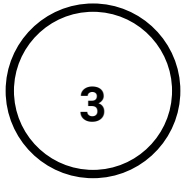
Functional Decomposition



Data Processing

- Data Processing
  - Interpret accelerometer input data from .CSV file
  - Use of OpenCV for feature tracking to obtain
    - Stride Length
    - Stride Frequency
    - Top Speed

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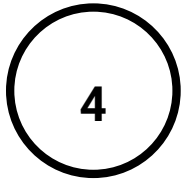
Functional Decomposition



Program

- Program
  - Synchronize data from IMU with Video Processing
  - Ability to save or erase runs
  - Display useful data
  - Feature to view changes in data / changes over time

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IMU (Inertial Measurement Unit)

- Gyroscope
  - Angular Rotation
- Accelerometer
  - Linear Acceleration
- Data Process
  - MetaBase app
  - Computer
- Challenge
  - Drift
  - Double Integration

Beauponte Mezonlin

Concept Selection- IMU

Internal Measurement Unit (IMU)			
	MetaMotion R 	10 DOF IMU Sensor 	Blue Trident 
Price	$87	$25	$1,600
Weight	0.3 oz	0.11 oz	0.21 oz
Battery Life	8 hrs	~	12 hours
Range	+-16g	+-16g	+-16g
Frequency	400 Hz	200 Hz	1125 Hz
Durability	Water resistant, protective shell	No case	Water resistant, protective shell

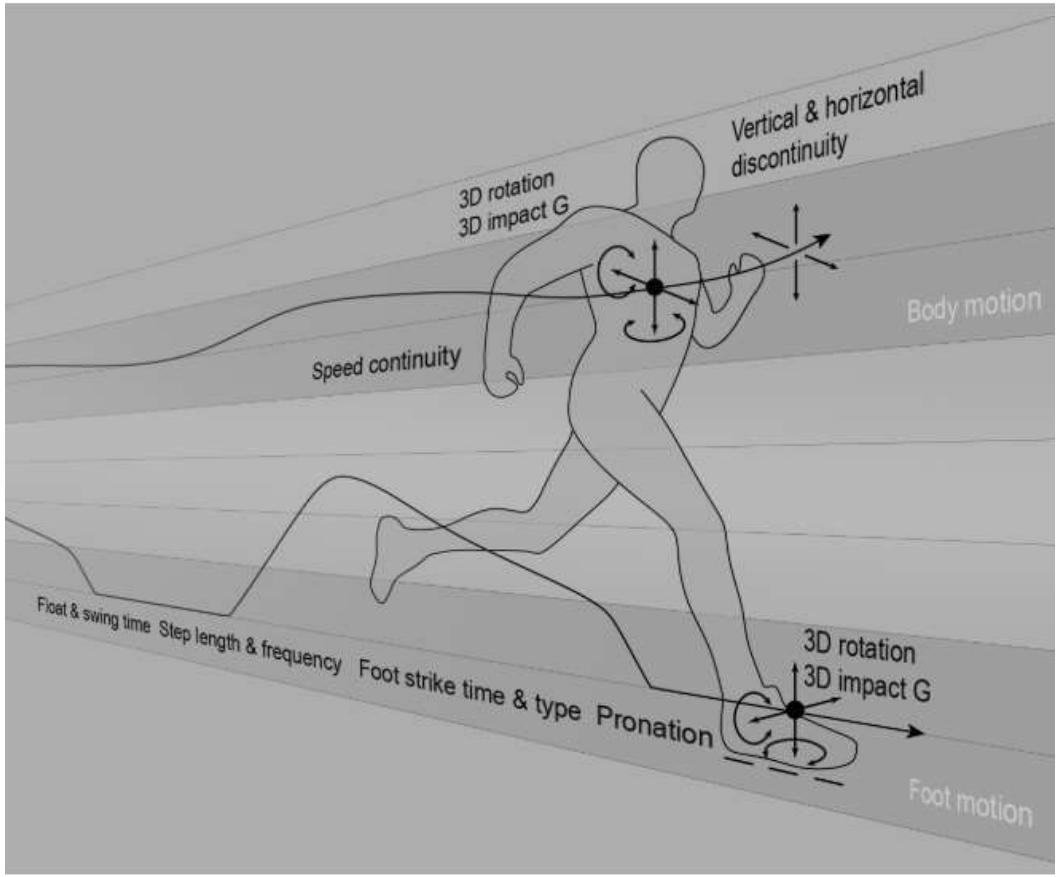
Beauponte Mezonlin

Concept Selection- IMU

Internal Measurement Unit (IMU)			
Good: 1 Neutral: 0 Bad: -1	MetaMotion R	10 DOF IMU Sensor (D)	Blue Trident
Price	0	1	-1
Ease of Use	1	0	1
Weight	0	1	0
Battery Life	0	-1	1
Range	0	0	0
Frequency	0	-1	1
Durability	1	-1	1
Score	3	-1	3

Beauponte Mezonlin

Concept Selection - IMU Position: Chest



- Body depends on upper extremities and trunk
  - Propulsion
  - Balance
  - Stability
- Sensor placement on the chest
  - User comfort
  - Accurate reading of acceleration

Stephanie Damas

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Camera System

Camera System			
Good: 1 Neutral: 0 Bad: -1	Intel RealSense Depth Camera D435 	iPhone Camera System 	MYNT EYE 3D Stereo Camera Depth Sensor 
Depth Sense	0	0	1
Video Resolution	1	1	-1
Frame Rate	1	1	1
Adaptability to light changes	1	1	1
size	0	1	0
price	0	1	-1
OpenCV compatibility	1	1	1
Score	4	6	2

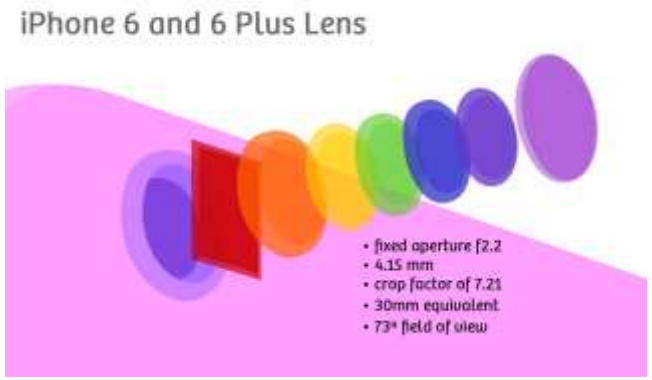
Video Resolution: high enough to capture the movement of the leg for accurate measure of stride length [1920 x 1080]

Size: reasonable size to be portable. Ease of use is most important.

Price: reasonable price to keep our device affordable and convenient

Stephanie Damas

iPhone 6s Plus...and on



Specifications

- 4K video recording (8M pixel per frame)
- Optical image stabilization for video
- Continuous autofocus video
- Noise reduction

Selection

- *Ease of use*
- Compatibility with accelerometer being used
- *Affordability*

Stephanie Damas

.mov >> OpenCV

- iPhone videos are saved as .mov files

- Convert to .avi file using external video convertor
- Use libraries MPlayer or FFMpeg

- OpenCV uses *VideoCapture* function to read in videos

Stephanie Damas

Concept Selection - Program

Programming Software			
Good: 1 Neutral: 0 Bad: -1	Microsoft Visual Studio (C++/C)	Matlab	Python
Familiarity	1	1	-1
Functionality	1	-1	1
Accessibility	1	1	1
Score	3	1	1

Christian Gazmuri

Microsoft Visual Studio >> OpenCV

- Implementation of OpenCV on Visual Studio can be done in a few minutes once OpenCV is downloaded.

- Already established functions in OpenCV that can interpret video files.

- Corresponding classes that are able to store and manipulate video data with matrix objects.

$$MSE = \frac{1}{c * i * j} \sum (I_1 - I_2)^2$$

$$PSNR = 10 \cdot \log_{10} \left(\frac{MAX_I^2}{MSE} \right)$$

```
double getPSNR(const Mat& I1, const Mat& I2)
{
 Mat s1;
 absdiff(I1, I2, s1);       // |I1 - I2|
 s1.convertTo(s1, CV_32F);  // cannot make a square on 8 bits
 s1 = s1.mul(s1);           // |I1 - I2|^2

 Scalar s = sum(s1);        // sum elements per channel

 double sse = s.val[0] + s.val[1] + s.val[2]; // sum channels

 if( sse <= 1e-10) // for small values return zero
     return 0;
 else
 {
     double  mse =sse /(double)(I1.channels() * I1.total());
     double psnr = 10.0*log10((255*255)/mse);
     return psnr;
 }
}
```

Christian Gazmuri

Microsoft Visual Studio >> Accelerometer

- Accelerometer gives data within .csv files.
- C++ can take in those files and interpret data.
- Organized structure of data in relation with time.
- Allows for easy comparison to values given from video analysis.

time (-07:	elapsed (s	X-Axis (g)	Y-Axis (g)	Z-Axis (g)
2018-07-3	0	-0.311	-0.192	0.936
2018-07-3	0	-0.315	-0.195	0.942
2018-07-3	0	-0.316	-0.192	0.941
2018-07-3	0.12	-0.314	-0.193	0.943
2018-07-3	0.12	-0.313	-0.192	0.943
2018-07-3	0.12	-0.314	-0.193	0.944
2018-07-3	0.24	-0.313	-0.19	0.946
2018-07-3	0.24	-0.301	-0.2	0.945
2018-07-3	0.24	-0.292	-0.204	0.947

Christian Gazmuri

Bill of Materials

Sprinter Data Collection

Assembly Name : Sprinter Data Collection
Assembly Number : 1
Assembly Revision : 1
Approval Date : 29-Oct-19
Part Count : 3
Total Cost : $110.28

#	Part Name	Description	Qty	Units	Picture	Unit Cost	Cost
1	MMR – MetaMotionR	IMU + Case	1			$ 86.99	$ 86.99
2	R Clip-on	Clip for MMR	1			$ 7.00	$ 7.00
3	Polar Replacement Soft Strap	Strap that will be worn on chest of runner	1			$ 16.29	$ 16.29

Christian Gazmuri

Next steps…

- Research
  - Different phone camera system compatibility
  - Video processing/specifications for measuring distance
  - Use of accelerometer/ interpreting data
  - Determining synchronization of two different data sets

- Meet again with the coaches and students to get test video files
- Complete PHA form to do testing with device

Christian Gazmuri

Project Summary

- Goals:
  - Assist coaches and sprinters in viewing runner data
  - Focus on device being low cost and accurate
- Give viewable outputs:
  - Stride length
  - Stride frequency
  - Acceleration
  - Top speed
  - Distance

Christian Gazmuri

Questions