Assessing Header Impacts in Soccer with Smartball
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Motivation
- Cumulative effect of heading the ball causes concussions in soccer
- Worth studying each impact
- Current methods using wearable sensors inconvenience players and are generally not accessible to amateurs

Concussions in Soccer are Significant

Existing Wearable Trauma Sensors
The Triax SIrM-P, X2 Biosystems X-Patch, and Reebok Checklight.

Smart Soccer Ball
- Header impacts could be measured by a smart soccer ball
- This solution offers several advantages:
  - One ball can monitor 22 players
  - Players suffer no inconvenience
  - More accessible to non professional players

Smart Soccer Ball Concept

Understanding the Smart Ball
- Created two apps to mimic RealApp and SmartBall in order to intercept transmissions:
  - EmuApp: Emulates RealApp, allowing us to retrieve data directly from the Smart Ball
  - EmuBall: Emulates SmartBall, allowing us to retrieve commands transmitted by RealApp

Impact Force Estimation
- A key challenge due to the small measurement range combined with the low sampling rate of the sensor
- Necessary to predict force using one time training with labelled data
- Picked multilinear regression to exploit the causal linear relationship between the observed acceleration and impact force
- Collected data with drops from fixed heights onto a force pad consisting of three piezoelectric sensors

Forcepad Experimental Setup

Machine Learning
- Interior 3-axis accelerometer suspended on rubberized bands
- Sampling rate of 1000 Hz
- Measurement range restricted to ±4 g
- Limited storage capacity of 1096 x,y,z acceleration values

Ongoing and Future Work
Beyond improving the accuracy and robustness of force estimation, we are pursuing the following:
- Can the forces measured by the smart ball be thresholded to separate potentially unsafe impacts from the rest?
- Are there scenarios in which head-mounted sensors or smart ball perform better than the other?
- Pursue a hybrid scheme that inherits the best of both techniques if the above is true
- Test the system in real soccer matches with the USC men’s and women’s soccer teams

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