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ABSTRACT: This paper focusses on making an interactive gesture tracking system using augmented reality that duplicates the real world environment by blending virtual elements into the real world. This paper describes what augmented reality is, differentiates augmented reality with the traditional virtual reality that is used to duplicate the real world and immerse the user completely into the virtual world where nothing is reality. This paper discusses the core elements required to develop an application in

augmented reality. The tools required are, leap motion device and unity software. A detailed form of creating an application with the output generated is given. This survey would give the basic idea of augmented reality and to develop a sample interactive application via partial augmented reality. 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. Mobile phones and video games are the prior elements which led to the enhancement of augmented reality. Augmented reality focusses on creating a environment where user would not find any difference between the real world and the virtual elements. All the virtual elements appear in the field of view, Fig1: The above picture shows a visualization of the cottage in that real world environment which is not real but virtual. AUGMENTED REALITY vs VIRTUAL REALITY The latest publicity in the market is augmented reality and virtual reality which do make things happen which are totally impossible. Augmented reality has gained the consumer's attention compared to virtual reality. Both, augmented reality and virtual reality system work on immersing the user on the virtual environment created by the system but in different ways. Augmented reality, as discussed before, adds certain virtual elements to the real world but Virtual reality creates a complete different environment. In fact, to automate a virtual reality system is very expensive compared to augmented reality. Virtual reality requires a separate room to create a completely virtual environments, head-mounted displays or world-fixed displays, or hand-held displays to visualize virtual elements and others sounds and music for generating feedback. In contrast, augmented reality is well possible with a mobile which is lot more feasible. But their applications are different. Virtual reality is used in applications like training system used to train pilot, military etc. where we require a complete virtual environment for training the pilots where the trainee would get a feeling of real environment. Augmented reality, in contrast, is used in many commercial business, education etc. to improve the involvement of user with less cost. Fig2: The above picture depics the difference between reality, augmented reality where the surroundings are real and the virtual reality where the entire surrounding is duplicated. HOW DOES AUGMENTED REALITY ACTUALLY WORK Augmented Reality superimposes artificial objects through graphics and provide feedback via audio systems into the real world environment. Augmented reality is achieved in the mobile phone by using the camera and GPS system to gather the surrounding information. On moving the mobile phones over the building the user could get the restaurant details, company details etc. All these things are made possible

through the combination of camera and GPS system. Hence the system works by analyzing the surrounding information and projecting the virtual image into the real environment and blending them into one image giving the user a feeling of real environment. DOES THE FUTURE FORECASTS POSITIVE FOR AUGMENTED REALITY Augmented reality uses GPS system and it is the main component to achieve the augmented reality concept. But the GPS system is precise only within 9 meters of reach. Hence a device to sense the real world environment should be designed. Also users need not have to rely on the mobiles because augmented reality is also been implemented in glasses which help users a lot more comfortable and enlarged view of the virtual system. In future, you can easily access a computer system by just wearing the glasses using augmented reality. A sun glass would contain a big library of 10,000 books, a store of 1,000 songs and 100 videos etc. would just look amazing. You could also record the entire thing happening in front of you via these glasses. If you are lost somewhere you could use the GPS system and augmented reality to guide you to the place you want to reach. In future, augmented reality would allow us to get the information about a person like their Facebook id, twitter etc. just by pointing the phone upon a human, by recognizing and analyzing their facial information. This leads to a very serious problem- security. This violates a person's privacy which is really the most important factor to be considered upon. And, these glasses may also tend to distract you from what is happening in the real environment. This may lead to carelessness and carelessness leads to accidents. The user's consciousness would now be focused on the virtual world and not on the real world. This would result in changes in the brain as both virtual environment and real world are been visualized simultaneously. Considering all, technology is growing fast, and augmented reality is going at a faster pace wherein these things come as a hurdle to the growth of augmented reality. But it would not affect the growth at a tougher rate as it has been secured a great interest to people especially amongst the kids and the youth. INNOVATIVE POPULAR APPLICATIONS THAT CONQUERED THE MARKET SPACE USING AUGMENTED REALITY: 1. HEADS UP DISPLAY: Heads up display is a transparent display that displays the information on the windshield. The driver can see the road for driving and also can look over the guide to the place he wants to reach simultaneously. This is achieved by the heads up display by presenting the direction distance to the place to be reached over the car's windshield. The heads up displays identify the route using the GPS system that works brilliantly without the need for the driver to look away from the road and also getting the driver to the correct location. This changes the way of driving a vehicle. This makes a vehicle and intelligent one. This is possible with GPS to detect the environment, infrared cameras, internet and mobile to convert your normal car's windshield into an intelligent information displayer. 2. IKEA: IKEA is a Swedish company that sells furniture, appliances and home accessories. Home accessories like

furniture, though you know your hall dimensions, background settings etc. for your brand new couch, you might wish to have a look up of the couch inside your hall before buying it which is not possible. But with augmented reality, this is completely possible. One pointing your phone towards the empty space in your hall, where the couch is exactly meant to be kept, and the augmented reality helps in projecting a virtual image of your couch combined with the surrounding that is your hall without the requirement of bringing the couch inside your room. This provides lots of options to customers where they could buy their products without having any regrets. Fig 3: This picture augments the sofa upon the living room. 3. AUGMENTED REALITY IN MEDICINE: Augmented reality is significantly used in medicine field. Augmented reality had been helping widely to teach complex concepts and technologies to medical students. Augmented reality helps you find the inner damage in the patient's body parts. Help them zoom in and zoom out their body parts so that the doctor can easily find all the damages clearly and easily without any requirement of x- ray. This helps in saving lot of time and money. Hence augmented reality has placed its authority over medicine not only for treatment but also for training purpose. 4. AUGMENTED REALITY IN MANUALS: Augmented reality can help with understanding the manual providing all the instructions visually with the help of a video. The user doesn't have to take the pain to search all over the documents for a tutorial for a particular component, instead the user just have to move his mobile such that the component is visible. The camera detects the object, process its information and can provide a short video or graphical tutorial about the component. This helps improving understandability with ease. 5. AUGMENTED REALITY IN EDUCATION: Augmented reality has provided us a completely new way of delivering education to students. Using augmented reality, students can understand all the concepts easily without spending more time as well as money in reading books. Augmented reality visually represents all the theories and conception which helps students in understanding them easier. It makes learning more and more fun wherein students can learn and understand everything in much shorter span of time. With the invent of augmented reality, students can be helped with their homework by providing a short tutorial on that concept by the teacher when the student scan the homework page. The student could replay it again if the student couldn't get the concept right in the first place. This saves time for the teacher and also helps the student. Augmented reality can help providing a short review of the book when the book cover page is looked upon. This helps the reader easier to select the novel or book by accessing to the reviews instantly on looking at the cover book. Safety can be employed in a laboratory in even more appropriate manner using augmented reality. We can use augmented reality enabled devices that provide a trigger to display rules and procedures for a lab equipment. All these techniques improvise the education system and can be widely employed. Fig4: This

picture shows a small summary of the book upon reading the front page. TOOLS REQUIRED CREATING AN AUGMENTED REALITY APP UNITY: A GAME DEVELOPMENT BEAST UNITY is a system which is very popular for developing games across platforms which is developed by Unity Technologies. Unity helps in developing a video game for pc, websites and also for mobile phones. The main advantage in this software is, it helps you to develop games across wide variety of platforms wherein the developers need not design the game for every single platform. Hence the unity software is well portable. Unity has also extended its game development in augmented reality. Unity now has become the operating system of augmented reality game development. Fig5: This is the unity IDE overview. 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. 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. 3. HIERARCHY VIEW: Hierarchy view comprises of all GameObject belonging to a particular scene which the developer is currently in. It promotes the concept called parenting where the developer can drag the GameObject under another object. To make a hierarchy of GameObject, drag the child GameObject and place it onto the parent GameObject. This helps obtaining an relationship between the GameObjects yet independent components. The properties of the parent GameObject is been inherited by the child GameObject. Hence the movement and orientation in the parent GameObject will also reflect in the child GameObject. 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. 6. 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 GameObject can be also modified in the scene or they can be modified with exact dimensions and values directly through inspector tab. LEAP MOTION: AUGMENTED REALITY MADE POSSIBLE Leap motion is a

device that is developed by leap motion Inc. Leap Motion device detect hands, finger and finger-like tools (e.g.: pen, pencil) movements and their positions. It recognizes the entire object within its field of view. Its field of view ranges from 25 to 300 millimeters above the device. It helps taking these movements as an input to our system. It gives the input with high precision and high frame rates. Every point of the movement is recorded in a frame. The leap motion device tracks the movement and gestures and records it as frames. Each frame object contains all the tracking data. Fig6:This is the right hand Cartesian Coordinate system of Leap Motion device. The leap motion device is a right handed Cartesian coordinate system which represents the three dimensional coordinate system where the thumb, index finger and second finger of right hand held perpendicular to each other oriented across Z-axis, X-axis and Y-axis respectively. As shown in the diagram, the origin is the center of the leap motion device pointing the top of the device. X-axis increases along the horizontal way, Y-axis increases towards the top of the device and Z-axis increases towards the user. A leap motion device records the frames in microseconds. The leap motion device gives very accurate results with high frame rates. All the tracking data can be accessed through these frames. It can measure the object in millimeters distance. GESTURE TRACKING • The Leap Motion software

2recognizes certain movement patterns as gestures which could indicate a user intent or command. • Gestures are observed for each finger or tool individually. • The Leap Motion software reports gestures observed in a frame the in the same way that it reports other motion tracking data like fingers and hands.

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4This gesture controller provides an approximately 150º field of view and uses a depth sensor to track hand features up to 1/100th of a

millimetre. FIG 7: GESTURE MOVEMENTS FIG 8: GESTURE MOVEMENTS When leap motion get into

gesture it can generate over 200 frames per second. These types of movement in leap motion which the gesture can work with LEAP SENSOR. When a hand or finger comes into play it will displays the reality image of a hand or finger from the leap motion sensor to the computer devices. It can displays you the trend of LEAP MOTION SENSOR and how it traps the hand or finger .There are different types to interact with sensor. When hand or finger interacts with the sensor the outcome of the hand would be as shown in the figure. FIG 9: HAND MOVEMENTS TO THE SENSOR GETTING STARTED WITH AUGMENTED REALITY: 1) Create a new project. 2) There are few libraries to be imported to use unity and the leap motion device. Libraries to be imported for 32-bit Windows: a. LeapSDK/lib/UnityAssets/Plugins

> **1/LeapCSharp.NET3.5.dll — Leap Motion C# library for .NET 3.5** b. **LeapSDK/lib/**

UnityAssets/Plugins/LeapCSharp.dll — 32

> 3**-bit Leap Motion** C# **library for Windows** c. **LeapSDK/lib/** UnityAssets/Plugins **/Leap.dll**— 32 **-bit Leap Motion library for Windows**

Libraries to be imported for 64-bit Windows: d. LeapSDK/lib/UnityAssets/Plugins

> **1/LeapCSharp.NET3.5.dll — Leap Motion C# library for .NET 3.5**

e.

> 3**LeapSDK/lib/x64/** LeapCSharp **.dll — 64-bit Leap Motion** C# **library for Windows** ? ? ? ? f. **LeapSDK/lib/x64/Leap.dll — 64-bit Leap Motion library for Windows**

Libraries to be imported for 32- and 64-bit Mac OS: Unity Pro g. LeapSDK/lib/UnityAssets/Plugins

> 1/**LeapCSharp.NET3.5.dll — Leap Motion C# library for .NET 3.5 and Unity** Pro
>
> h. **LeapSDK/lib/**

UnityAssets/Plugins/LeapCSharp.bundle — Leap Motion C# bundle for Unity Pro Unity Standard (free license) i.

> 1**LeapSDK/lib/LeapCSharp.NET3.5.dll – Leap Motion C# library for .NET 3.5 and Unity Standard** j. **LeapSDK/lib/libLeapCSharp.dylib – Leap Motion C# library for OS X and Unity Standard** k. **LeapSDK/lib/libLeap.dylib – Leap Motion library for OS X and Unity Standard**

3) Open new project by selecting File?New Project? Create new Project? Create. 4) The plugins folder from the LeapDeveloperKit\LeapSDK\lib\UnityAssets and import it into project folder by click and drag into the unity project directory. 5) Certain dll files are needed to be imported for the unity software to get the tracking inputs required from the leap motion device. On Windows: x86/LeapCSharp.dll x86/Leap.dll On Mac: libLeapCSharp.dylib libLeap.dylib 6) Copy LeapCSharp.NET.3.5.dll to the root of your Assets folder. 7) Connect the leap motion device to the system. 8) To create a C# file, go to Assets folder(right-click)? Create?C# Script. using UnityEngine; using System.Collections; public class sample : MonoBehaviour { void Start () { } void Update () { } } Start()? The programmer can make the initializations under this functions. Update()?The programmer can make the updation used for all frames over here. A SAMPLE BOXING APPLICATION: 1) For this boxing application, a Leap Controller Multiple that contains scripts to track the hand gestures. 2) A plane is created where the game gravity everything is taken care. 3) A room is created where the boxing game is set. 4) Gloves are created that replicates the hand gestures to play the game. 5) Lights are used to provide lightening to the system that acts like a sun to the surrounding game environment 6) The hand coordinates are assigned to the Gloves hands and hence, the gloves imitate the movement of hands 7) Physics are assigned to the bag that is to be stricken down. 8) Capsule

Collider is assigned to the 4capsukes that hold the bag instead of assigning it to the bag to provide more reality and smooth movement of the boxing application 9) A collision between the gloves and the bag is detected to detect the punch and the game goes on accordingly. THE OUTLINE FLOW OF THE BOXING APPLICATION: START Leap motion Sensor Game Object Glove 3D Model Bag Model Leap motion Sensor Leap motion Sensor Leap motion Controller Capsule colloider Left Leap motion API Leap motion Sensor Left Right Leap motion Sensor Left Leap motion Sensor Right Mapping Coordinates Collision occurs o occursYES NO Frame Rendering Render physics to the Corresponding direction Output SAMPLE CODING AND EXPLANATION: 1) Import the necessary package. As we require Leap Extensions to use the Leap motion device, also import Leap through "using Leap" statement. using UnityEngine; using System.Collections; using Leap; 2) Create a class LeapHandController. 3) As we code the application using C#, Use MonoBehaviour which is a base class from which every other scripts gets derived. public class LeapHandController : MonoBehaviour { 4) Create a hand array to get the hands as input for the boxing application. public UnityHand[] unityHands; public UnityHandSettings handSettings; private float timeVisible = 0.2f; 5) Specify all initializations using start() void Start () { 6) Attach controller methods to Leap's hand updates. LeapInputEx is the class used to access the controller in the script. LeapInputEx.HandUpdated += OnHandUpdated; LeapInputEx.HandFound += OnHandFound; LeapInputEx.HandLost += OnHandLost; 7) Enable hand gestures like swipe, circle, key tap and screen tap. LeapInputEx.Controller.EnableGesture(Gesture.GestureType.TYPESWIPE); LeapInputEx.Controller.EnableGesture(Gesture.GestureType.TYPECIRCLE); LeapInputEx.Controller.EnableGesture(Gesture.GestureType.TYPEKEYTAP); LeapInputEx.Controller.EnableGesture(Gesture.GestureType.TYPESCREENTA) ; unityHands[0].AssignSettings(handSettings); unityHands[1].AssignSettings(handSettings); } 8) Specify the updates of each frame under this function. void Update() { LeapInputEx.Update(); } 9) When a hand is detected, create a new ID for the hand and broadcast it to the listeners. private void OnHandFound(Hand h) { Messenger.Broadcast<int>(SIG.HANDFOUND.ToString(), h.Id); } 10) Keep on watch for updates of another hand. private void OnHandUpdated(Hand h) { bool undeterminedHand = true; for (int i = 0; i < 2; i++) { if ((unityHands[i]).hand != null && unityHands[i].hand.Id == h.Id && unityHands[i].isHandDetermined) { unityHands[i].hand = h; undeterminedHand = false; } } 11)If a new hand is detected, then assign the new hand id if (undeterminedHand) AssignHands(h); } 12) broadcast lost hand ID to registered listeners e.g. game objects, controllers, etc. private void OnHandLost(int Id) { Messenger.Broadcast<int> (SIG.HANDLOST.ToString(), Id); for (int i = 0; i < 2; i++) { if (unityHands[i].hand != null && unityHands[i].hand.Id == Id) { unityHands[i].HandLost(); } } } 13) Now, determine if detected leap hand is

left or right hand private void AssignHands(Hand h) { 14) delay left/right analysis for better accuracy if (h.TimeVisible < timeVisible) return; 15)If fingers are detected, determine left / right based on thumb for (int i = 0; i < h.Fingers.Count; i++) { Finger f = h.Fingers[i]; if (!f.IsValid) continue; 16)Identity the thumb position through vector3 that indicates the direction and magnitude. Vector3 palmRightAxis = Vector3.Cross(h.Direction.ToUnity(), h.PalmNormal.ToUnity()); float fingerDot = Vector3.Dot((f.TipPosition-h.PalmPosition).ToUnity().normalized, palmRightAxis.normalized); if (Mathf.Abs(fingerDot) > 0.9f) { int index = fingerDot > 0 ? 0 : 1; if (unityHands[index].hand != null && unityHands[index].hand.Id != h.Id) { if (unityHands[index].isHandDetermined) { SolveAmbiguity(index, h); return; } Debug.Log("OVERRIDING OLD HAND"); unityHands[1 - index].isHandDetermined = true; unityHands[1 - index].AssignHand(unityHands[index].hand); unityHands[index].isHandDetermined = true; unityHands[index].AssignHand(h); return; } unityHands[index].AssignHand(h); unityHands[index].isHandDetermined = true; if (unityHands[1 - index].hand != null && unityHands[index].hand.Id == unityHands[1 - index].hand.Id) { unityHands[1 - index].HandLost(); } return; } } for (int i = 0; i < 2; i++) { if (unityHands[i].hand != null && unityHands[i].hand.Id == h.Id) { unityHands[i].AssignHand(h); return; } } 17) If finger analysis did not determine a hand, make an assumption based on position AssumeHand(h); } 18) Assume left / right hand based on absolute leap position private void AssumeHand(Hand h) { int index = h.PalmPosition.x < 0 ? 0 : 1; if (unityHands[index].hand == null) unityHands[index].AssignHand(h); else SolveAmbiguity(index, h); } 19)Solve Hand ambiguity (two right hands or two left hands) private void SolveAmbiguity(int conflictIndex, Hand h) { Hand leftMost = h.PalmPosition.x < unityHands[conflictIndex].hand.PalmPosition.x ? h : unityHands[conflictIndex].hand; Hand rightMost = leftMost.Id == h.Id ? unityHands[conflictIndex].hand : h; unityHands[0].hand = leftMost; unityHands[1].hand = rightMost; } 20) Complete the necessary, to clean delegate assignment between scenes. private void OnDestroy() { LeapInputEx.HandFound -= OnHandFound; LeapInputEx.HandUpdated -= OnHandUpdated; LeapInputEx.HandLost -= OnHandLost; } } SAMPLE OUTPUT: 1 Fig 10: The above figure depicts the environmental set up of leap motion device. Fig11: This is the leap motion visualizer for version 1. Fig12: The is the beginning of the game where it is being initialized. Fig13: This is the final output of the boxing game CONCLUSION: This paper have thus given a complete understanding of what augmented reality is, What are the future expectations over augmented reality. The core part of the augmented reality, i.e, the leap motion device is discussed. The type of gesture tracking system is identified. The main game development beast, Unity is explained. The connection of unity and Leap motion device is discussed. An application is designed by getting the hand gesture tracking input through Leap motion device. The application is discussed in detail. All the

interfaces, classes and packages required are studied thoroughly. Hence this paper would help understanding augmented reality and its applications and also to develop a basic partial augmented reality application.