IEEE Region 3 SoutheastCon 2021

Assessing Athletic Performance with a Wearable Inertial Measurement Unit

Stephen Mitchell
Engineering
James Madison University
Harrisonburg, VA
mitchess@dukes.jmu.edu

Dr. Jason Forsyth
Engineering
James Madison University
Harrisonburg, VA
forsy2jb@jmu.edu

Dr. Michael S. Thompson
Electrical and Computer Engineering
Bucknell University
Lewisburg, PA
mst008@bucknell.edu

IEEE - Region 3 SoutheastCon Atlanta 2021

Introduction

- Sports analytics market size is projected to hit 4.6 billion USD in 2025, with a compound annual growth rate of 31.2%

https://www.grandviewresearch.com/industry-analysis/sports-analytics-market?utm_source=prnewswire&utm_medium=referral&utm_campaign=ict_5-dec-19&utm_term=sports-analytics-market&utm_content=rd

- Player analytics are becoming more accessible, however in many cases still prohibitively expensive
- Goal of research is to measure one such player analytic using commercial components instead of the normal expensive equipment

Background

The Reactive Strength Index (RSI)

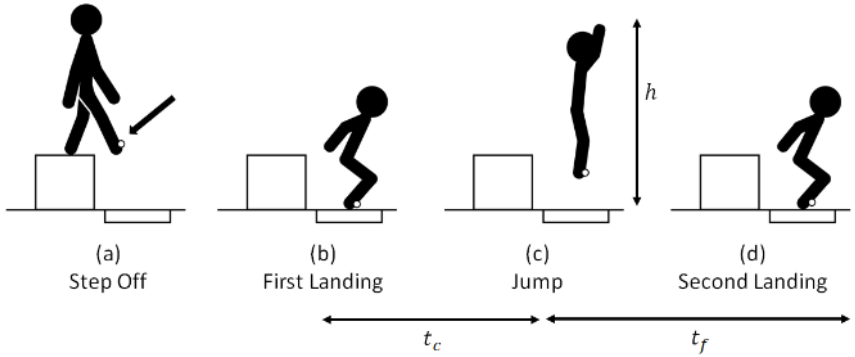
- Measures the capacity a player has for explosive movement
- Can be used to determine how fatigued a person is due to exercise
- Over time can be used to see performance change
- Requires expensive hardware to measure
  - Creates an inequity of data for lower-budget sports programs

Background

Measuring the RSI

- Exercise the RSI was measured from was a drop jump
- Data collected from both an accelerometer and force plate

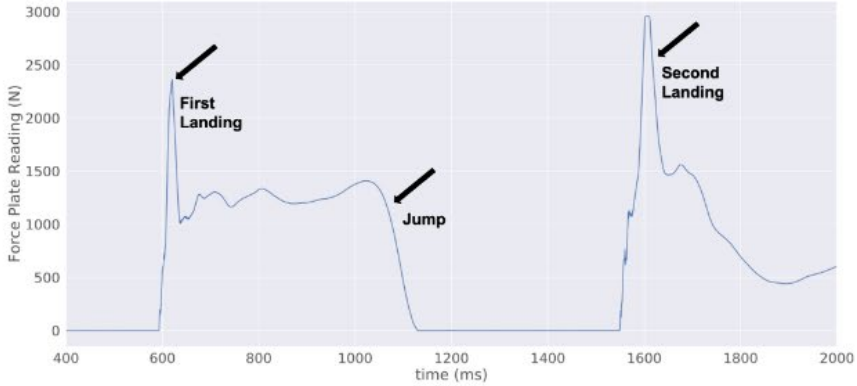
$$RSI = \frac{g{t_f}^2}{8t_c}$$

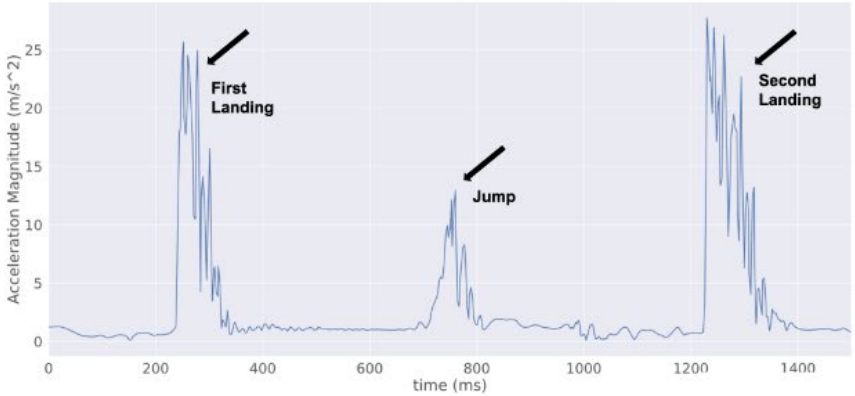


Methods

Force Plate Data vs Accelerometer Data

- Standard measurement of the RSI uses a force plate
- Noise is generated by user and sensor movement





Methods

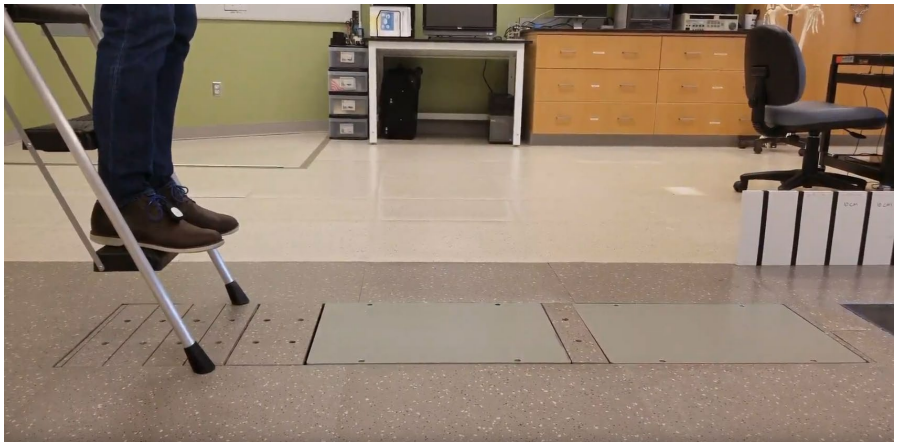
Minimizing Error

- Moving sensor from the hip to the top of the foot
- Overlaying force plate data on top of accelerometer data
- Taking a moving average of accelerometer data to determine the takeoff point

Methods

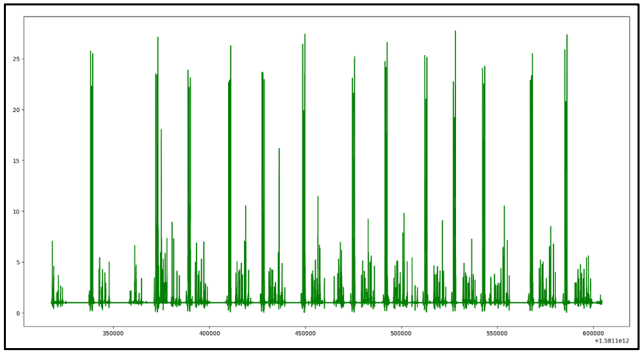
User Study Procedures

- 11 participants
- 10 drop jumps each
- Data recorded on shoe-attached accelerometer (MbientLab MetaMotion R) and biology laboratory force-plate

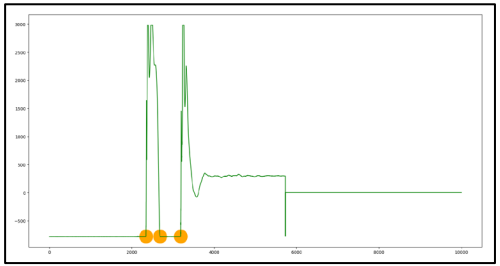


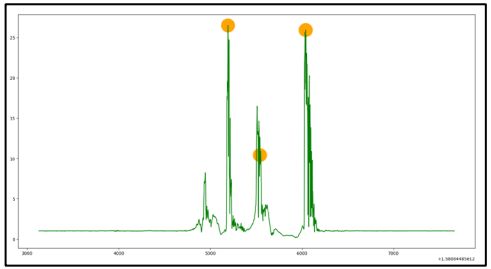
Methods

Analyzing Gathered Data



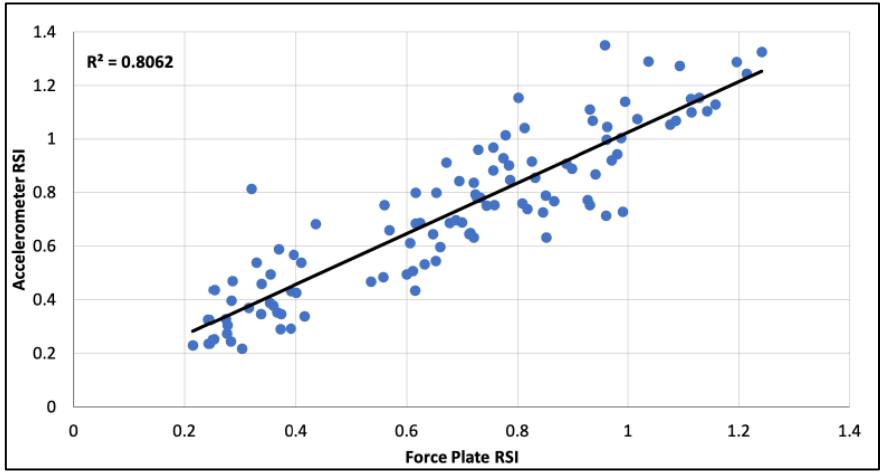
- Accelerometer data split into individual jump files and paired with matching force plate files
- Data labeling algorithm ran on each file to find landing/jumping points and compute RSI





Results

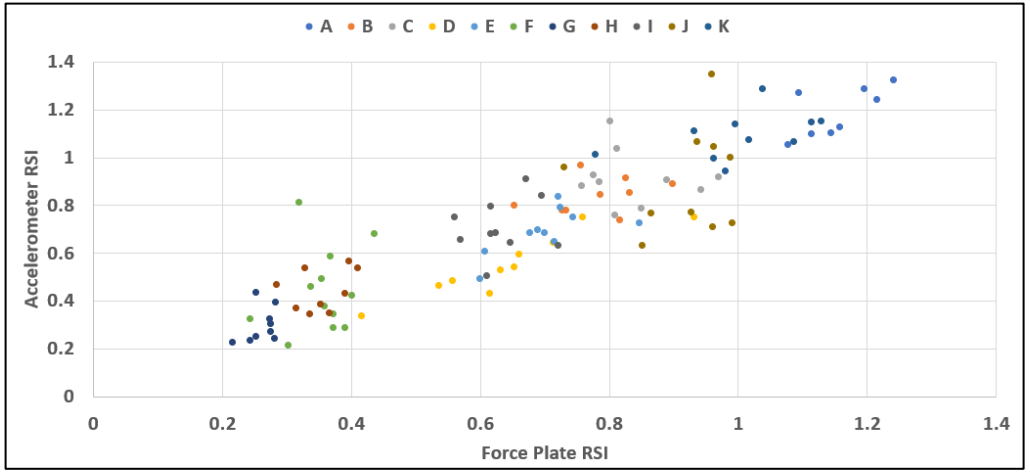
- RSI computed for each participant trial for both force plate and accelerometer data
  - Measurements should be the same
- Average RSI measurement error of 0.107 +/- 0.09



Results

Variation Between Participants

- Large variation in error between participants
  - As low as 0.049 +/- 0.06
  - As high as 0.183 +/- 0.10
- Differences potentially due to jumping form
  - Participants were of amateur status
  - Most had never performed a drop jump



Conclusions

- Measuring of the RSI with commercially available units is feasible
  - Acceptable bounds of error need to be determined
  - Error measured was higher than prior research on accelerometer-measured RSI (0.06 +/- 0.05 compared to our 0.107 +/- 0.09)
    - Custom hardware on athletes
- Noticeable differences in error between different participants
  - Further research needs to be done into the source of this error

Acknowledgements

Stephen Mitchell
Engineering
James Madison University
Harrisonburg, VA
mitchess@dukes.jmu.edu

Dr. Jason Forsyth
Engineering
James Madison University
Harrisonburg, VA
forsy2jb@jmu.edu

Dr. Michael S. Thompson
Electrical and Computer Engineering
Bucknell University
Lewisburg, PA
mst008@bucknell.edu

IEEE Region 3 SoutheastCon 2021

Thank you!

Stephen Mitchell,

mitchess@dukes.jmu.edu

Jason Forsyth, forsy2jb@jmu.edu

Michael S. Thompson, mst008@bucknell.edu