Assessing Header Impacts in Soccer with Smartball

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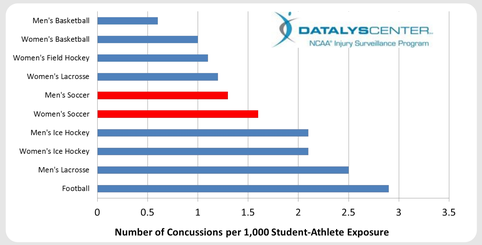
Motivation

- ❏ 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 SIM-P, X2 Biosystems X-Patch, and Reebok Checklight.

Smart Soccer Ball

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

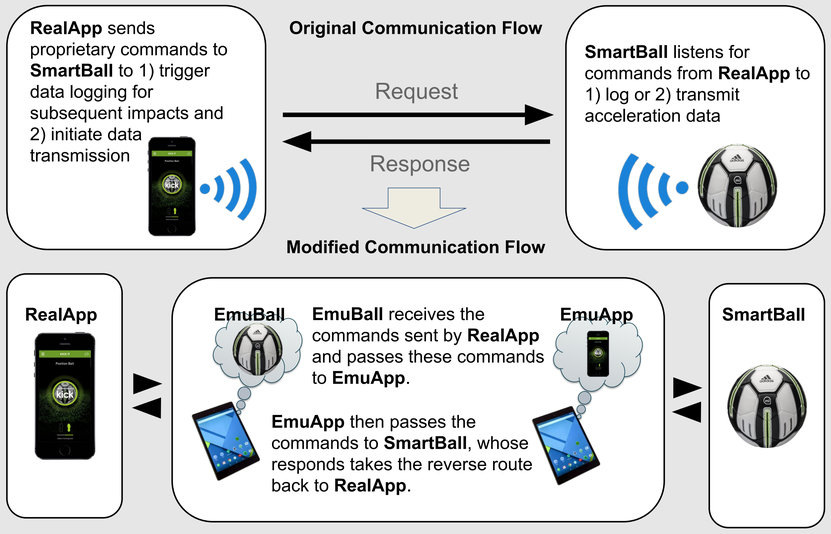
Concept

Smart Soccer Ball

- ❏ Adidas miCoach Smart Ball, size 5, regulation weight
- ❏ Provides only rudimentary data for stationary kicks
- ❏ API is not public so communication procedure must be inferred

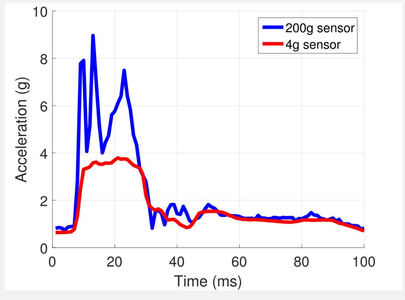
Understanding the Smart Ball

- ❏ 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 recieve commands transmitted by RealApp



- ❏ 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

Truncation due to Sensor Range



Smart Ball with External Sensor

Impact Force Estimation

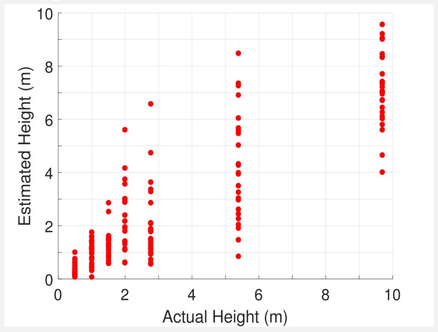
- ❏ A key challenge due to the small measurement range combined with the low sampling rate of the sensor
- ❏ Necessary to predict force using one time training with labelled data
- ❏ Picked multilinear regression to exploit the causal linear relationship between the observed acceleration and impact force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

Forcepad Experimental Setup

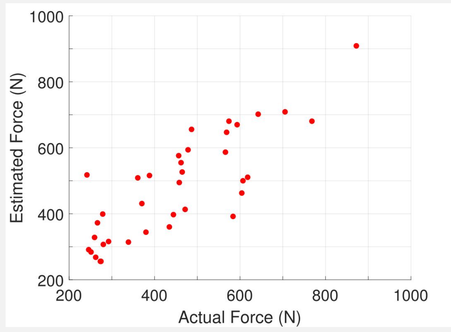
Machine Learning

- ❏ Training and testing done with sets of 175 impacts
- ❏ Several features were used:
  - ❏ First peak width ∝ impact duration
  - ❏ Amplitude of subsequent peaks ∝ decay ratio
  - ❏ Magnitude of first peak until 10% drop in acceleration

Height Correlation



Force Correlation



Actual vs estimated height and force, respectively, when ball dropped on the force-pad from various heights.

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