VIRTUAL REALITY GAME BASED PHYSIOTHERAPY SYSTEM USING KINECT SENSOR

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Abstract: “Nowadays, the unhealthy behaviors of the people are seen around us. Without proper and sufficient exercises, the degradation of the health has become a common problem. Irrespective of knowing this fact people still don’t change their approach towards leading a healthy life. Some don’t get time to go to gym or walk or to do little exercise while others find it hectic to do so. For such problems, this paper provides an idea to inspire people to do some exercise with entertainment. With this approach, people enjoy the exercises with little fun. The main goal of this particular approach is to develop a Virtual Reality (VR) game on android which receives the information through MPU6050 sensors and the same actions are reflected in the game. This game has different levels whose actions with different number of exercises like arm exercise, leg exercise, neck exercises are included. Therefore, by playing this game on different levels the person performs the daily exercise at home with enjoyment and calculation of calorie is enabled. This helps in the mental refreshment of the user along with the benefits of exercise. Through this approach, one can inspire the people to stay healthy and to lead a healthier life with entertainment”.

Keywords- Arduino, MPU6050, Virtual Reality

1. Introduction

Just as exercise creates a number of positive effects in the body, a sedentary lifestyle creates negative effects. Lack of exercise affects the heart, lungs, blood sugar levels, joints, bones, muscles and mood. It may even play into the development of other heath conditions such as cancer and mental decline. Not exercising affects your ability to control the weight. One of the most common reasons people give for not exercising is that they're too busy and don't have enough time. People often make time for the things that they think truly matter in life. Once a person has some of the biggest consequences of not exercising, the perspective on the importance of exercise may shift and person may suddenly find themselves wanting to spend more time working out and investing on future health.

2. Literature Survey

A sedentary lifestyle without proper and sufficient exercises is an unhealthy behavior that can lead to obesity and other chronic diseases. People who realize the danger of this behavior are normally reluctant to change because of their long-established habits and lack of motivation. An approach that has been successfully applied for encouraging people to initiate their exercise routine or perform a more physical activity is the use of exergame. For the past few years, exergames have been used as a tool for encouraging people to have more exercises for their good health. An exergame is a computer game that is aimed to promote more physical activities by providing motivational support to people via a combination of gaming entertainment and exercise regimes.

Another important aspect of exergames is the type of motivational support that is used to persuasively inspire people to change their long-established inactive lifestyle to perform some physical activities. The extent of physical challenge is considered as one of the most critical factors in designing motion-based games. There have been studies about the relationship between the level of physical challenge and how much fun a game offer. While it is found important to appropriately set the physical challenge level, in
current practice the setting is usually done manually and tested by a trial-and-error approach, which is non-trivial, tedious and largely dependent on the experience of the level designer.

The main aim is to create a Virtual Reality (VR) game for different age groups to inculcate the habit of enjoying light exercise with fun by making the use of motion sensing inertial sensors and associated algorithms for its analysis and demonstrates how exercise intensity considerations can be incorporated into the automatic synthesis of a game level. This approach is to develop a VR game on android which will receive the information through motion sensors and the same actions will be reflected in the game. This game has different levels with actions are reflected with the different number of exercises like arm exercise, leg exercise, neck exercise. Therefore, by playing this game on different levels the person can do the daily exercise at home with enjoyment and calculation of calorie is done. This helps in the mental refreshment of the user along with the benefits of exercise. Through this paper, people are inspired to stay healthy and to lead a healthier life with entertainment.

3. Requirements Analysis

Designing a Virtual Reality game using wireless body sensors to track the body motion and reflect the same in gaming where it measures the gained health in terms of calorie count. The probable users of different age groups can enjoy gaming and also do the relative exercise related to that game. The user gets incredible experience of game with the help of Gear VR and animate digital character models in 3D with the help of motion sensor. The game is processed in a series of level where each level is associated with some exercise.

A. Motion Capture: In order to track the motion of the body mocaps are used. They offer considerable advantage over the traditional system. Firstly, the user provides low latency and close to real time results are obtained. Secondly, complex movement and realistic physical interactions are easily recreated in a physically accurate manner. Also, the amount of data that produced within a given time is extremely large.

B. Body Motion Analysis: The motion of body segment to be considered for action in gaming is detected by angular motion of sensor around the rotation point. The detected real time information is transmitted using Wi-Fi wireless transmission module to designated system for analysis. The information of motion is captured by the sensor nodes attached to the different body segments. The biomechanical model is considered during identification of target body segment for sensor node.

C. VR And Game Development: VR provides the compatibility for phones that follows the platform’s software and hardware specifications. On-board sensors are used to track position of the users. Unity 3D is compatible for designing 2D or 3D games where primary scripting API are provided. Software cycle is used for development of games where different levels are present according to the body moments.

D. Calorie Calculation: Virtual reality games require full body motions, causing a certain amount of fatigue. The player could quickly feel exhausted if the levels are not designed well, which may prompt him to stop or quit the game. Balancing the exercise intensity level and the fun factor of the game is challenging. This approach demonstrates how exercise intensity considerations can be incorporated into the designing of a game level.

4. Requirement Specification
For playing the game through various levels the player first needs to register and enter various details. The player can start from the beginning or proceed from the past progress. The sensor conveys orientation data which is reflected in the game. Also, the pedometer algorithm is used to calculate the calorie burnt while playing the game. The calorie count is then reflected in the form of scoreboard at the end. First the player must know how to connect the device with the VR. The player needs to enter the following details before playing the game: Create a valid username, Create password. All this information will be needed to login in the system and to save the game progress. Also, the player needs to enter the following details at the time of registering: Height, Weight, Age, Gender. These attributes are needed to calculate BMR which in turn is a part of calorie calculation.

Following steps should be followed for the working environment setup:

a. Install android studio for the required sdk installation.
b. Install Unity 3D and do the necessary configuration with installed sdk.
c. Connect compatible device with VR.
d. Choose the VR mode to operate device in VR mode.

<table>
<thead>
<tr>
<th>Test Cases</th>
<th>Precondition</th>
<th>Test Steps</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Register into the system</td>
<td>Register form should be displayed with all fields</td>
<td>1. user must fill all the fields 2. select register button</td>
<td>Register successfully</td>
</tr>
<tr>
<td>Login into the system</td>
<td>Login form should be displayed with all fields</td>
<td>1. user must fill all the field 2. select register button</td>
<td>Login successfully</td>
</tr>
</tbody>
</table>

The above table shows various tests conducted based on the conditions. After entering the user details, it requires to be verified. This verification process is taken over by checking each fields of the input by validating whether the entered details are in right format like only text, no spaces or any special symbols. Secondly, the login field is verified in such a way that none of the field in this page left empty. Also, in password field some security mechanism must be included to hide the input from adversaries. The MPU 6050 communicates with the ESP8266 through the I2C protocol. The MPU 6050 is connected to ESP8266 as shown in the following Fig. 1. MPU Module This is commonly used module for developing hardware which based VR-Game Project.

Connect MPU 6050 module 5V pin to ESP8266 5V pin. Next, the GND of the ESP8266 is connected to the GND of the MPU 6050.
(i) The User Interface consist of Login and Register Button where the user can Register his details and then go for login. If already registered then directly can go for the login.

(ii) Validations are provided to authenticate the user. If not validate then register and login. User can logout if he wants to exit.

(iii) The database is stored on the firebase from where the data can be accessed.

4.1 Game Design

A. Game 1[Neck Movement]:

- The game includes three levels where the user starts with the level 1. Users has to collect the coins and move on. The count of how many coins yet to collect will be displayed on the screen.
- When the count reaches to zero the gateway will be opened and the user will be directed to level 2. There will be different maze’s where user will collect coins and move forward.
- Similarly, this will lead to level 3 where there will be little complexity with fun.
- A menu is also provided from where player can pause or quit the game.

B. Game 2[Body Motion]:

- In another game scenario, MPU6050 is configured first with Arduino.
- It gives six values as output: three values from the accelerometer and three from the gyroscope. The MPU 6050 is a sensor based on MEMS (Micro Electro Mechanical System) technology. Both the accelerometer and the gyroscope are embedded inside a single chip.
- This chip uses I2C (inter-integrated circuit) protocol for communication.
- The orientation data is uploaded on cloud. The application in unity simply draws the data and reflects the same for the character.
- Since it uses serial port communication it does not provide free movement to the user for playing purpose.
5. Testing

a. Unit Testing

It is a level of software testing where individual units/components of a software and tested.

b. Integration Testing

Integration Testing is a level of software testing where individual units are combined and tested as a group. If any faults in interaction can be identified.

<table>
<thead>
<tr>
<th>Test id</th>
<th>Test objective</th>
<th>Test case description</th>
<th>Expected result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Check the link between login and play module</td>
<td>Enter the login details then the page</td>
<td>Login successfully and ready to play</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to start the game appears</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Check the link between play and game module</td>
<td>After clicking on play button game</td>
<td>Started with the game</td>
</tr>
<tr>
<td></td>
<td></td>
<td>starts</td>
<td></td>
</tr>
</tbody>
</table>

c. Acceptance Testing

Acceptance Testing is a level of software testing where a system is tested for acceptability.

<table>
<thead>
<tr>
<th>Test category</th>
<th>Test description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calorie count</td>
<td>Player is getting calorie count or not.</td>
</tr>
</tbody>
</table>

6. Result and Discussion

6.1 Main GUI Snapshots

This section discusses with the results after the execution of the system under various circumstances. The section also gives an idea of the situation in which the system works efficiently. The performances are captured with appropriate parameters. Obtained results verifies that, this kind of VR-Game helps in burning the unwanted calories and keeps the user healthy to improvise the overall health benefits.
The game has been designed carefully by keeping the users in mind by attractive home screen shown in Fig. 2. This home screen opens up with title FIT-O-FUN, which means making the user fit with fun activities. This particular screen has other two notable buttons (i) Play (ii) Quit. The user enters into the VR-Game using the play button. The quit button helps in exit.

The captured data are stored in Firebase Database. It a real-time flexible and usable database widely used. Google has developed this tool for main for building applications related to infrastructure, also to increase the quality of the of the applications.
Fig. 4. Game Level (a) Long Shot (b) Closer View

The above Fig. 4 has two classifications long shot and closer view in which Fig. 4. (a) represents the long shot of the user which is captured by the sensor to reflect the actions performed. This long shot helps in viewing the physical structure movement of the user depends on it. Fig. 4 (b) presents the closer view of user. This gives more clarity and accuracy when the person moves front and back. The turning options are also enabled in this point of time to perform various exercises. The count of each movement is incremented and displayed on the right screen. This consolidated details are transferred as message and mail is sent to the phone connected to the application.

Fig. 5. Calorie Count

The above Fig. 5. Shows the calories burnt during the period. The scheduling property have been enabled in the application to facilitate the user to keep a note on how much calories are burnt during the specified period. The data are stored in the Firebase database developed by Platform Google.
7. Conclusion

This paper has been discovered that, pre-requisites for developing the game and configured accordingly. The game scene is build using Unity3D editor and executed on compatible android device. VR is growing industry. Educational applications may benefit from the technology of virtual technology games, which increase one’s engagement and motivation. Such a multiuser time and motion study would provide interesting insights for evaluating the interaction performance. PC and specialized hardware are getting better, faster and cheaper because of development in VR. Computing power has doubled approximately every 18 months. According to this we should have powerful computer to immersive VR programs at our home by year 2037.

References