

Semi-automated last touch detection for out-of-bounds possession decisions in football

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FIFA EPTS TEST REPORT

EPTS Performance Test

Product Name	Player & Ball Tracking System (Live - Delayed Data)
Partner	Hawk-Eye Innovations Limited
EPTS Product Type	Optical System
Quality Level	FIFA Quality
Test Date	18.09.2021
Certification Date	01.07.2022 to 30.06.2024
Assessment Metrics	Live Performance Data
Ball Tracking	Yes


INTRODUCTION

Introduction

The FIFA Quality Programme for EPTS Performance offers a two-year FIFA Quality certification for tracking providers who are able to generate player and ball tracking data. This process is carried out by quantifying the accuracies of wearable and optical tracking systems. This certification is offered to providers after quantifying the accuracy of their wearable (GNSS & LPS) player tracking systems or optical tracking system. The test, conducted at an independent stadium, sees participants perform different scenarios in a specified test area. The collected data is measured via root mean square difference (RMSD) and evaluated for accuracy using a specified rating system.

Declaration of conformity

This report details the results of EPTS Performance Tests carried out in accordance with the 'Handbook of Test Methods for EPTS Devices'. For further information about the exact test procedure, please refer to the September 2021 version of the [Handbook](#)

Technician	Dr Jade Haycraft
Date	11.02.2022
Signature	
Report checked by	Professor Rob Aughey
Date	11.02.2022
Signature	

PLAYER TRACKING TEST DETAILS

Test details	
Test Date	18.09.2021
Test Location	Estadio Ramón Sánchez Pizjuán, Sevilla, Spain
Test Institute	Track at Victoria University
Test Number	126317
Test Manual	EPTS Performance Standard 2021
EPTS Product Type	Optical System
Assessment Metrics	Live Performance Data
Number of Cameras Used	12
Median Latency	12.370 seconds

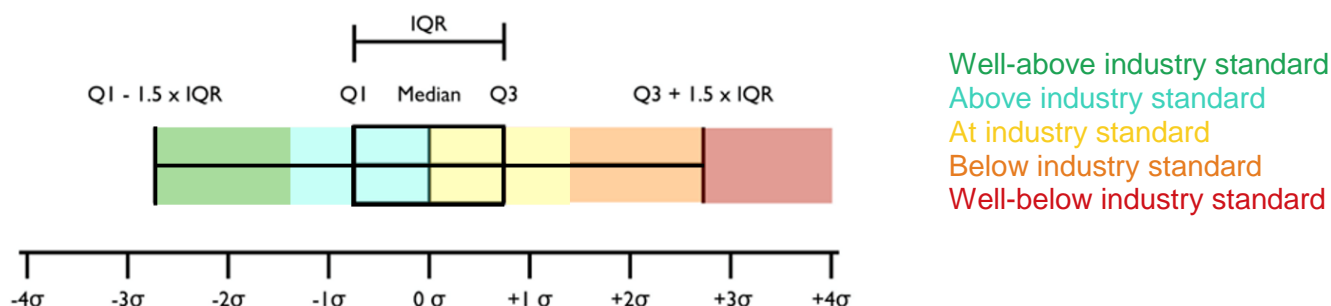
Fulfilment of test requirements

Test block	Capture & submission
Circuit	Yes
2 v 2 Game	Yes
5 v 5 Game	Yes
Sprints	Yes
Full Pitch Coverage	Yes

Analysis interpretation

Measure	Definition
Root Mean Square Difference (RMSD)	A commonly used measure of accuracy based on the standard deviation (σ) of the differences between the manufacturer and Vicon system. A large sample of RMSD values from GNSS, LPS & Optical provider comparisons were used to set the ranking criteria.
Data Points Compared with Vicon	Varies depending on the quality of Vicon capture, as only the highest quality data is used for comparative purposes.
Live Data Submissions	Live data is considered as data that can be used in real time, this varies depending on the application.

Rating System (including legend)



Analysis conducted on >1,000,000 data points from over 30 systems at the past three EPTS test events form the basis of the ranking system, these are reviewed on a yearly basis.

Rating by FIFA Velocity Band

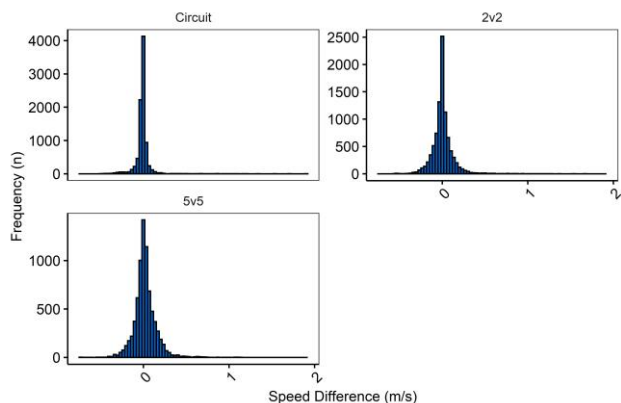
Rating by FIFA Velocity Band

	0-7 km/h	7-15 km/h	15-20 km/h	20-25 km/h	25+ km/h
Velocity RMSD (m/s)					N/A*
Position RMSD (m)					N/A*

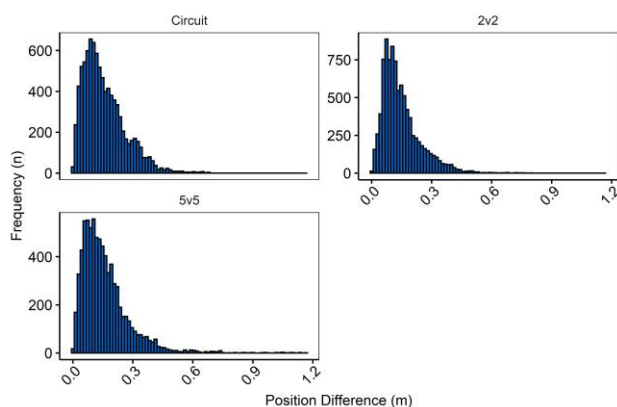
Well-above	Above	Standard	Below	Well-below

*Due to a lack of data collection in the 25+ km/h speed band from this test event, the decision was made to omit the data from all provider reports. This is not a reflection of a provider's ability/inability to provide high velocity data.

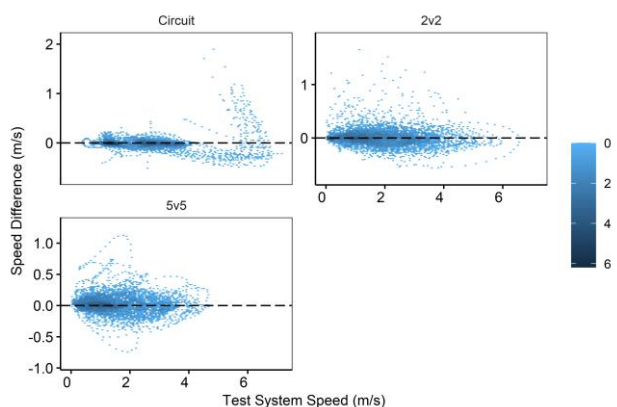
Histogram of Speed Differences ($\text{m}\cdot\text{s}^{-1}$)



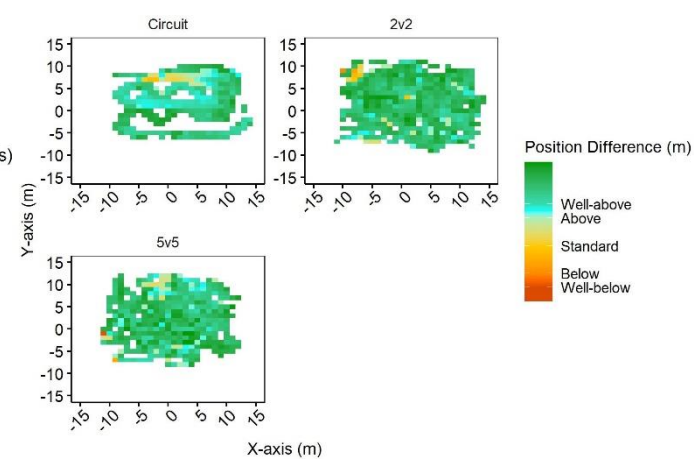
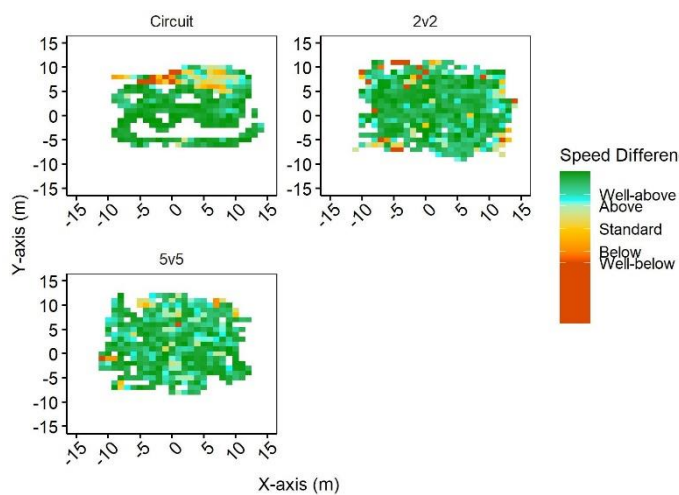
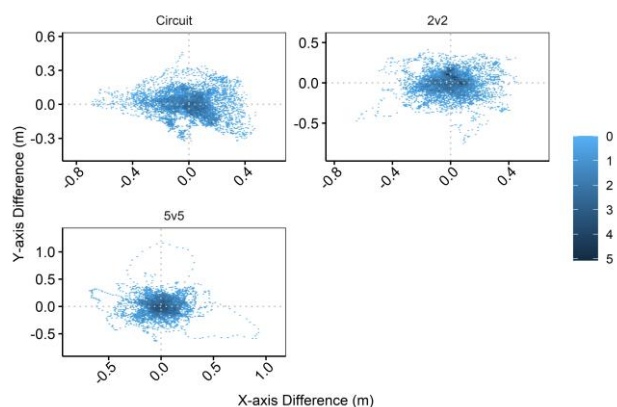
Histogram of Position Differences (m)



Speed Difference to Vicon ($\text{m}\cdot\text{s}^{-1}$)

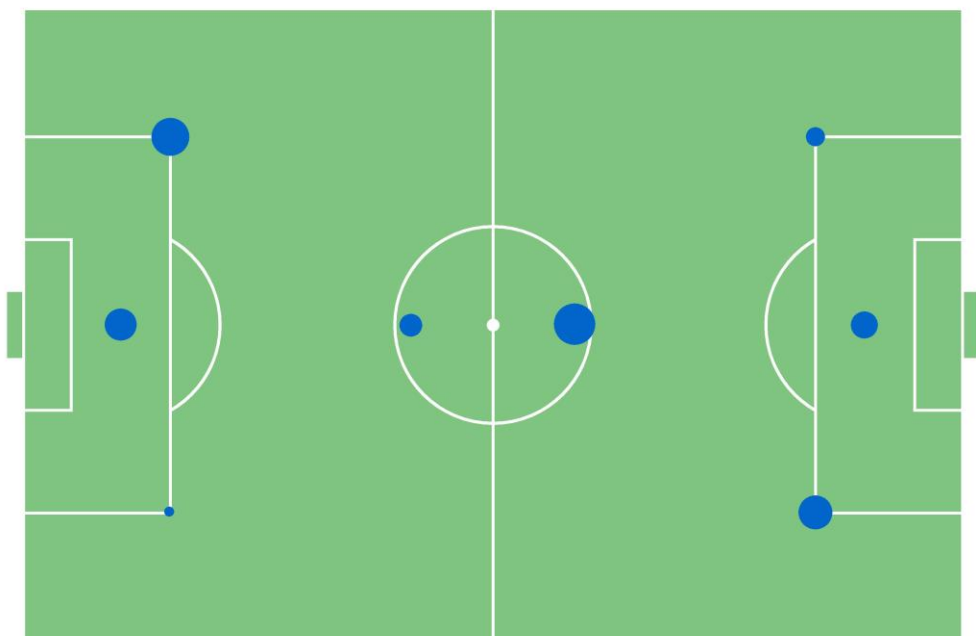


Position Difference to Vicon (m)



BALL TRACKING TEST

Full Pitch Difference to Known Positions (m)



Position Difference (m) ● 0.05 ● 0.10 ● 0.15 ● 0.20 ● 0.25

3D ball test methods are in development and will be implemented at future test events.

LIVE TESTING

Applications for live tracking data have increased dramatically over recent years making it important to assess both the quality and the latency of the data. In this test, latency refers to the difference in time between when the data is created and when it is available for use. At this stage, FIFA considers live data to be data that can be used in real time which allows for a variety of different latencies depending on the specific use case. A summary of the two live tests can be found below:

1. Server Upload **Assessment** – this assessment relates to data uploaded in real time (see latency on page 3) that is used for analysis.
2. Pitch Side **Visualisation** – currently this only assesses the ability to deliver live data to a tablet/screen located pitch side and does not test the validity and reliability of said data. Future tests will involve an obligation to take part in the 'Server Upload Assessment' in order to be considered live.

When reading the results, it should be noted that a lower latency does not necessarily mean a better performing system and, at times, latency is added specifically to quality control data. What is important, however, is to understand that different latencies have different use cases and end users should consider this with regards to their specific application. In addition, the participation of a provider in only one test does not necessarily mean that they are unable to provide the other service.

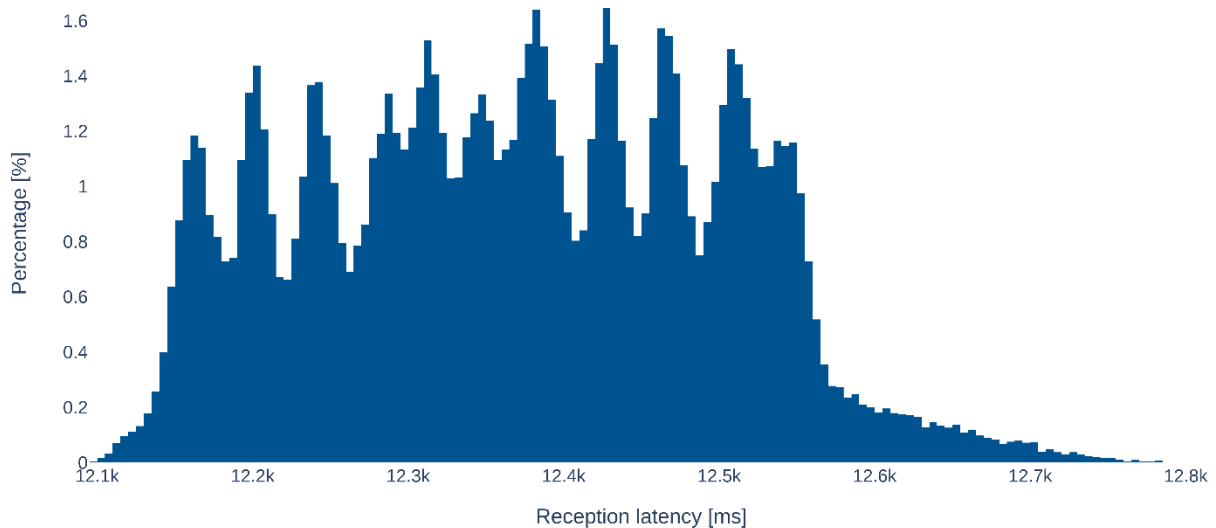
<i>Latency Test Conducted</i>	
<i>Server Upload Assessment</i>	Yes
<i>Pitch Side Visualisation</i>	No

Server Upload Assessment

The data below illustrates the variation in upload latency to an open-source message broker software,

This test method uses an open-source message broker software called Rabbit MQ. Tracking providers upload their live data to the platform, Google/MIT then act as a client and publish the messages to the Google Cloud Platform with a timestamp. The latency of how long the data takes from creation to publication time is shown below; this includes the latency caused by the server itself which has been assessed – the median latency was 11 ms and 99% of the messages were received within 195 ms. This latency value is included in the latency measurement of each manufacturer.

Median reception latency 12370.9 ms



Data Analysis	
Median reception latency	12.370 seconds
99% reception latency	12.663 seconds