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miPod – A Wearable Sports and Fitness Sensor

Introduction

Wearable sensors have become an important training tool in fitness and sports for professional and amateur athletes (Armstrong 2007). They can provide individualized and personalized feedback during training sessions and competitions, give an optimal mentoring and can improve the user's personal health status (Bonato 2003). For all applications, the measurement of kinematic, physiological and vital data is of high importance. Therefore, in an extension of previous work on a sensor prototype (Blank et al. 2014) we present the wearable, small and lightweight low power miPod sensor system, which can be integrated into clothing and sports equipment in an unobtrusive way without influencing exercises and performance.

Methods

The miPod (Fig. 1 left) contains a magnetic-inertial measurement unit (mIMU) including 3-dimensional accelerometer, gyroscope and magnetometer as main sensing unit. Additionally, the miPod records temperature and barometric pressure data and is able to precisely measure time using a stabilized onboard clock. This can be used to enforce a constant stable sampling rate and to synchronize multiple sensors. Furthermore, the sensor integrates a low power 32-bit ARM Cortex-M3 microcontroller with on-node algorithm processing capabilities. Measured data is stored on a 1 GB flash memory. The miPod is powered by a small lithium-polymer battery to achieve a long runtime. Charging and data transmission is realized by a wired USB connection. Battery and circuit board are combined in a printed polymer case, which corresponds to the dimensions (about 35 x 25 x 8 mm) of the adidas miCoach SPEED_CELL and its appropriate cavities (Fig 1. right). This allows sensor integration into clothes, shoes and sports equipment in a fast and easy way.

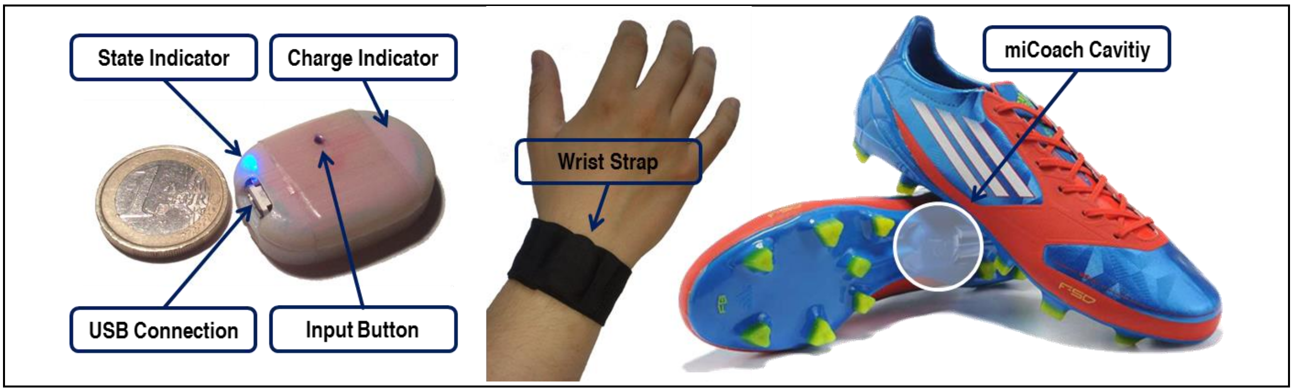

Fig.1: Left: Complete miPod sensor node showing LED indicators (state and charging) input button and USB connection. Middle: Wrist strap for sensor attachment. Right: miCoach cavity inside a soccer shoe.

Results

The miPod can measure all nine mIMU (accelerations, angular velocities, (earth-) magnetic field) axes, barometric pressure data and temperature as well as a time stamp for each data sample. On the one hand, all mIMU data can be recorded at 1300 Hz over 20 hours. On the other hand, it is possible to realize long-term activity monitoring at lower sampling rates with reduced data channels over days or weeks. Accelerometer ranges (±2 g to ±16 g) and gyroscope rates (±125 °/s to ±2000 °/s) can be chosen easily for each application. This versatile measurement ability combined with the further reduced size enables new possibilities in detailed kinematic analysis during highly dynamic motions in comparison to commercially available sensors used in sports and fitness research. There are different ways to attach the sensor to the athlete's body or to sport and fitness equipment. It can be integrated in straps of different sizes, e.g. on the wrist (Fig.1 middle), ankle, hip or chest. Furthermore, the sensor can be put into miCoach pockets of fitness shirts or it can be inserted in cavities of miCoach applicable sports shoes (Fig. 1 right).

Summary and Outlook

In this contribution, we presented the miPod sports and fitness sensor. It is able to measure kinematic motion including barometric pressure data and temperature while providing accurate timing. The sensor can be worn easily using straps or as part of the athlete's clothing or equipment. This system is currently used in different studies and research projects to proof its on-node processing algorithm and data fusion capabilities along with the validation of its signal quality. In the future, this system will be used to recognize the athlete's activity, to provide feedback during training sessions and competitions, to act as data interface for exergames, to improve the user's health and to help avoiding sports and movement injuries.

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References

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