Inertial Sensor-Based Approach for Shot/Pass Classification During a Soccer Match

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Introduction

Motivation
Performance indicators in soccer [1]
- Total number of shots
- Total number of passes
→ Need for assessment tools

State-of-the-Art
Performance assessment in soccer [2]
- Video analysis
- High costs and low portability
→ Mainly applicable for elite teams

Our Goal
Shot/pass classifier
- Inertial sensors
- Pattern recognition methods
→ Low-cost solution for amateur teams

Data Collection

Hardware Setup
Sensor unit
- Located in soccer shoe cavity
- Accelerometer (±16 g)
- Gyroscope (±2000 °/s)
- Sampling rate: 1000 Hz

Storage unit
- Located in shin guard
- SD card (2 GB)

Study Setup

Study A
- Controlled exercises, e.g. dribbling-pass-shot
- 11 equipped amateur players

Study B
- 11 vs. 11 game (60 minutes)
- 17 equipped amateur players

Methods

Pattern Recognition Pipeline
1. Peak detection
   - Butterworth high-pass filter
   - Signal magnitude vector
   - Absolute difference (left and right shoe)
2. Segmentation (1 s)
3. Feature extraction (in total: 48)
4. Event leg classification
   - LEFT/RIGHT
5. Hierarchical event classification
   - SHOT/PASS/OTHER
   - Support Vector Machine (linear kernel)

Evaluation

Study A: parameter selection/classifier training
Study B: testing complete system (1. - 5.)
- Balanced accuracy
- Ground truth: video labeling

Results & Discussion

Confusion Matrix

<table>
<thead>
<tr>
<th></th>
<th>PASS</th>
<th>SHOT</th>
<th>OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>PASS</td>
<td>227</td>
<td>2</td>
<td>131</td>
</tr>
<tr>
<td>SHOT</td>
<td>51</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>OTHER</td>
<td>58</td>
<td>3</td>
<td>3445</td>
</tr>
</tbody>
</table>

Balanced Accuracy

PASS/SHOT vs. OTHER: 89.5 %
PASS vs. SHOT: 84.2 %
PASS vs. SHOT vs. OTHER: 78.7 %

Discussion
- Problem of imbalanced data
- SHOT/PASS labeling in games challenging
- Adequate OTHER removal
- Generic approach, applicable for e.g. crosses

Summary & Outlook

Video-based performance assessment tools mainly for elite teams
Provision of a low-cost solution for amateur teams
Balanced accuracy: 78.7 %

In future: personalized system with online learning

Acknowledgment & References

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