Gamification of a System for Real Time Monitoring of Posture

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Abstract. In this paper the gamification of a system for monitoring bad postural behavior is presented. The system is designed having children as main target users. Bad posture is a known cause of possible severe disorders in childhood and, in the worst-case scenario, may entail permanent spinal deviations. The developed system consists of two main components: a device equipped with inertial sensors (accelerometer, magnetometer and gyroscope), which are able to measure the patient's spinal curvature, and a Game Engine plugin (Unity3D and Udk) that provides the reading of the device data and through which the game programmer can link the posture information to a game variable such as: life count, number of enemies, energy and so on. If the player is in a bad posture, he gets negative feedback during the game, which affects the value of the associated variable.

Keywords: Posture · Inertial measurement unit · Serious game for health · Game engine plugin

1 Introduction

Bad posture attitude is one of the main causes of backache which can easily degenerate into more severe disorders, especially in childhood. Giving a feedback about the posture maintained during a class, for example, we can reduce the amount of ache complained by students [1].

In general, completing and wrapping a product (e.g., a medical device in the present case) in the form of a game (usually called serious game) is expected to sensitively improve its attractiveness, especially if it is aimed at children [2]. And serious games for improving people wellness are becoming very popular [3].

The structure of this document is as follows: Sect. 2 introduces the main features for a method for recognizing bad postures and shows the related state of the art. Section 3 presents the project, describing both the hardware elements and the developed algorithms. In Sect. 4 the advantages deriving from including some typical aspects of gamification. are discussed and a related plug-in is described. Section 5 provides the conclusions and illustrates future work.

K. Giokas et al. (Eds.): eHealth 2016, LNICST 181, pp. 164–168, 2017.
DOI: 10.1007/978-3-319-49655-9_22

2 Postural Attitudes Monitoring and State of the Art

In order to develop our project, a device able to monitor postural habits suitable for an everyday life environment (e.g. in a school or in an office) is needed; the latter should be non-invasive, not restricting nor altering the user's motion in any way. Nowadays, a lot of systems have already been proposed but no one has at the same time all three features we want develop. The main techniques for analyzing human posture use camera and optoelecronics sensor; they has a high precision, but their employing is restricted to a controlled environment [5]. Another method of analysis realizes the procedure using an electromagnetic tracking system, but the presence of metallic objects during the measurements can alter the results. The last system examined is based on potentiometric goniometers, but it restricts the patient's movements (Fig. 2).

3 The System

On the basis of the previous considerations, we decided to implement a system based on inertial sensors composed by a three-axis gyroscope, a three-axis magnetometer and a three-axis accelerometer. These sensors measure the orientation of a rigid body in the space in terms of its Euler angles with respect to a fixed system of reference. Accelerometers and gyroscopes are already been used for monitoring the spine position of a human being [4–7].

However, our system makes use of a further component (a magnetometer) in order to avoid the drift problem, typically caused by gyroscopes.

Our system may be divided in two separate parts, the former being devoted to measure the patient posture and the latter analyzing the data and allowing the user interaction. The two elements are able to communicate each other by means of a Bluetooth connection (Fig. 1).

The device equipped with sensors is composed by an ST iNemo module [8]. This module contains different kind of sensors, including inertial sensors we need. It has also a microprocessor able to filter sensors data and compute Euler angles.

The analyses of the user's posture is realized using two devices, built as we have descripted previously, placed in different spots of the user's spinal column. One of them, called master, provide the data transmission via Bluetooth, in addition to its measuring task, The second Inertial Measurement Unit (IMU), called slave, can only obtain and elaborate data from the sensors, and send them to the master using a wired connection.

The system architecture is designed to quickly change the number of IMUs employed, improving the measurement precision. The graphic user interface (GUI) is designed to run on an Android device. The device connects with the sensors through the Bluetooth protocol and it can update the GUI according to the received data, so the user can see a view of his position in real time. The mobile device is able to warn the user while he's keeping an incorrect posture in three different ways: a graphical one (Fig. 3), an acoustic one, and a haptic one. The data about a session can be stored within a database, allowing the user to analyze them at a later time.

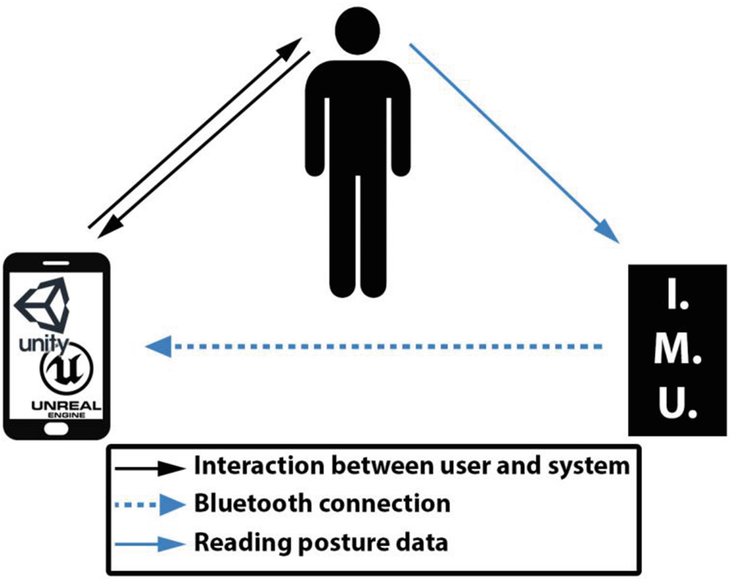

Fig. 1. System components relation

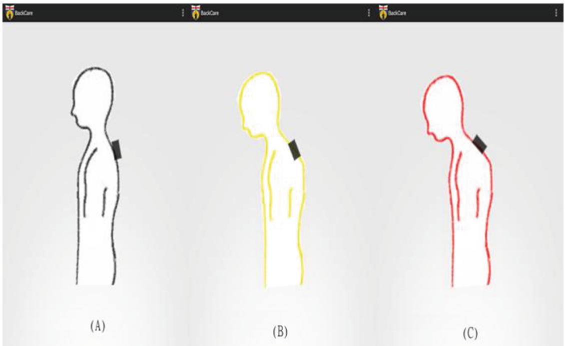

Fig. 2. Graphic User Interface: (a) Correct curve; (b) Medium curve; (c) Wrong curve.

Finally, the master IMU have to send data to a Unity3D plugin, which will be describe more in detail in the next section.

4 Improve Postural Habits with a Social Game

An aspect that has been considered in studying our system is the great achievement that social games have obtained in the last few years. A lot of studies show that the possibility of sharing results in a community makes a system more engaging [9–11].

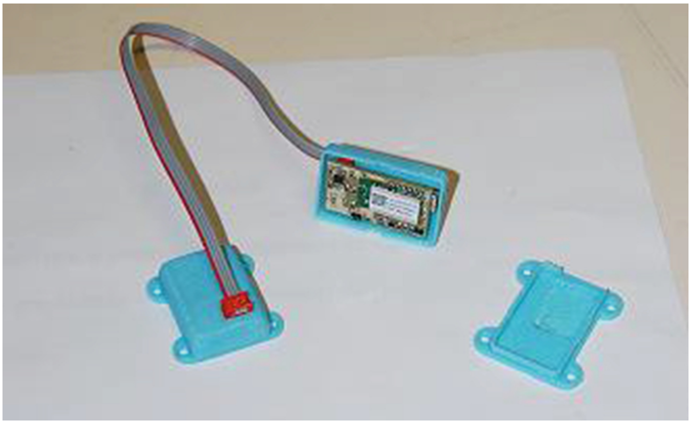

Fig. 3. The system hardware prototype.

This is an aspect applicable to every kind of goals reached by the user, who is nowadays accustomed to share his life events through social networks.

In the light of the above argument, we decided to develop an Inertial Measurement Unit (IMU) connection plugin designed for the two most popular game engines which are widespread within both the indie developers' community as well as big companies: Unity3D and Udk.

The plugin encapsulate the posture sensor and thus sends a value representing the correctness of the player's posture to the game which uses this information in a way that the game designer deems suited. As an example, the player's bad posture may be set to cause the game life bar to decrease more rapidly even in the absence of negative game events, such as the presence of enemies. The game designer may also, or alternatively, decide to correlate the plugin's signal to the enemies' generation, thus entailing a more difficult game experience when the player's posture is not correct.

Taking the player's posture into account, the value sent by the plugin is an accumulator which is:

- incremented by one every minute spent in a correct position
- unchanged every minute spent in a partially incorrect posture
- decremented by one every minute spent in a bad posture

If directly associated with a variable used for computing the overall game's score, the value delivered by the plugin could be also used to give game points to the players.

5 Conclusions

Preliminary experiments conducted in lab have shown the validity of the approach, both for the precision in measuring the posture and for the feedback given to the user.

In order to verify the real impact of our device, we have developed a social game exploiting a plugin, that delivers to the game the posture assessment provided by the device. The experiments conducted so far have left us quite optimistic about the results our system could give but, the real impact on social games is still to be analyzed in depth.

The next steps of our research will involve a partnership with a school through which we could test the system on a significant number of subjects. The general idea we propose is to split up the students in two groups: the first one should use the system as a game, with the opportunity of sharing the results and comparing them with other gamers; the second one should use only the real time feedback mode, without the gamification component. For this experiment we expect better results from the students' member of the first group, according with the theory explained beforehand.

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