VRaaS [Virtual Reality as a Service]: Integrated architecture for VR Applications

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Abstract—Cloud Computing is all about sharing resources and moving services, computation, data for cost and advantage. Many cloud providers host their services over the web and mobile apps for their peers. SaaS, PaaS, IaaS have been the basic providing strategies. Many applications use one of these areas of cloud computing. But all the applications may not be run accurately and cheaply using the existing strategies particularly virtual reality applications. A new architecture or strategy has to be built for such applications. In this paper, we suggest a new strategy named VRaaS (Virtual Reality as a Service) and its architecture for running such virtual reality applications. We also illustrate an example application which can be run using this architecture.

I. INTRODUCTION

Virtual Reality is a term which simulates the physical presence in places in real world as well as imaginary world, using computer-simulated environment. Many exploratory fields including telecommunication, telelearning and medicine are using this technology. It is basically an extension of graphical user interfaces. It should generally include 3-dimensional images from the perspective of the user which gives an idea about the respective real world .It gives the ability to track the human interactions particularly the head and eye movements, and correspondingly adjust the images on the user's display device to reflect the change. There have been many such ways to achieve such human-machine interactions but not many are cheap and accurate. We therefore, suggest smart phone based tracking of human interactions, using phone's global positioning system (GPS), sensors such as Accelerometer, Proximity Sensor, Ambient Light Sensor etc. and their endless applications over the mobile platform Android.

Also it is critically important to have a scalable and adaptable environment that can be used whenever client wants. To achieve this, a new architecture is suggested that involves the power of cloud and is termed as Virtual Reality as a Service (VRaaS). Apart from PaaS, SaaS, IaaS suggested architecture solves problems related to virtual reality and 3-D environment applications. Before we discuss about the architecture of VRaaS, let us discuss about the different advancements in the components of our architecture.

II. EXISTING TECHNOLOGY

A. *Virtual Reality*

Few virtual reality prototypes are available. Human-Computer Interaction Based on Eye Movement Tracking, in this approach, combined use of head motions for visual navigation and eye pupil positions for context switching within the graphic human-computer interface. And there are some software based on Virtual Reality coordinating on Graphics, Audio and User Interaction. Some examples include older packages such as World Toolkit from EAI. Cave Lib from VRCO provides an application base for the CAVE virtual environment. Virtual Reality in gaming world includes Project Natal, Nintendo Wii .These projects allow a new way of interaction. There are many military examples, including battlefield simulators for soldiers.

B. *Cloud computing*

Cloud Computing takes the concept of virtualization to a new step. There are public clouds, private clouds available for providing services. SaaS, PaaS, IaaS are the 3 different strategies that ensure the needed services are available to the user. Cloud computing in marketing field, is use to sell hosted services for Application Service provisioning that run the client server software on different location. SaaS and PaaS belongs this category. End users will be accessing the applications with the help of web browser or some mobile application. Providers of IaaS offer virtual machines and other resources like file-based storage, firewalls, load balancers, IP addresses, Virtual Local Area Networks (VLAN's).

The ubiquitous availability of high-capacity networks, low-cost computers and storage devices as well as the widespread adoption of hardware virtualization, service oriented architecture, autonomic, and utility computing have led to a tremendous growth in cloud computing.

C. *Smart Phone Platform (Android)*

Android is a computing platform designed for use in smart phones. The OS is based on Linux for advanced computer processing. Android Technology is rapidly increasing but mostly it is used for mobile phones. Because it is freely available to download, many developers find it easy to develop applications for Android. The current version provides a wide scale of features including the GPS, NFC (Near Field Communication), Improved Voice Search, Media capabilities and so on. Android supports connectivity technologies including GSM, IDEN, CDMA, Bluetooth, UMTS, Wi-Fi, NFC, LTE, and Wi-Max. It supports variety of audio/video/still formats. Tethering, Voice based features, Video calling are some other renowned features. Also, there have been creative products in consumer market that show the deep capabilities of the android features, one such product is GOOGLE GLASS. We would like to use the features provided by this current version of android for building our application.

III. VIRTUAL REALITY AS A SERVICE

A. *Introduction*

VRaaS is, serving virtual reality applications scalable, wherein a user can simulate 3-D environment; Interactions by user are tracked, using a smartphone. VRaaS could put an end to traditional hardware dependent applications and create a whole new ecosystem where in, clients need not wear heavy head mounted displays; they could just use their mobile devices and expect virtual reality application to work.

B. Architecture

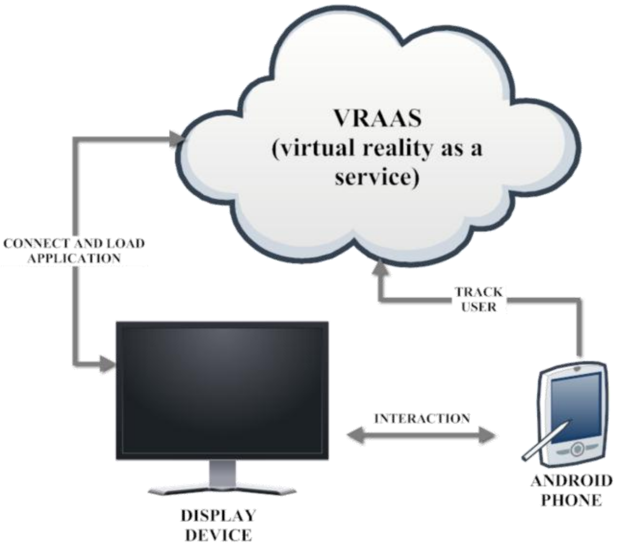

Fig. 1: Architecture

The architecture is depicted in above figure, Virtual reality application runs as a service in the cloud to which the display system and mobile interface are connected. When a user starts the application, the display device connects to the cloud and loads the application data required such as the textures, backgrounds, visual effects etc. As soon as the application is loaded, the cloud server triggers the smartphone for the user information. Following are few possible user attributes that could be tracked using a smart phone:

1) Movement
2) Velocity
3) Heart Rate
4) Surrounding Temperature
5) Location

All these attributes could be used in the virtual reality application to project the scene according to the user i.e. with respect to user the display could be changed. Here display system need not be a monitor, it could be head-mounted display or any other display system; but it should have connectivity to the cloud and run application with decent processing speed. This architecture could establish the virtual interaction between the client smart phone and the virtual reality display device.

C. Possible Applications

To illustrate, we are suggesting an application of VRaaS, in which a two dimensional screen could be used to project an interactive 3-D image. VRaaS will allow users to simply choose the virtual reality service and use it without external hardware attached, as smartphone will have the interaction tracking mechanism; also, it can be used scalable and uniformly. We suggest a Virtual reality application as a service, where user can simply run an app connected to cloud, which in turn tracks user movement and updates scene accordingly.

D. Suggested Application

Our test application holds the key in any virtual reality system. Our application tracks the user movement and changes the scene accordingly. User movement is tracked down using the smart phone GPS coordinates, basing on the coordinates net calculation, user current position is traced and corresponding scene is updated in the display system. Traditional systems use custom made sensors attached to the user, these additional hardware results in complex systems and also indicate poor resource utilization scenario, also the additional hardware are heterogeneous which is knapsack to build universal virtual reality applications over the cloud.

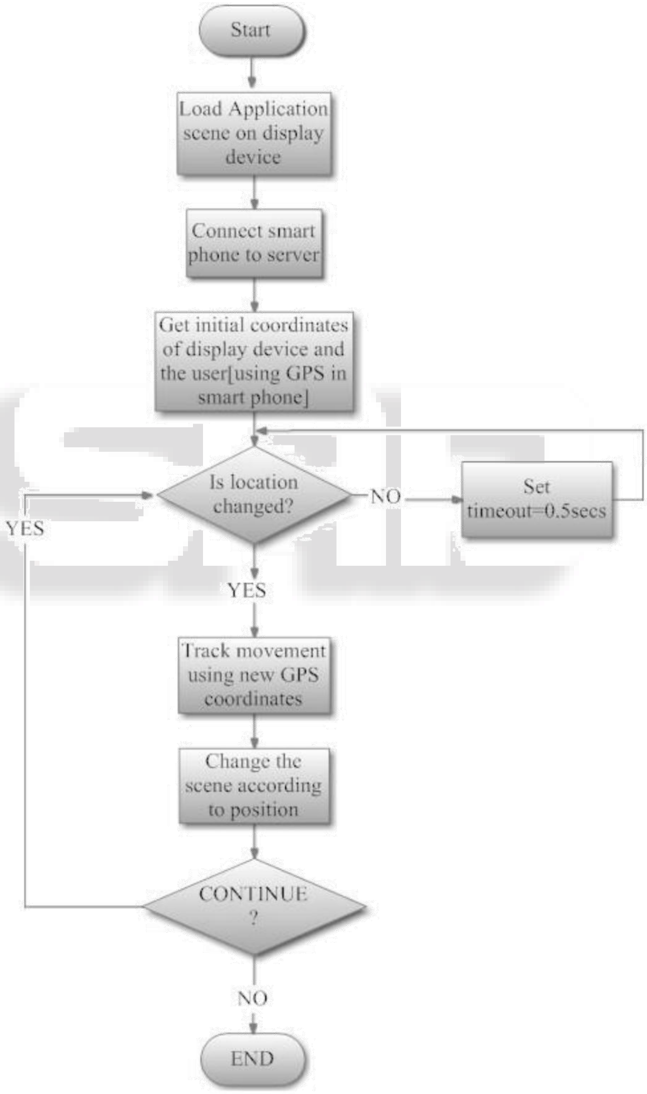

Fig. 2: Flow chart

The application first loads into display device from the cloud and smart phone also get connected to cloud server. After both the display device and smart phone are connected, the server calibrates the initial GPS coordinates of the user and display device using smartphone. Then the virtual reality application running over the cloud server checks for any location change, if the server identifies there is movement of user by calculating the new coordinates of user with respect to coordinates of the display device then the server updates scene in the display device. If the location is stationary then the server triggers a timeout of 0.5secs to save the CPU cycles. This process runs in loop and display system updates scene unless user wants to terminate the application.

E. Results

1) *Case1:* This is the initial position of the display device indicated by point D and user depicted as point P. Initial scene of a three dimensional image is shown below. By using Haversine Formula, the distance between display device and the user is about 0.009 miles.

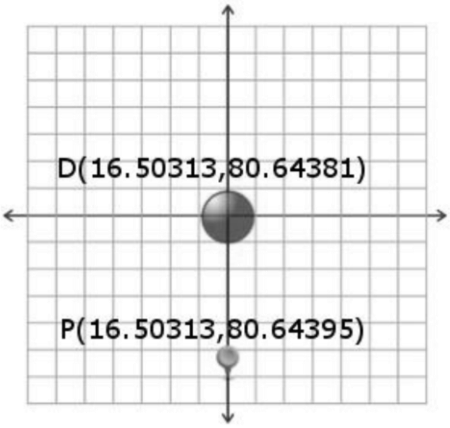

Fig. 3: Case1 coordinates

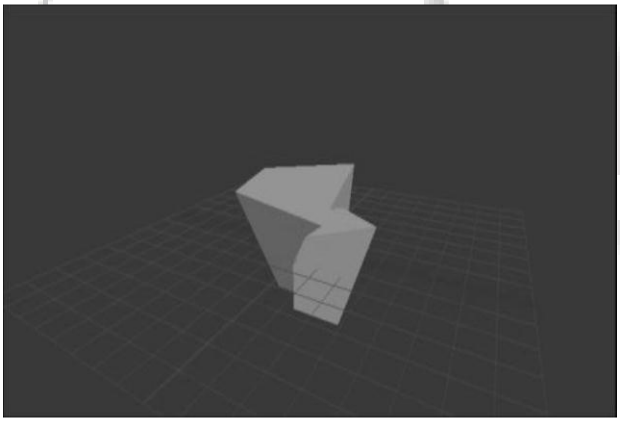

Fig. 4: Case1 scene

2) *Case2:* Now the user moves towards the display system, hence the GPS coordinates change and the net distance between display device and user is calculated as 0.004 miles with latitude value of both points being same, hence it can be inferred that the user has been moving towards the display system. The scene is updated with new scene which shows the zoomed effect of the three dimensional image.

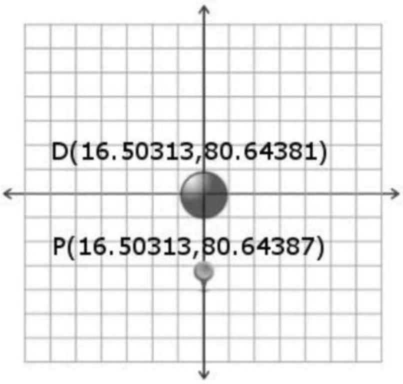

Fig. 5: Case2 coordinates

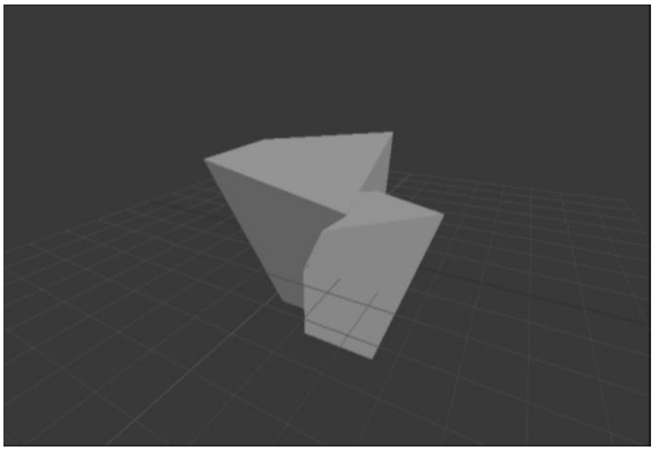

Fig. 6: Case2 scene

3) *Case3:* Now the user moves towards his right and now the distance of the new GPS location is found out to be 0.07 miles and both latitude, longitude being different. Also the latitude of the user is greater than the display device, it can be inferred that the user has moved towards his right and scene is updated with new frame showing the right face of the three dimensional image by rotation effect.

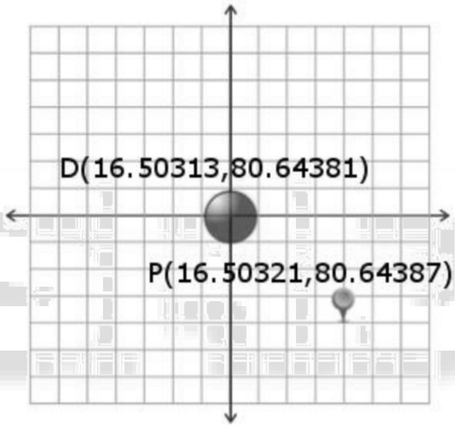

Fig. 7: Case3 coordinates

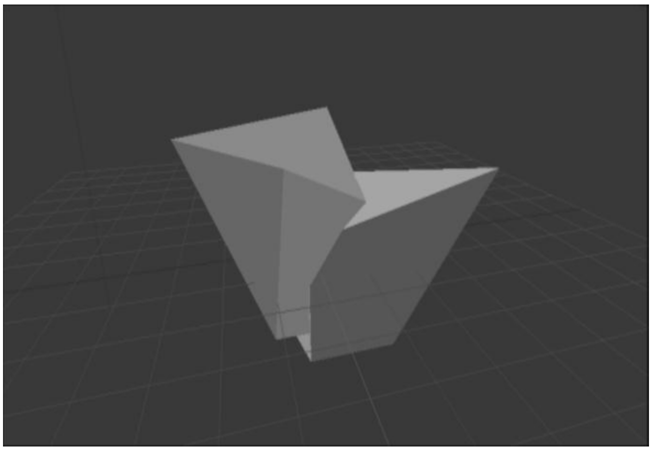

Fig. 8: Case3 scene

4) *Case4:* Now the user moves towards his left and the new coordinates have been updated. Now the distance between the two points D and P is 0.07 miles but this time the latitude of the point D is much greater than the latitude of point P. Hence, it can be inferred that the user have been moving towards his left and the scene is updated with the new value revealing the left face of the three dimensional image by applying rotation of scene.

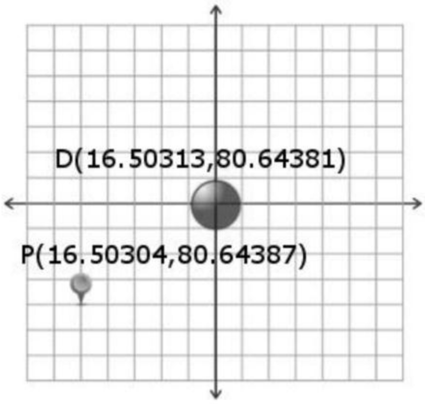

Fig. 9: Case4 coordinates

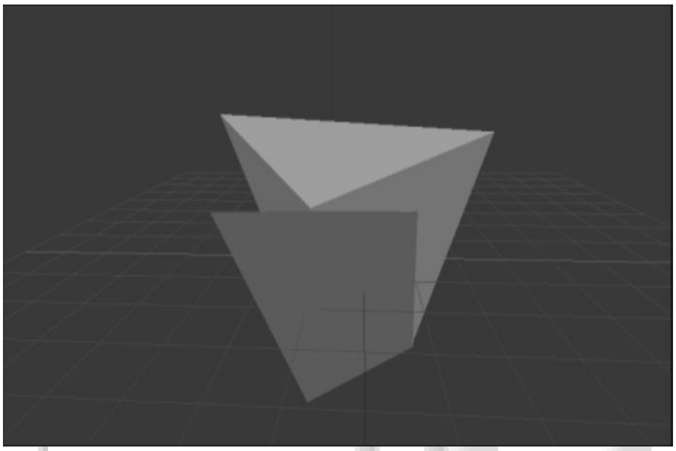

Fig. 10: Case4 scene

IV. CONCLUSION

In this paper, we have suggested an architecture where the virtual reality applications could be served as a service and smartphones could be used to sense the user's interactions. Though there are challenges in the architecture, further improvements in existing methodologies could bring VRaaS to reality. Also suggested architecture could free users from wearing sensors and body attached systems. A sample application to the VRaaS has been illustrated. Numerous applications can be developed using our architecture.

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