Development of a setup for the study of ball roll behaviour in soccer on artificial turf

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Overview

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• experimental setup
• results & discussion
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Introduction

- 3rd generation artificial turf: increased use in football, especially for training

- players & clubs still have some resistance for official games on artificial turf

- Joosten(2003): 77% players experience ball speed and roll capacity as high
Introduction

- ball roll distance test (FIFA, UEFA)
  - ball is released from 1m height
  - ball roll distance is measured
    - $4m < x < 10m \rightarrow \text{FIFA}^*$
    - $4m < x < 8m \rightarrow \text{FIFA}^{**}$
  - not all fields meet these requirements
  - influenced by external factors (wind, slope, wet/dry, brushing, …)
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Goal

• get a more profound understanding of the ball roll behaviour on artificial turf

• develop an experimental setup that allows the investigation of ball roll behaviour on different types of artificial turf, before and after use, as well as the necessary analysis software
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Experimental setup

- Photron Ultima APX-RS (200fps)
Experimental setup: development of image processing software

- software tool: analyse entire ball rolling movement on the turf
- Matlab GUI using the Image Processing Toolbox:
  - automatic ball tracking
  - spin detection
- video = sequence of tiff-images
- each frame:
  - ball position $\rightarrow$ ball speed
  - ball rotation $\rightarrow$ spin
Experimental setup: development of image processing software

- **ball position**
  - background subtraction
  - conversion to greyscale images
  - conversion to binary images
  - template matching
Experimental setup: development of image processing software

• ball rotation
  ‣ cross-hair markers on a white football
  ‣ spin algorithm based on Hull(2002), Goodwill et al. (2006)
  ‣ calculation of rotation between 2 subsequent ball positions
  ‣ rotation → spin
Experimental setup: 12m Lisport

- large-scale version of standard Lisport apparatus
- 12m x 1m samples
- 2 studded rolls
  - 100kg
  - 1m wide
- speed: 0.25m/s
- 40% slip between rolls
- allows to study the effect of wear & tear in the laboratory
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Results: initial tests - brushing

- $v_0 = \sqrt{2gh}$ (no losses or $E_{rot}$)
- influence of brushing: smaller ball speed, especially for small $h$

\[ h \quad v_0 \quad v_{1.5m} \quad 1.5m \]

\[ gh v^2 = \]

\[ \text{Speed after 1.5m [m/s]} \]

\[ \text{Initial launching height [m]} \]

unbrushed

brushed
Results: ball roll tracking - position

- $h=0.40, 0.60, 0.80\,\text{m}$ ($n=3$)
- variation is low (max 3%) $\rightarrow$ tracking is accurate and repeatable

![Graph showing the position of a ball rolling at different heights over time.](image)
Results: ball roll tracking - velocity

• horizontal velocity increases with h
• initial acceleration: transformation from $E_{\text{kin,rot}}$ into $E_{\text{kin,transl}}$
Results: ball roll tracking - rotation

- variation is low (max 3%) → tracking is accurate and repeatable
Results: ball roll tracking - spin

- variation is higher
- initial drop in spin: transformation from $E_{\text{kin,rot}}$ into $E_{\text{kin,transl}}$
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Conclusion

• experimental setup
  ‣ ball roll ramp
  ‣ replaceable artificial mats
  ‣ 12m Lisport
  ‣ high speed camera

• image processing software
  ‣ ball position → ball speed
  ‣ ball rotation → ball spin
## Conclusion

- brushing reduces ball speed, especially at low speeds
- tracking algorithm for ball position and rotation is accurate & repeatable
- ball speed and spin derived
- initial acceleration due to transition effects from ramp to field
Future work

• extra lenses → analysis of ball roll over more than 2 metres
• compare different types of artificial turf
• analyse influence wear & tear with 12m Lisport
• validate mathematical models for ball roll behaviour
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