Smartphone Recommendation System to Prevent Potential Injuries in Young Athletes

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Abstract. Over the last decades web and mobile technologies are increasingly being used in sports, especially in soccer, but none of them seems to allow to prevent injuries. However, training systems for young athletes do not have, for the most part, learning abilities in order to adapt, evolve and find new training recommendations. It is in this context which the Smart Coach project is presented in this work, and whose main goal is to introduce our mobile training recommendation system allow to young athletes evolve. The training mobile recommendation system is also designed to identify potential injuries risk for each young athlete.

Keywords: Mobile health application · Prevent injuries · Recommender systems

1 Introduction

Information and Communication Technologies (ICTs) namely mobile technologies are increasingly being used in the sport, especially in football, aiming to help the coaching team, enhance athletes training methods, improve the team results or support sports decisions and refereeing. However, training systems, for the most part, don't consider preventing potential injuries in young athletes' considering their characteristics, technique, tactics, physical and mental status, in the training selection and recommendation process.

Additionally, these systems do not use artificial intelligences techniques in order to adapt, evolve and find new training recommendations to allow the young athletes to evolve or to prevent potential injuries. These limitations render the systems results, inadequate, and unfocused on the players needs and specificities. The *SmartCoach* recommendation system intends to fill this gap, expecting to innovate and make impact, using user modelling and recommendation techniques and mobile technology. This adds support to coaches and technical staff,

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allowing them to analyse better their young athletes' skills and enhance their development and training. In this paper we introduce the *SmartCoach* web mobile system. It allows to represent technical, tactical, physical and/or psychological characteristics of young athletes, and adapt a Dynamic Training Model, defining a training schedule to improve a young sportsman performance, targeting is evolution as a player and to prevent potential injuries.

2 State of the Art

2.1 Recommender System

A Recommender System can be characterized like a collection of different techniques and methods used by different applications or systems to filter and organize their items, in order to select either the best ones or the most suitable ones, according to the user profile [6].

Health Recommender Systems (HRS) are becoming an important tool in health decision making processes in healthcare services [1]. HRS increase usability of technologies and reduce information overload in healthcare decision processes [1].

The mode of operation normally used by recommender systems is to use the user profile as the basis for a series of calculations to infer which are going to be, amongst all the items available, the ones that will better please the user, according to a wide variety of approaches [7].

Recommender systems are essentially based in three types of paradigms (content, collaborative and knowledge-based) and all their possible combinations [3–5,8].

2.2 Context-Awareness Computing

Context-aware computing is a paradigm where applications and services use environmental information to provide relevant information and/or services to the user. The concept of context has been researched over the last decades in software engineering, especially in areas such as Natural Language Processing, and more generally in Human-Computer Interaction. Context makes the interaction with computers easier by adapting the information to the user, discriminating what is relevant and what is not, so that the user in human-machine interactions can focus on high-level tasks, which is very important in scenarios of information overload, especially as we move towards a world of ubiquitous and pervasive computing and the Internet of Things.

Even though the term "context" has been addressed many times in the literature since the 90s, it is still difficult to understand as sometimes there is not a clear boundary between what is context and what it is not. One of the most widely cited definitions for context was proposed by Abowd and Dey (Abowd, 1999), with the following statement: "Context is any information that can be used to characterise the situation of an entity. An entity is a person, place,

or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves."

Abowd and Dey (Abowd, 1999) identified four context information types that can be considered more important than others and called them "primary context". They answer basic questions like who (Identity), where (Location), when (Time) and what (Activity or Status). Additionally, they considered "secondary context" any relevant information that can be derived from primary context.

3 *SmartCoach* Web Mobile System

The *SmartCoach* web mobile system (Fig. 1), with learning capacity, was implemented to facilitate the interaction between members of a club technical staff, medical staff and their young athletes, reinforcing the young person counselling, and their potential as an athlete.

The system allows young athlete performance evaluation, considering several attributes (Fig. 1). The data is collected in an intuitive and adaptive manner, using a friendly mobile interface.

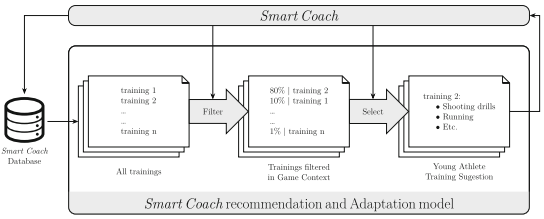

Fig. 1. Smart Coach recommendation and Adaptation model

The *SmartCoach* system, is designed and implemented using an innovative hybrid recommendation algorithm, which allows to relate the representation of the technical, tactical, physical and/or psychological characteristics of the young athlete, with a model of dynamic training, in order to identify and prevent injuries risks, customize training and improve skills that the athlete has some deficit. The application is aimed mainly for young athletes and is now being used in a small club youth academy for their soccer players data collection.

3.1 Smart Coach User Profile Modelling

The athlete profile model is used, to identify the most appropriate training to fulfil young athlete training necessities and to prevent injuries. The *SmartCoach* User Modelling solution involves initially the definition of stereotypes for young athletes. These stereotypes were defined during interviews with several football coaches. Also, we are using the K-Means [2] clustering algorithm application to data obtained during matches and training of several football academies in Portugal. Each cluster was classified with a set of attributes, with diverse weights

and mapped according to their relevance in training, and their influence in football tactics and team performance. The clustering outcome is the young football player profile, e.g., goalkeeper, defender, midfielder, striker. Each cluster has a user type, which is classified with several types of attributes/tasks that typically has to perform during a football match. Also, a personal health record is implemented for each young athlete with the goal to supply medical information.

3.2 Context-Awareness Approach

Finding proper patterns and accurately predicting the potential injuries *SmartCoach* can provide better recommendation. Here context has an important role, because the football player behaviour may be influenced by the context (i.e. football boots, pitch types, weather conditions, etc.).

From alerting and warning situations, to special events in the state of the football match, *SmartCoach* can predict several scenarios where the use of context awareness (i.e. football boots, pitch types, weather conditions, etc.) could be relevant to deliver the right information, at the right moment, to the right person with several recommendations to prevent potential injuries.

3.3 *SmartCoach* Injuries Matrix

This tool has components to present data in a matrix format, created from various variable context-awareness groups and the aggregation of information related to frequent injuries in young football players. Also, the injuries matrix construction allows us to produce statistical knowledge presentation. This information helps to support decision-making and the acquisition of data-based knowledge.

3.4 Training Determination Process

The training determination process intends to infer, based on the young athlete state, captured at a certain point of time, the set of training exercises the athlete should execute in the same time window (Fig. 1). This information allows the determination of relevant workouts, appropriate to actions being performed. The action being performed recognition can be an uncertain and imprecise process. The observation of athlete's actions may not have an objective evaluation, and as such, may result in inaccurate conclusions.

In *SmartCoach* web/mobile application, the training exercises, are associated with defined stereotypes in the young athletes' models. The parameters function regarding the young athletes' performance attributes, such as the training and necessary steps to complete it successfully or the context awareness variables like the type of boots, pitch surface/quality and weather conditions. For each stereotype a hierarchical set is defined, that associates all the trainings that are within its competence and the relations between them are represented.

In view of the initial catalogue of all possible training sessions, the adaptation model (Fig. 1) will initially, use the user's stereotype information and

the attributes considered relevant by the coaching and medical staffs to perform/apply our filtering algorithm. This will allow, for example, that only trainings related to young athletes' actions and goals are considered. Hence, an ordering is made according to the probability of each activity being performed at a given time from among all possible, using data such as the expected course of training and young athletes' personal performances and injuries history.

4 Conclusions

In this work is considered that the best way to please users is to suggest trainings that can improve their abilities or prevent injuries. The first version of the data collection prototype is being evaluated in two football clubs' academies, which we will designate by club A and club B. The study will run over two months in two teams: one from club A and one from club B. The athletes age is between 15 and 18 years. None of the athletes and staff had any experience using mobile applications to support training. However, they are familiar with mobile apps and personal computers (PCs), namely, social networking and playing videogames.

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