

VISUALIZATION IN SPORTING CONTEXTS

The Team Scenario

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Abstract: Wearable sensor systems require an interactive and communicative interface for the user to interpret data in a meaningful way. The development of adaptive personalization features in a visualization tool for such systems can convey a more meaningful picture to the user of the system. In this paper, a visualization tool called Visualization in Team Scenarios (VTS), which can be used by a coach to monitor an athlete's physiological parameters, is presented. The VTS has been implemented with a wearable sensor system that can monitor players' performance in a game in a seamless and transparent manner. Using the VTS, a coach is able to analyze the physiological data of athletes generated using select wearable sensors, and subsequently analyse the results to personalize training schedules thus improving the performance of the players.

1 INTRODUCTION

Pervasive sports monitoring systems represents a paradigm shift in sports science. Recent advances in wireless communications, low-power integrated circuits, sensor design, and energy storage technologies have enabled the deployment of wearable sensors in sports monitoring, thereby gaining a more accurate picture of athlete performance.

Athletes, coaches and sport scientists are constantly searching for clues that can enhance performance. Traditionally, a range of laboratory-based technologies have been harnessed for physiological measurements. However the performance of athletes in competitions will differ from that observed in controlled laboratory environments. Pervasive sports monitoring systems measure physiological parameters in training and competition (subject to the rules of the sport in question). Such systems use wearable sensors to measure physiological parameters and wireless communication technologies to transmit the measurements back to base stations for analysis. Examples of these measured physiological parameters include heart rate, body temperature, respiration rate, and blood pressure. Wearable sensors can be woven or knitted into an item of clothing and worn next to the skin without disturbing the comfort level or concentration level of an athlete during competitions (Nicolau, 2010).

Physiological monitoring systems generate signif-

icant quantities of data. Visualizing this data such that coaches can make tactical decisions in real-time is an ongoing research challenge (Bertin et al., 2010). In this paper we present Visualization in Team Scenarios (VTS) to monitor physiological performance of players.

This paper is organized as follows: Section 2 presents related research in the area of wearable physiological monitoring systems. Section 3 describes the architecture of VTS. Section 4 identifies some future research directions after which the paper is concluded.

2 RELATED RESEARCH

Wearable physiological monitoring systems for use in sports scenarios are under development in various research labs. The Smart Vest (Pandian et al., 2008) is capable of monitoring a number of vital parameters such as ECG, PPG, heart rate, and GSR in a comfortable and transparent manner. The physiological data monitored by Smart Vest, along with geo-location of the wearer, is continuously transmitted using RF links to a remote monitoring and analysis station. Analysis of all the measurements are carried out in real time and presented in an appropriate format at the station. Validation was carried out to check the consistency and reliability of the data from Smart Vest as

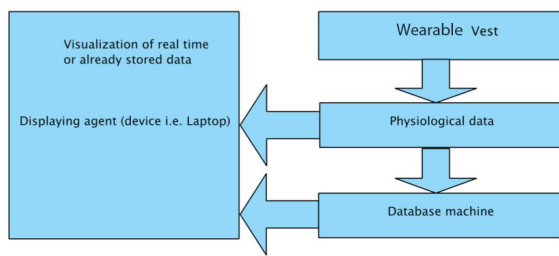


Figure 1: The general architecture of VTS.

compared to standard measurement methods. This has shown varying degrees of success in achieving the necessary accuracy on all measurement combinations.

Another system, called wearable sensors (Coyle et al., 2009) (Carpi and DeRossi, 2005) for monitoring sports and training performance operates by measuring and analyzing sweat pH and sodium levels during exercise. Sweat composition can change during exercise as a result of dehydration. Dehydration is a major issue while training, and it results in symptoms such as headache, dizziness, cramps, vomiting, increased heart rate and so on. The pH and sodium levels of athletes can indicate more about body condition. Analysis of these levels can assist athletes in developing personalized hydration strategies to increase performance. Since the electrodes were integrated in-house using Teflon rods and PVC tubing, the resultant system was not comfortable to wear.

SensVest (F. et al., 2005) measures a person's physiological signals, and transmit them to a remote base station. This research project was specifically designed for the use of science teachers and students. SensVest maintains a number of different sensors on an athlete's body at all times during an exercise to estimate the performance.

In the personal exercise domain, Wan et al (Wan et al., 2009) have described the Ambient Exercise Monitor. This system harnesses physiological data for monitoring what energy is expended in course of personal exercise.

Though significant research has taken place, the issue of visualization of physiological parameters in sporting contexts has received little attention. Likewise its use as an aid to decision making has not been explored to any great extent. In an effort to address this issue, we have developed VTS (Visualization in Team Scenario). VTS focuses on aiding the interpretation of captured physiological data through the provision of an interactive and intuitive interface.

3 SYSTEM OVERVIEW

VTS allows a coach to analyse physiological data subsequent to its capture. VTS is based on wearable vests that are equipped with appropriate wearable sensors. These vests capture the physiological parameters of the players. The generated physiological data is sent wirelessly to a base station. There, it is stored in a database for later analysis.

3.1 Architecture

There are three basic components of VTS: Wearable vests, Database server, and interface screen (in our case we have used laptop). The general architecture of the system is illustrated in figure 1.

1. A wearable vest is used to collect physiological parameter of wearer's body including players' heart rate, respiration rate, skin temperature, and GPS data. This data is transmitted in real time to base station, which may a laptop or workstation.
2. A database system receives the physiological data from the vests, forwards it for display and stores it.
3. An interface component provides an interactive graphical user interface to the coach who can personalize the display if required.

3.2 Implementation

A prototype wearable sports vest with embedded sensors was acquired. The base station was connected to a laptop which in turn hosted the database and visualisation components. The core components were all implemented in the Java. However, visualization is implemented in the Processing Development Environment (Fry and Reas, 2010). This environment is available as open source under the GPL. Processing has evolved into full-blown design and prototyping tool used for large-scale installation work, motion graphics, and complex data visualization.

3.3 Operation of VTS

VTS operates as follows:

1. All players that a coach wishes to study are equipped with the vests.
2. The coach requests physiological data from the vests. The base station then scans an area of about 100 meters in diameter, and returns a list of available vests. The coach then associates the vests with individual players.

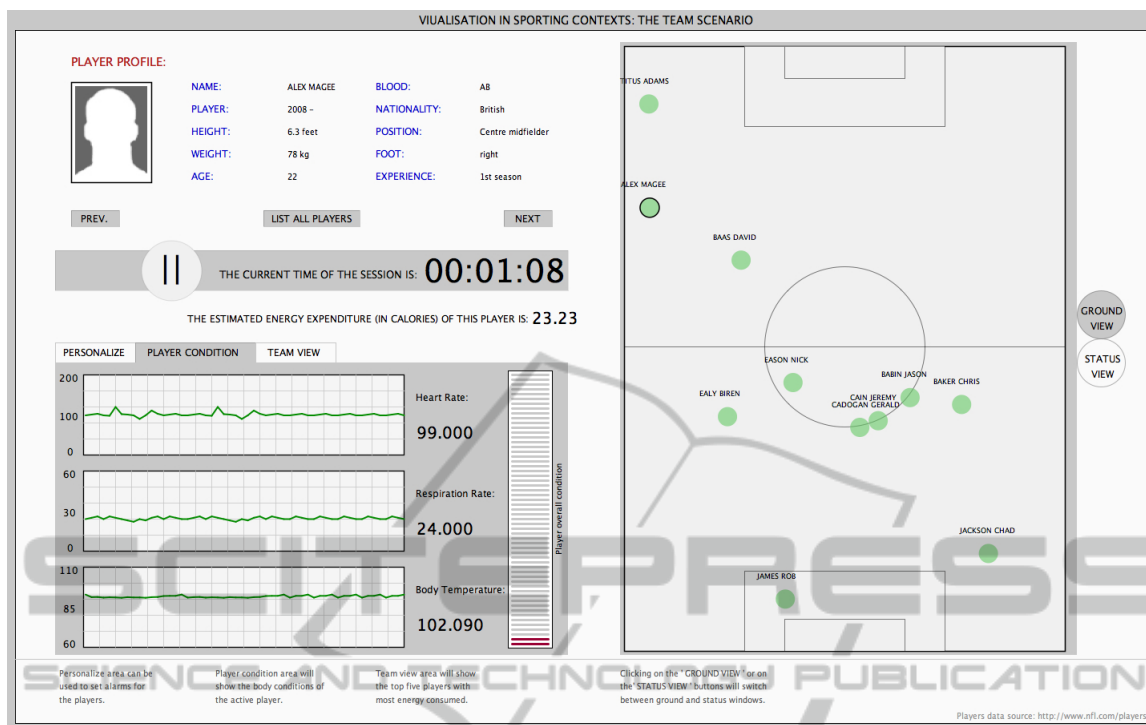


Figure 2: Standard VTS interface showing various parameters.

3. The data is collected and stored over the course of a training session or game.
4. The coach can then access the data and visualise it as they see it (Figure 2).

One interesting feature of VTS is its support for alarms and thresholds. A coach can set thresholds for different parameters e.g. heart rate. Once the alarm values are set, the coach can start analysing the physiological data received from vests. Should an athlete's heart rate exceed a certain threshold, the coach's attention will be directed to this, and they can analyse prior and subsequent parameters more carefully (Figure 3).

4 FUTURE WORK

Though data is captured in real time, the current version of VTS does not adequately support real-time analysis. It is planned to enable visualisation of the data in real-time. More sophisticated analysis tools are planned. For example the recovery time of an athlete is vital in team sports as this is an objective indicator of how tired they really are. It is intended to develop algorithms for measuring recovery time and other performance indicators in real time.

5 CONCLUSIONS

This short paper presented a prototype visualization tool for wearable sensor systems to monitor the performance of athletes. It is the authors' contention that VTS (and similar systems) represents a key development in sports performance and coaching. It is probable that many sports in the future will integrate a range of sensors for monitoring athlete performance whilst in competition. This will have significant implications for coaches, sports scientists and of course the athletes themselves.

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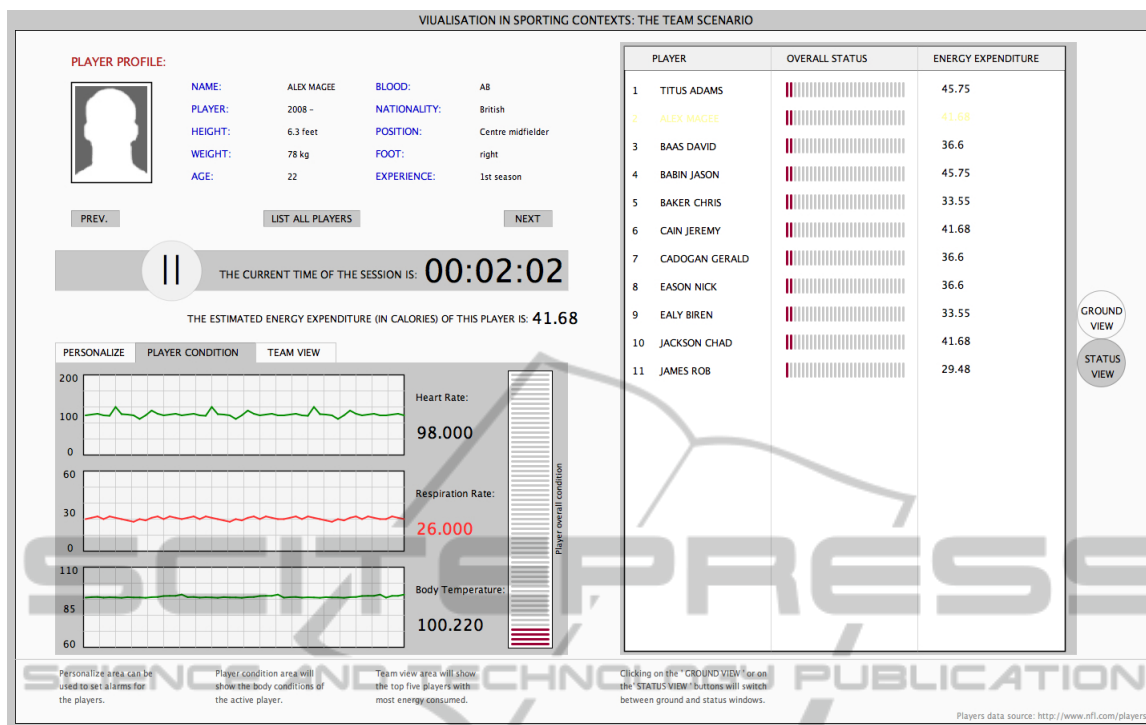


Figure 3: VTS after an alarm has has been generated.

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