Preventing Sports Injuries Through Motion Capture

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Sports Injury Prevention

Why is Injury Prevention so Important?

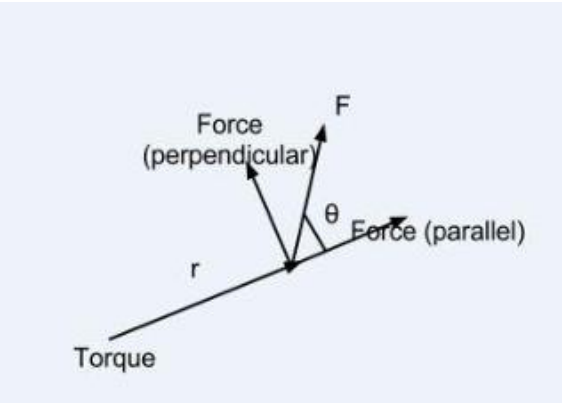
- Research shows young athletes who sustain an injury are more likely to be re-injured, or experience a new injury in the future.
- Evidence suggests that some injuries can have long term impacts that limit athletic activity and daily function. These injuries can also result in chronic pain and disability, even in young adults.
- The ultimate goal of research in this area is to ensure evidence-based injury prevention strategies identified through research can be more quickly and effectively implemented in local youth sports programs.

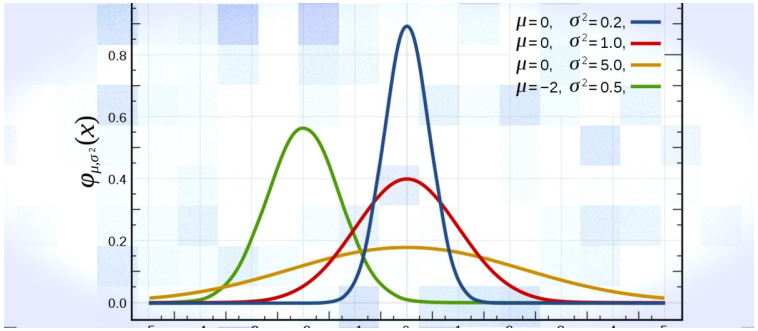
Background

Some Research on Soccer Injury Prevention Includes the following:

- *Predictive modeling of football injuries.* [1]
- *Effective injury forecasting in soccer with GPS training data and machine learning.* [2]
- *Effective injury prediction in professional soccer with GPS data and machine learning.* [3]

Mechanics versus Statistics





Main Differences between Mechanics and Statistics

- Mechanics analyses what is actually happening using motion data (the forces, torques etc.).
- In statistics, probability distributions (Normal, Binomial etc.) are used. A probability distribution is a mathematical function that provides the probabilities of occurrence of different possible outcomes in an experiment.

Predictive modeling of football injuries

Stylianos Kampakis collaborated with Tottenham Hotspurs FC in the Premiership and Wolverhampton Wanderers.

3 Investigations carried out

1. Predicting the recovery time of football injuries using the UEFA injury recordings.
2. Predicting injuries in professional football using exposure records.
3. Predicting intrinsic injury incidence using in-training GPS measurements.

Techniques and Methods

Machine Learning and Statistical Methods

Some of the methods used include:

- **Neural Networks** - consists of different layers of nodes, with connections among the layers.
- **Decision trees** - describes a family of algorithms that concentrate on the idea of partitioning the space in different regions, and then applying a model to each region.
- **The generalised linear model and regularizers.**
  1. Standard model for regression: $y = x^T b + \epsilon, \quad \epsilon \sim N(0, \sigma^2)$
  2. Generalised linear model: $E(y) = \mu = g^{-1}(x^T b)$

Conclusion

- The results illustrate that it is possible to reach some degree of accuracy in this task, but the size of the dataset, and maybe the variables themselves, limit the performance.
- This work paves the way for future research that can include bigger and more complicated datasets and can also be extended by protocols that can combine experts opinions.
- Future research will build on top of the current results in order to provide a functional system for assessing injuries in professional football.

My Research

- I will focus on motion capture from a professional soccer team to reverse-engineer, using inverse methods, how players are affected by forces and torques.
- The project will explore if current motion data gives enough information to explain the appearance of certain injuries and indicate how such injuries can be reduced.

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Main Research Question

How effective can mechanical models developed from motion-capture data be in understanding forces and torques humans experience during physical activity?

Fig: Motion Capture at EA Sports.

Aims and Objectives

Aims

- To reverse engineer bio-mechanical models from motion data from professional soccer players.
- To examine and analyse individual dynamic behaviour using these models.
- To identify injuries that have been caused by specific sets of players motion/behaviour.
- To identify methods of reducing/eliminating particular injuries.

Aims and Objectives

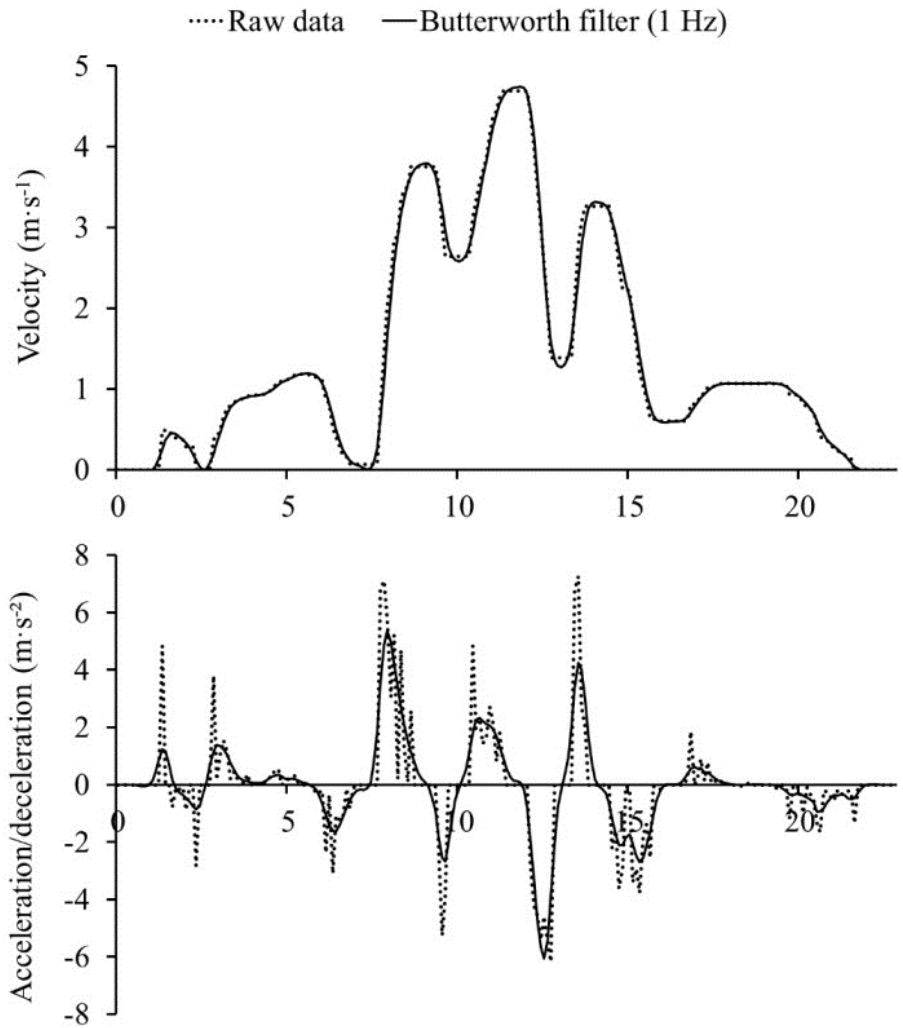

Figure: GPS-derived raw velocity and acceleration/deceleration.

Aims and Objectives

Objectives

The main objectives are to design and develop software for the following systems:

1. Systems to automatically generate individual player models based on individual motion data.
2. Data analysis systems that will use the developed models to produce individual summaries of forces, energy and power applied to the body during specific movement.
3. Systems to compare this statistical output with player health data.

Relationship of the project to Existing Research

- The use of motion data for gait analysis is widely used in medicine to detect and analyse movement problems of sufferers of *Parkinson's* and other degenerative diseases as well as in sports science.
- The proposed project will build on these methods and ideas to incorporate the soccer-data analysis for the specific purposes suggested here.
- I will build on the injury prevention research by developing software to model the forces and torques applied to professional soccer players in the course of training and matches.

  - These models can then be applied to other sports.

References

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Effective injury forecasting in soccer with GPS training data and machine learning.

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