

An Intelligent Boxing Application through Augmented Reality for Two users – Human Computer Interaction Attempt

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Abstract

Background/Objectives: The technological achievements seen in this modern world are very intuitive. One such intuition has resulted in this research. All of us must have seen the movie IRON MAN and the gestures the hero perform are all simply superb and it has been the motivation for us to proceed with this application that we created. **Methods/Statistical Analysis:** Augmented Reality is a technology which enriches the real world with digital information. An Augmented Reality (AR) Interface superimposes digital objects or interactive computer graphics, on to the real world dynamically. Since its introduction, the technology has been capable of presenting possibilities that have been challenging for other technologies to offer and meet. Nevertheless, AR environments has been largely limited to simple browsing or simply viewing of virtual information registered to the real world. In a few more years, AR will definitely change the way individuals view the world. **Findings:** We focus at making an interactive gesture tracking system using augmented reality that duplicates the real world environment by blending virtual elements into the real world. This idea is then taken to build an application in AR, through which two users can in parallel use the Boxing application using the punch gestures. The application would let the winner announced through finding out the amount of pressure applied for knocking out the boxing bag. We have discussed in this paper the core elements required to develop an application in augmented reality, which holds good for boxing application we developed as well. The tools required are, leap motion device and unity software. A detailed form of creating an application with the output generated is given. AR is going to be the future and the software giants are all investing dollars into it. So this innovation is a step ahead in AR research which can be further extended to many other applications.

Keywords: Body Balance, Isokinetic Trunk Strength, Stabilization Exercise, Yoga

1. Introduction

Augmented reality is a lately evolving technology that duplicates the real world environment by adding virtual elements into the real world elements by the computer. Augmented reality blends the real world elements with the virtual elements that are generated by the computer. The virtual elements generated by the computer are basically intended to engage, entertain and completely immerse the user into the system. The augmented reality

concentrates on creating a system where user can view the world in a completely different manner. This increases the chance of getting a better feel for the users who love playing games and application related to gestures. Mobile phones and video games are the prior elements which led to the enhancement of augmented reality. Augmented reality focusses on creating an environment where user would not find any difference between the real world and the virtual elements. A special device, should be called a sensor indeed, leap motion is used to detect hand

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movements. Unarguably, this is one of the best sensors available in the market to detect the gestures. The biggest advantage which makes leap a better one over other gesture sensors is its sensitivity and reaction time. Also another feature to appreciate is, the leap can be used in horizontal or vertical planes. May be head mounted displays for building AR headset as Getvu⁷ could use the leap motion sensor in vertical orientation as well.

Using gesture tracking system a direct interaction with digital information is made possible. To conclude the introduction, it will be apt to cite the growth AR/VR technologies which even has enabled setting up a theme park based on VR⁷. The world will move more towards augmented reality from virtual reality which will in future get chances for setting up an AR theme park or even more than that.

2. Terminology

Encyclopaedia Britannica¹ gives the following definition for AR: “Augmented reality, in computer programming, a process of combining or ‘augmenting’ video or photographic displays by overlaying the images with useful computer-generated data”. Augmented reality research combines the fields of computer vision and computer graphics. The research on computer vision as it applies to AR includes among others marker and feature detection and tracking, motion detection and tracking, image analysis, gesture recognition and the construction

of controlled environments containing a number of different sensors. Computer graphics as it relates to AR includes for example photorealistic rendering and interactive animations.

Tom Caudell, a researcher at aircraft manufacturer Boeing coined the term augmented reality in 1992. He applied the term to a head-mounted digital display that guided workers in assembling large bundles of electrical wires for aircrafts². This early definition of augmented reality was a system where virtual elements were blended into the real world to enhance the user’s perception. Later in 1994, Paul Milgram presented the reality-virtuality continuum³, also called the mixed reality continuum. One end of the continuum contains the real environment, reality, and the other end features the virtual environment, virtuality. Everything in between is mixed reality. A Mixed Reality (MR) system merges the real world and virtual worlds to produce a new environment where physical and digital objects co-exist and interact. Reality here means the physical environment, in this context often the visible environment, as seen directly or through a video display. In 1997, Ronald Azuma published a comprehensive survey on augmented reality and due to the rapid development in the area produced a new survey in 2001⁴. He defines augmented reality as a system identified by three characteristics:

- it combines the real and the virtual
- it is interactive in real time
- it is registered in 3D

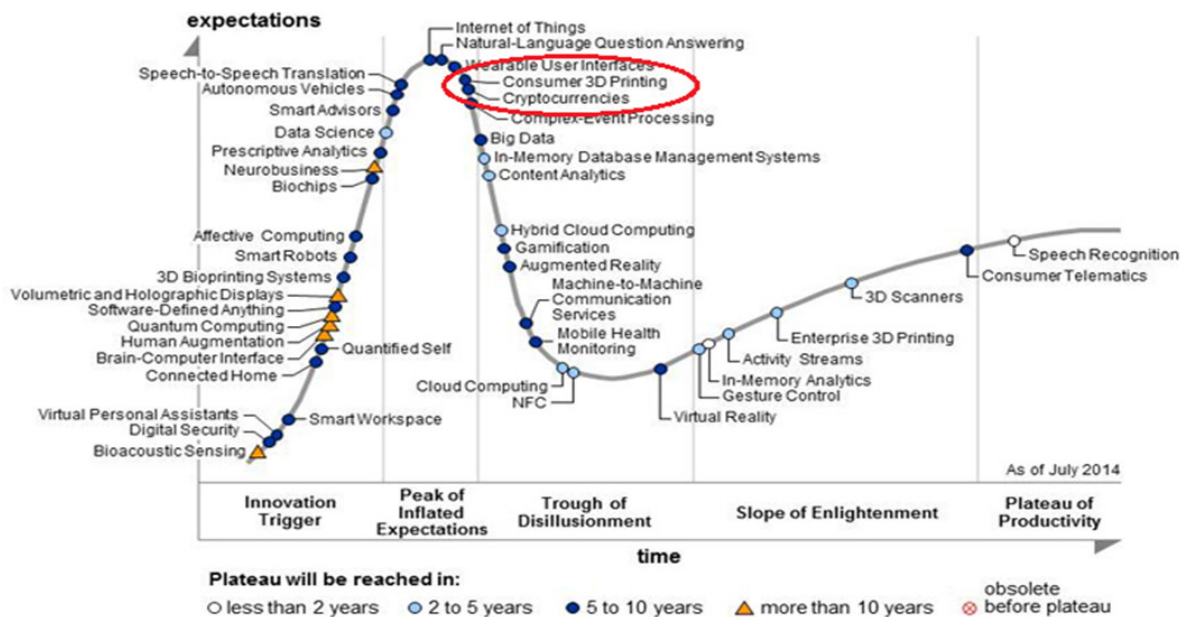


Figure 1. Gartner's hype curve.

In Gartner's hype cycle for emerging technologies in 2011^{5,6} augmented reality has just passed the peak, but is still at stage Peak of inflated expectations (see Figure 1). Gartner's review predicts the time for mainstream adoption to be 5–10 years. Augmented reality is now on the hype curve in a position where mass media hype begins. Those who have been observing the development of augmented reality have noticed the tremendous increase in general interest in augmented reality.

3. Existing System and Proposed Innovation

The existing system like ikea, gives someone the ability and chance to place virtual furniture in their respective houses with the help of augmented reality. One can check if a particular furniture can fit in the house in a particular place. Innovations are at its best with these kind of applications through AR. Figure 2 can reflect the idea being used by ikea to market their products. One would simply love the technology being used. Ikea app superimposes the virtual elements on the real world elements using GPS system and camera to extract background information.

In the proposed system, an interactive application is developed which not only superimposes the virtual elements, but also provide the output based on the user input that uses gesture tracking system to communicate. A special device called leap motion is used to detect hand movements using gesture tracking system a direct interaction with digital information is made possible. Two users can give punches with as much strength as they can to the boxing bag and the application designed will let us know on who has given more pressure and made the bag to fall down. It is like knocking the bag down and whomever does it faster is the winner. A very powerful and fast growing gaming engine Unity is used as the platform with Leap motion sensor are being used to get the app built. The environment which provide interaction with user is completely augmented. Such an interactive environment through augmented reality is created with the help of leap motion sensor as the hardware device to track the hand movement and gestures and unity as a software which is used in to code the logics and it helps in the integration segment of sensor with the computer.



Figure 2. IKEA using AR for furniture sale promotion.

Figure 3 gives a simplified idea of what is being done through the app. Player with the logic (code) can punch the bag as shown in the figure, diagrammatically.

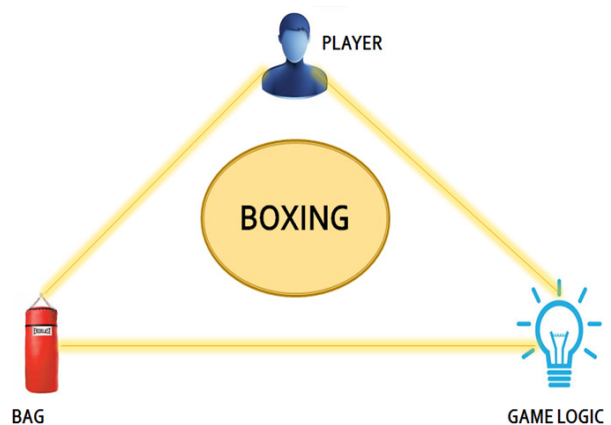


Figure 3. Augmented reality boxing app construction.

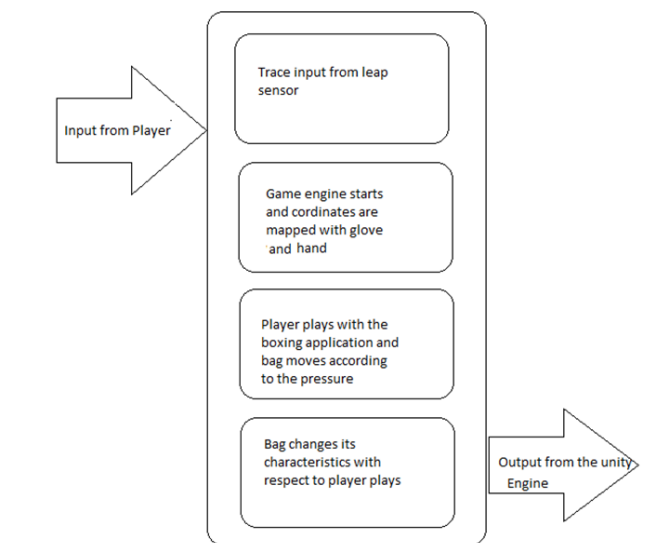


Figure 4. working methodology.

Figure 4 represents the input and output design for the application developed. The input is all given in the form of punch from the user. I.e. it is nothing other than the pressure being given at the bag. The input given in the form of the punch is acquired and is transferred to the unity gaming engine, where the core logic resides in the form of software code. Based on the pressure given the bag will move here and there and when the pressure is above threshold (35, as per our code) the bag will get cut and the user will be declared winner. When it comes to multiplayer mode, the user who has given much pressure will be declared winner and the results shown in the following section can reveal this fact.

4. Components used in the Innovation

The three major components used in the project are leap motion controller, unity platform and a computer. This complete section deals on the Unity and Leap motion controller.

UNITY is a very popular platform for development of games. Unity is a cross-platform game creation system developed by Unity Technologies, including a game engine and integrated development environment (IDE). Unity helps in developing a video game for pc, websites and also for mobile phones. Unity helps you to develop games for various platforms where the developers need not design the game for every unique platform. Unity Game engine is well portable and also extended its game development in augmented reality. Unity now has become the operating system of augmented reality for development for any kind of application and for gaming version.

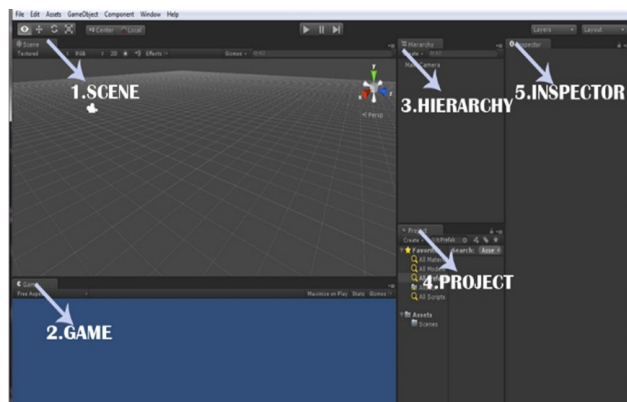


Figure 5. Five major components of unity.

One can download the software from the below URL

and it is licensed free software.

<http://unity3d.com/unity/download>. Figure 5 reveals the five important components of the Unity.

4.1 Scene View

Scene view is the place where the developer used to manipulate the game objects. It helps the developer to move around and help in developing games with ease. The hand tool is used to move around the window by dragging the camera all around. Use hand tool combine with control key allows you to zoom in and zoom out. This helps in viewing the game component in distant view and also views minor details. Hold down alt key with hand tool to drag across the orbit of the camera.

4.2 Game View

Game view represents the complete published view of your game. It helps the developer to view the outline that shows how the users play the game that is developed. Game can be viewed by using the play mode that helps you to see how the game is actually working. In short, it gives the output of the developed the game. The game can be stopped using exit play mode. This window can be set to aspect ratio which is preferable for the application.

4.3 Hierarchy view

Hierarchy view comprises of all Game Object belonging to a particular scene which the developer is currently in. It promotes the concept called parenting where the developer can drag the Game Object under another object. To make a hierarchy of Game Object, drag the child Game Object and place it onto the parent Game Object. This helps obtaining a relationship between the Game Objects yet independent components. The properties of the parent Game Object is been inherited by the child Game Object. Hence the movement and orientation in the parent Game Object will also reflect in the child Game Object.

4.4 Project

A game project consists of various scenes, scripts, texture, audio files and so on. All these information are contained within an Assets folder. The project view consists of the assets folder contents. This consists of all the contents that are included in your game. All these together form the game. The developer can create; edit and delete the contents of the assets folder. Certain objects can also be imported into this assets folder.

4.5 Inspector

As already discussed, the unity consists of various scenes, scripts, texture, audio files and so on. On selecting an individual component, the inspector tab displays the complete information about the game component. The Game Object can be also modified in the scene or they can be modified with exact dimensions and values directly through inspector tab.

The next major component of our research is leap motion sensor⁸. It is one of the brightest innovations one should say. VR and AR can groom themselves very well more gestures and interactions through Leap motion sensor. These days, the sensor is interfaced with Android also and hence increasing the chance of creating more gesture based applications with even smart phones and tablets⁸.

LEAP Motion sensor senses the natural hand movement and allows a new way of interaction with the digital content using hand gestures like pinch, grab, swipe, rotate etc. Leap does its motion sensing at a fidelity unmatched by any depth camera currently available: it can track all 10 of your fingers simultaneously to within a hundredth of a millimeter with a latency lower than the refresh rate on your monitor. The device has a two monochromatic IR cameras and three infrared LED's, the device tracks an area of 1 meter. The LED's in the leap motion sensor generates pattern-less IR light and the cameras also generate 300 frames per second of reflected data, which is then sent through a USB cable to the host which may be a computer or mobile. In the case of Preciseness & Accuracy Leap motion is definitely better than Kinect and other hand tracking sensors.

Figure 6 represents the gestures supported by Leap and application built by Team GetVu from Amrita University. It really opens avenues for many applications for future.

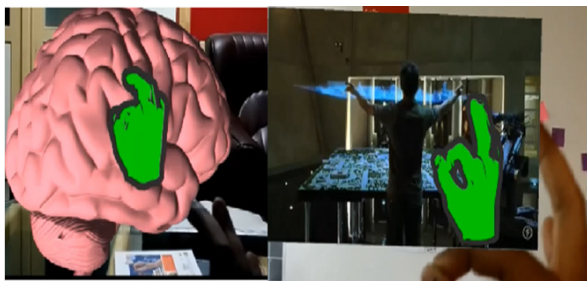


Figure 6. Gestures supported by leap motion sensor.

Figure 7 shows how leap motion sensor will look like. It is very light weighted, it supports both horizontal and vertical mounting. Horizontal mounting enables someone to mount it onto an AR headset as engineers from Amrita University did with GetVu AR headset⁷.



Figure 7. Leap motion sensor.

Leap sensor software has to be installed in client side. It will help users to get interaction established with the machines. Leap sensor software has specific versions and the same depends entirely on the operating system installed on the machine. The Leap Motion Developer SDK contains the necessary libraries to get started with integrating the Leap Motion Controller into your project and is no difficult task really. Researchers have already shown a lot of guidelines towards this step and many blogs and guidelines are available online which we used. Copy the Leap SDK folder to a suitable location on your computer. Unity Assets which is present under /Leap SDK/lib folder will contain plug-in files for Unity. Import that Unity Assets into your Unity project in order to use LEAP controller inside Unity. One can download LEAP SDK from the official URL given below.

<https://developer.leapmotion.com/downloads>.

One has to take care on the following file details for respective operating systems:

- On Windows: run Leap_Motion_Installer_version.exe
- On Mac OS X - Open Leap_Motion_Installer_version.dmg
- Run Leap Motion.pkg
- On Linux (Ubuntu):
 - a. For 32-bit systems, run: `sudo dpkg --install Leap-version-x86.deb`
 - b. For 64-bit systems, run: `sudo dpkg --install Leap-version-x64.deb`

5. Software Modules

Coding is a bit of challenges as creation of bag and boxing environment is all done for the first time for this type of applications. Also it is to be appreciated that the webcam available in the laptop is made use fully to get the augmented reality environment. Whomever is using the application will have respective image being caught in real-time and embedded as the background for the application. Complete coding has been done in C Sharp. The following are the modules written and integrated together to make the application work.

1. Module to create a boxing bag. (A spawner will work to get the bag created, whenever the application is launched)
2. Application restart module, after the bag is knocked out. This time can be set by the user as well, if need be.
3. Pressure measurement module. This module will measure the knocking velocity.
4. Module for recognition of hand gestures.

We could code all the above within 1000 lines. So the complexity of the code is very much in control and memory usage was also handled perfectly in order to avoid and memory lock issues.

6. Results and Analysis

Once the leap motion sensor is connected, it is mandatory to check if the sensor is working properly and could detect the gestures. There are many inbuilt applications available for this purpose and we use a hand tracker to confirm that the device has been detected by the laptop. Once this sign is cleared, the application written can be launched. Figure 8 reveals how this could be achieved. Figure 9 shows how the environment will look like. It has a boxing bag and a pair of gloves shown. When the application is launched correctly, the web camera in the laptop or desktop starts capturing the image of the user and it will be embedded in the screen along with the application. This has been shown in Figure 10. It has a user who is about to punch the bag. Figure 11 shows both the users knocking the bag. One can see that the bag gets cut and knocked out for the user in right hand side of the app. Since he has applied more pressure than user in left hand side, the bag got

knocked out early. This has been reflected in Figure 12. Figure 13 shows the readings. I.e. it shows the pressure applied to the bag for both the users and one can see the values. Once the bag is knocked down, the application will re-launch the bag in no time. It takes about 10 seconds to re-launch the bags again for the game to be started.

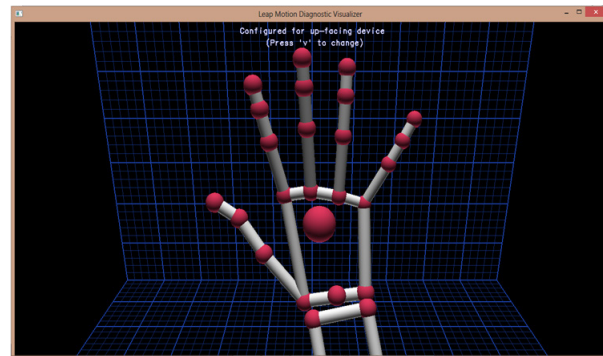


Figure 8. Testing the leap with finger tracker.

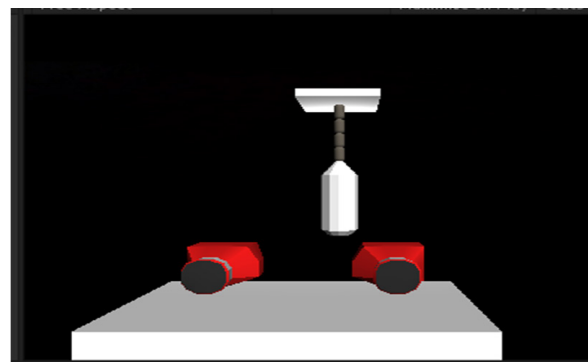


Figure 9. Virtual boxing gloves and bag.

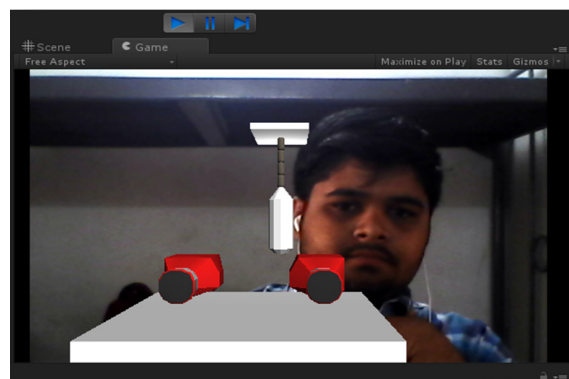


Figure 10. Application has been started and user is seen in the application.

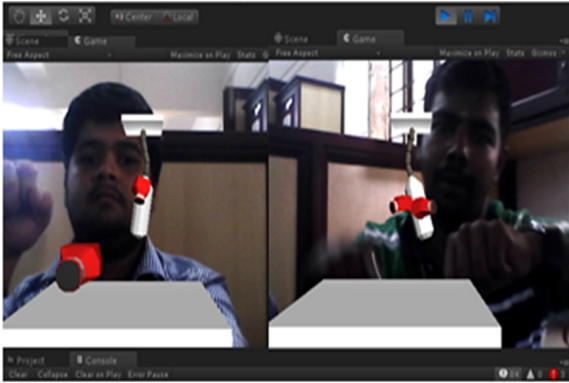


Figure 11. Two users starts knocking the bag.

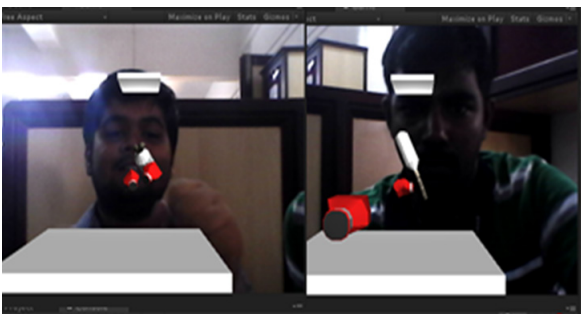


Figure 12. Boxing bag is cut, user two has applied more pressure.

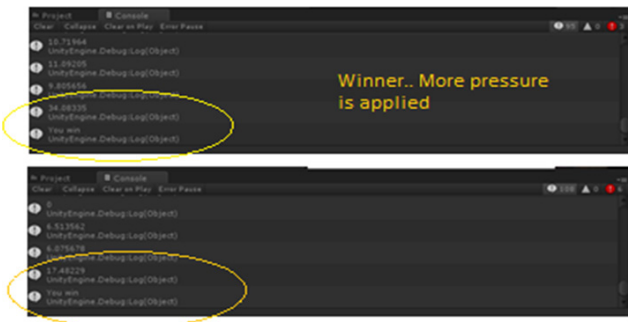


Figure 13. Pressure measurement, Shows 34.04 more than the second user.

7. Conclusion and Future Scope

We have created a UI that would replace the conventional UIs which makes use of a mouse or joystick. Gesture interaction with the system was achieved in a smooth and uninterrupted manner with the help of the Leap Motion Controller. We have achieved in taking the user interaction experience with the AR interface to the

next level by incorporating it with gesture interaction. This system poses to be user-friendly by providing high precision and accuracy

The same application itself has a lot of potential to include image processing ideas into it. We plan to detect the players with face detection algorithm, which would be more challenging and little daunting as well, technically. Also the scores can be updated in a database and can be compared with past scores to understand how well the person is knocking the bag.

It has a lot of social relevance and this can be further developed for training physically injured persons with exercises as it would be exciting for them to see something virtually and to do practice. Haptics is one area where AR can play a major role. Constructions, Medicine, Education and where not? Everywhere, we find AR to play a vital role in future.

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