Coachtech; measurement and online feedback system

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Summary

Coachtech system has been developed over the past decades at the Vuokatti Sports Technology Unit of the University of Jyväskylä to help athletes and coaches in their daily training and testing as well as scientists to conduct sport research.

Introduction

The aim of the Coachtech has been to develop an online easy-to-use acquisition and analyzing system that combines analog signals with videos and calculates predetermined parameters automatically providing immediate feedback.

Methods

The Coachtech system consists of: wireless measurement nodes (WN), access points, ethernet components, selected network cameras providing RTSP stream, PC equipped with Coachtech software, and web based user interface.

The small and lightweight WN were developed to acquire several kinds of analog signals synchronously and to synchronize the video with the collected data. The WN includes +/- 5V analog inputs, analog-to-digital converter (ADC), microcontroller and a radio transceiver. A 16 bits resolution was selected for the ADC converter to enable sufficient dynamics and resolution for wide board of sensors, e.g., force plates, force sensor instrumented skiing equipment (Zhao et al. 2022), photocell triggers, draw wire sensors, and speed of a treadmill. The radio transceiver conforms to the IEEE802.15.4 with exceptions; over-the-air data rate is extended from 250 kbps to 2 Mbps and the carrier-sense based medium access control (MAC) is replaced by a proprietary one, which is time slots based. The exceptions enable more efficient utilization of the radio channel and thus, collecting up to 28 raw signal channels sampled at 1000 Hz in real-time.

Two alternative versions of WNs (NODE_2CH and NODE_6CH) were developed. Their features are listed in table 1. NODE_2CH is purposed for weight critical applications but having limited battery life. NODE_6CH having larger battery is purposed for the static sensors such as force plates.

Table 1. Characters of the WNs

NAME	WEIGHT [g]	DIMENSIONS [mm]	BATTERY [mAh]	ANALOG INPUTS
NODE_2CH	22 g	14 x 35 x 48	250	2
NODE_6CH	53 g	19 x 39 x 77	850	6

Results and Discussion

The developed system is utilized for several different sports and tests such as cross-country skiing on a treadmill (Figure 1a), vertical jump tests (Figure 1b), biathlon shooting (Figure 1c), and running. In addition to the video and signal graphs, all different use cases contain a set of key variables calculated from the signals. E.g, cycle characteristics in cross-country skiing and shooting technical variables in biathlon shooting.

The most recent feature is a markerless motion analysis that has been validated against high-speed motion analysis cameras using reflective markers (Torvinen et al. 2024).

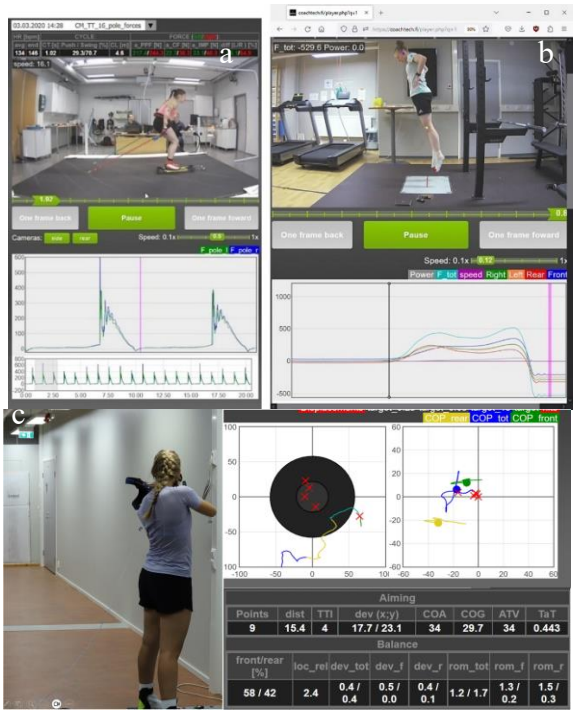

Figure 1: A view of the Coachtech in cross-country skiing on treadmill (a) vertical jump test (b) and biathlon shooting (c).

Conclusions

The system offers additional value to different sports and in addition to the Vuokatti Sport Campus. Overall, the Coachtech is currently at use in eight other locations in Finland.

References

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[2] Torvinen P., Ruotsalainen K., Zhao S., Cronin N., Ohtonen O., Linnamo V (2024) Evaluation of 3D markerless motion capture system accuracy in skate skiing on a treadmill. Bioengineering, 11(2), 136; https://doi.org/10.3390/bioengineering11020136