Accuracy analysis of 5 Hz and 20 Hz GPS devices for measuring velocity in team sport-specific movement patterns

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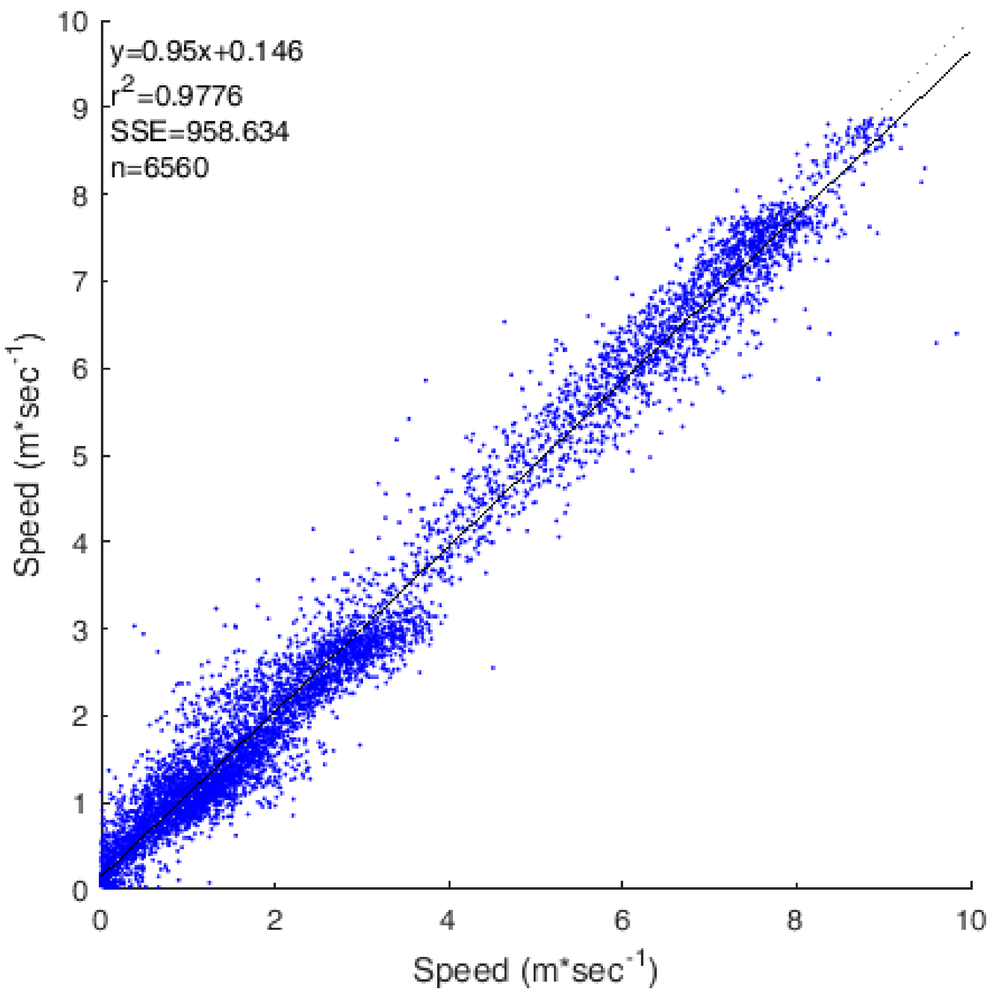
Purpose

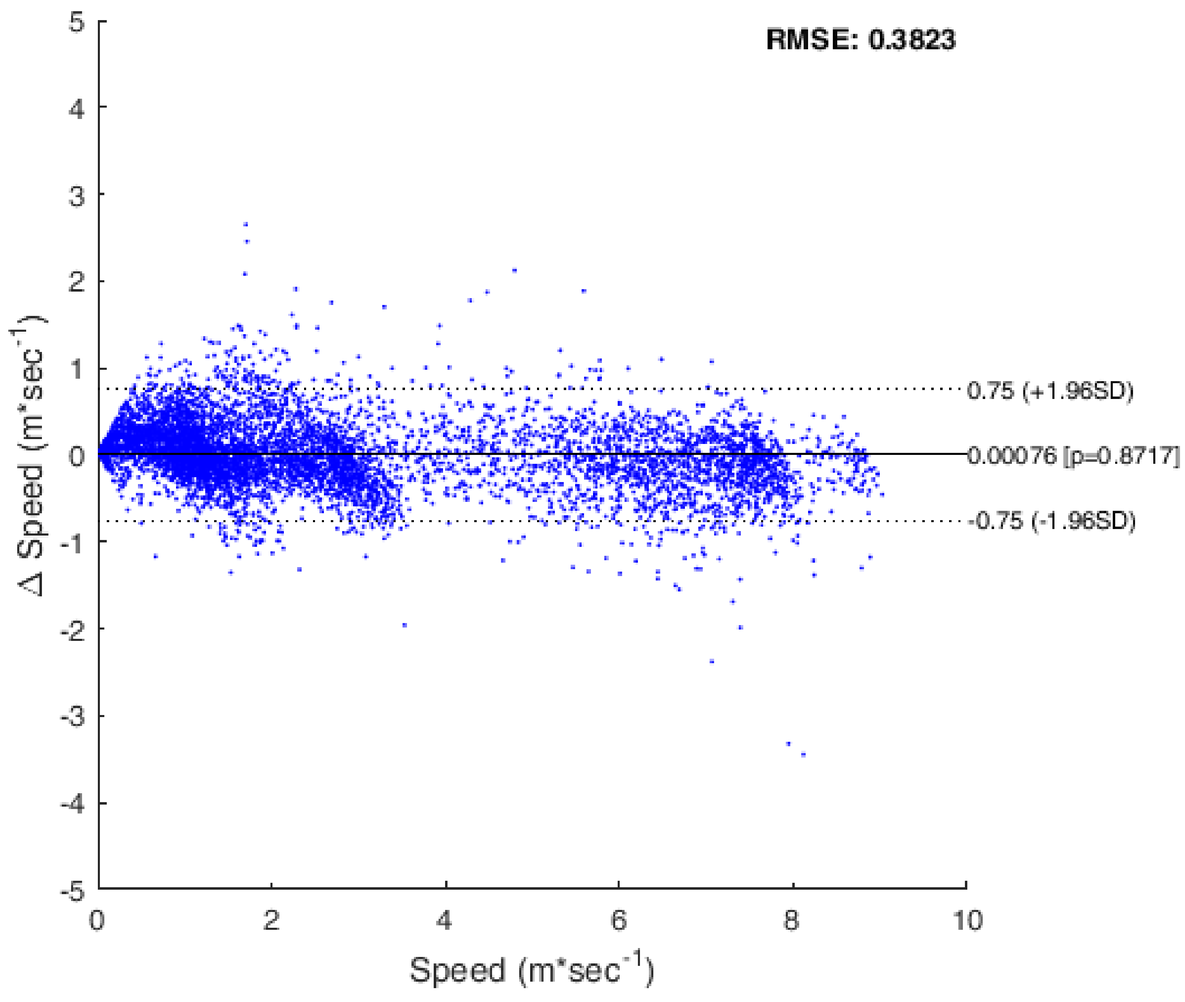
This study aimed to analyze the accuracy of a 5 Hz GPS-System (GPSports, Canberra, Australia) and a 20 Hz GPS-system (GPEXE, Exelio srl, Udine, Italy) by comparing the velocity profiles of sport-specific sprint tests obtained from both GPS units and a reference method (LAVEG Sport, 100 Hz, Jenoptik, Jena, Germany & VICON, 250 Hz, Oxford, United Kingdom).

Methods

Five semi-professional soccer players performed five different straight line sprint protocols (10m, 20m, 30m, 40m and a soccer specific sprint test[1]) as well as a multi-directional 'zick-zack sprint' protocol (4 changes of direction with a 45° angle of 5 meters in length). Measurements from the GPS units and the criterion measure were synchronized post hoc via a least-squares-optimization algorithm. The observed differences are presented by means of the root mean square error (RMSE), sum of squared errors (SEE) and Pearson's product-moment correlation coefficient r. All calculations are based on the processed speed data provided by the manufacturers' software (Team AMS by GPSports and GPEXE web application, respectively).

Results total: 20 Hz (GPEXE)





Correlation (left) and Bland Altman Plot (right) of all GPEXE measurements.

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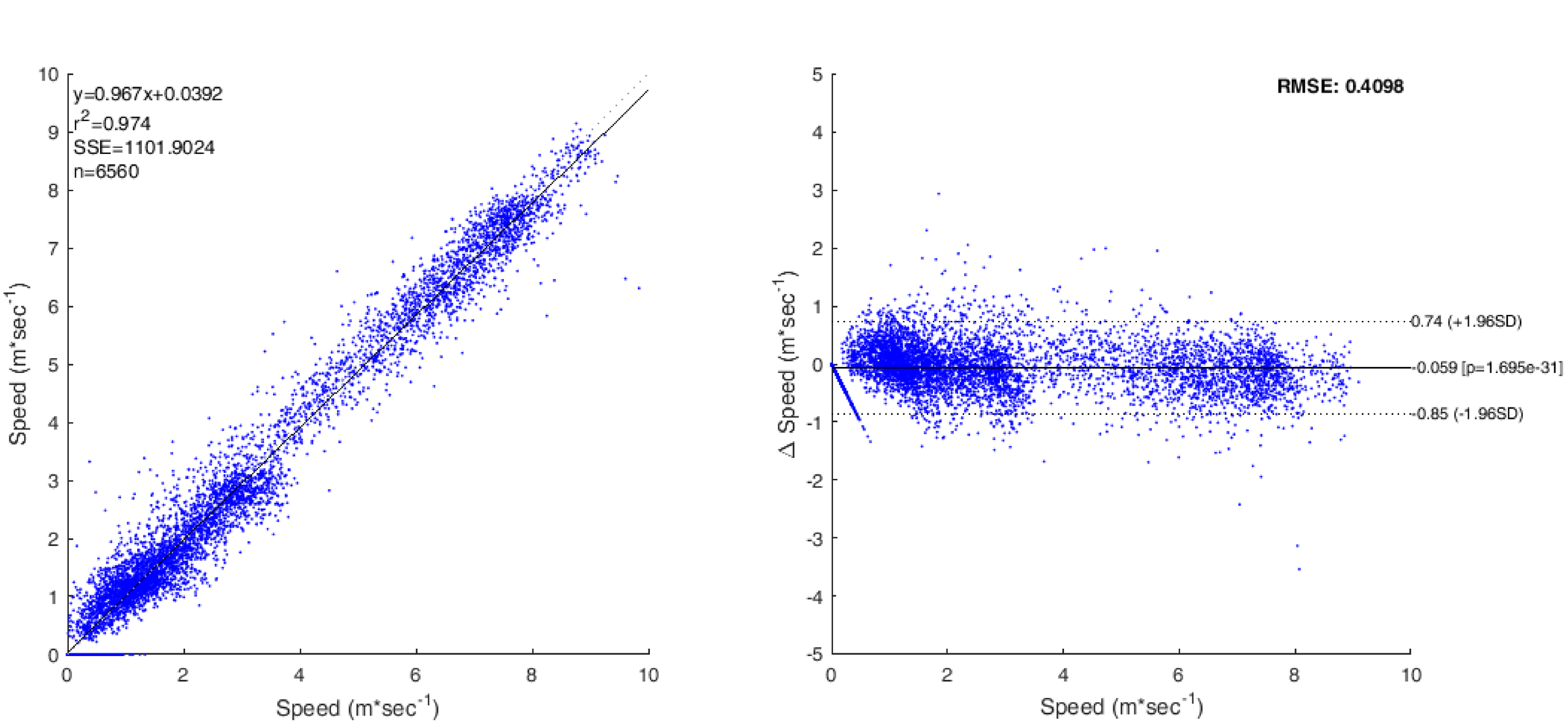
Results: 5 Hz (GPSports)



Correlation (left) and Bland Altman Plot (right) of all GPSports measurements.

Results Linear Sprints: GPEXE vs GPSports

	Correlation (r)		Root mean square error (RMSE)	
Speed Zone	**20 Hz (GPEXE)**	**5 Hz (GPSports)**	**20 Hz (GPEXE)**	**5 Hz (GPSports)**
0-2 m/sec	0,837	0,847	0,492	0,529
2-4 m/sec	0,797	0,766	0,502	0,617
4-6 m/sec	0,794	0,752	0,421	0,457
>6 m/sec	0,870	0,853	0,391	0,422
Total	**0,990**	**0,987**	**0,427**	**0,467**

Accuracy of 20Hz GPS units (GPEXE, Exelio srl) for measuring velocity in soccer specific sprints

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Results Soccer Run: GPEXE vs GPSports

	Correlation (r)		Root mean square error (RMSE)	
Speed Zone	**20 Hz (GPEXE)**	**5 Hz (GPSports)**	**20 Hz (GPEXE)**	**5 Hz (GPSports)**
0-2 m/sec	0,847	0,830	0,291	0,323
2-4 m/sec	0,824	0,795	0,364	0,401
4-6 m/sec	0,839	0,822	0,359	0,377
>6 m/sec	0,692	0,700	0,534	0,539
Total	**0,984**	**0,981**	**0,335**	**0,364**

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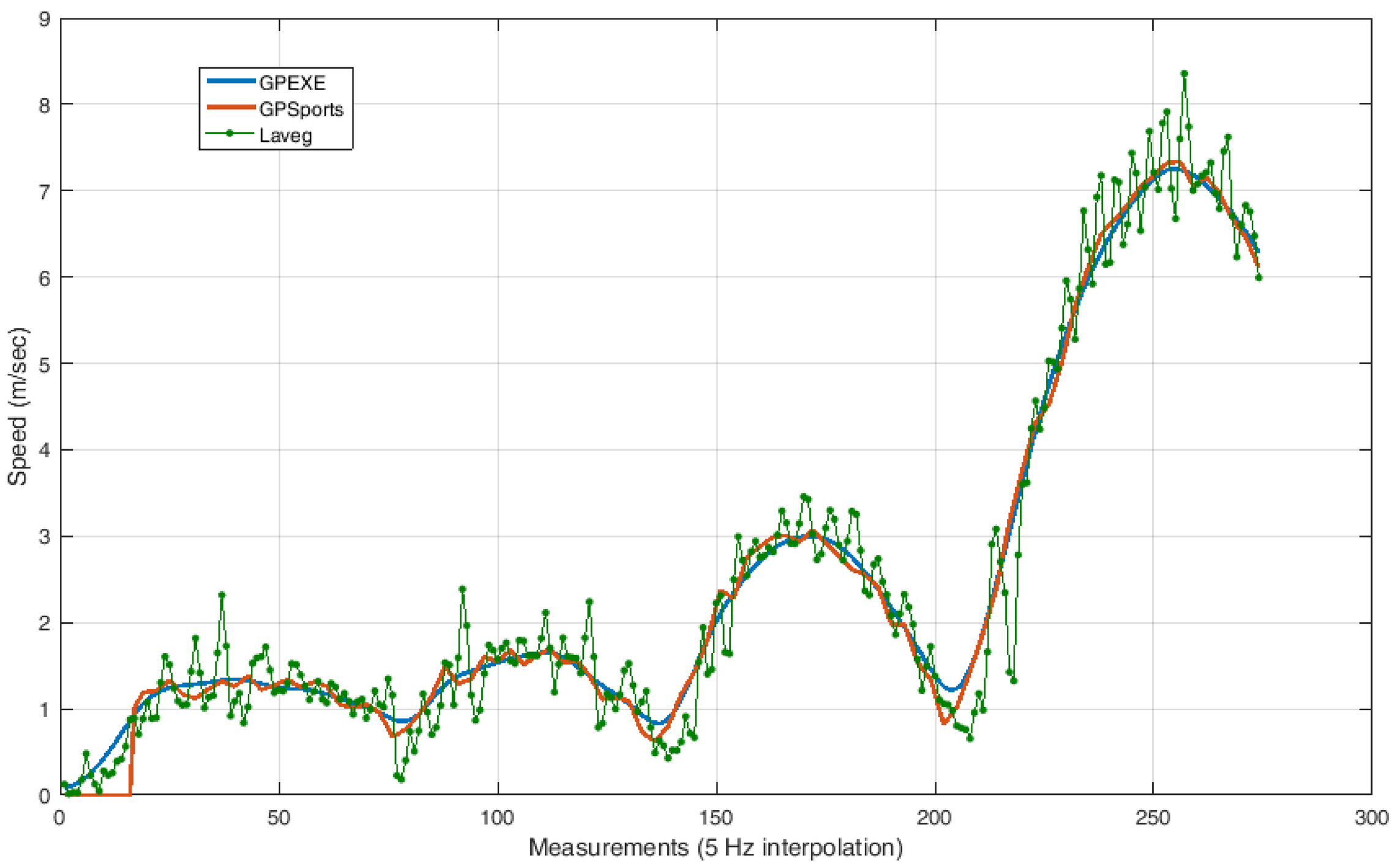
Results: Exemplary Presentation Soccer Run



Comparative presentation of GPEXE, GPSports and LAVEG velocity curves during an exemplary soccer specific sprint run.

Accuracy of 20Hz GPS units (GPEXE, Exelio srl) for measuring velocity in soccer specific sprints

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Results Change of Directions: GPEXE vs GPSports

	Correlation (r)		Root mean square error (RMSE)	
Speed Zone	**20 Hz (GPEXE)**	**5 Hz (GPSports)**	**20 Hz (GPEXE)**	**5 Hz (GPSports)**
0-2 m/sec	0,694	0,640	0,588	0,492
2-4 m/sec	0,735	0,658	0,375	0,538
Total	**0,839**	**0,809**	**0,528**	**0,525**

Conclusions

In conclusion, GPS accuracy increased with a higher sampling rate. Against expectations, accuracy increased with increasing speed for both 20 Hz and 5 Hz GPS systems in the linear sprint protocol. In both soccer runs and change of direction runs however, accuracy decreased with increasing speed, indicating that the change of directions on a small area as well as rapid speed changes tend to represent a greater challenge. Results showed that both GPS systems tend to overestimate velocities at low speeds to a lesser extent whereas velocities at higher speeds are slightly underestimated. Further, this study demonstrated that the 20 Hz GPS (RMSE = 0,382) is more accurate for measuring velocities during sport specific movement patterns compared to the 5 Hz GPS (RMSE = 0,409).

1. Rampinini, E., et al. (2015). "Accuracy of GPS devices for measuring high-intensity running in field-based team sports." International Journal of Sports Medicine **36**(1): 49-53.