

# Virtual Reality Platform for Enhancing the Virtual Objects in Building Automation

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**Abstract**— Surfing the Web while walking down a crowded street or driving a car may create a problem. Augmented reality- in the form of Google Glass, Sony's Smart Eyeglass, or Microsoft HoloLens- may appear to solve that problem. These devices present contextual information transparently or in a way that obscures little, seemingly letting you navigate the world safely, in the same way head-up displays enable fighter pilots to maintain situational awareness. In this paper we will study the application of virtual reality in building automation. With augmented-reality gear barely on the market, rigorous studies of its effects on vision and mobility have yet to be done. To develop an Application to visualize the architecture of flat on development site with the concept of virtual reality. With the help of android phone and Google cardboard we are building a device for developing virtual reality. We are also developing the application for tourists so they can visit the tourist's places virtually. The effects will be developed in Unity 3D and also using DIVE Software Development Kit.

**Key words:** Augmented Reality, Google Cardboard, Unity 3D, DIVE Software Development Kit

## I. INTRODUCTION

### A. Virtual Reality

Virtual reality is the fully immersed computer simulated environment that gives the user the feeling of being in that environment instead of the one they are actually in. A lot of videos games have already developed the technology and put the user in an interactive world in the driver seat of the car or on the battle field etc. The perception of reality is not alter or simply a spectator on seeing events that are happened in virtual world. In order of your brain to perceive a virtual environment there are few factors that are vital for the creation of an immersive experience necessary for virtual reality. There are some popular display methods to experience virtual reality is through a head set. Head set devices uses stereoscopic display to make you see three dimensional and the depth to the image you are looking at, like how our eyes see. Stereoscopic display does not make an immersive experience. The ability to track users motion, particularly there head and eye movement, allows the image display in the head set actually change the perspective. The movement of head to different directions allows the image to render what in present in that environment. Besides vision certain virtual reality experiences will also include other sensory simulation like sound and even tactile feedback like touch. Lastly in order to truly alter the perception of our reality there has to be certain level of virtual interactivity. True interactivity should allow certain level of user control navigation. When we are able to freely move within that environment and interact with things in it, our brain can truly perceive that world is real and thus virtual reality. Virtual reality has a lot of practical applications as outside

of gaming and has been used as a training simulators for soldiers, pilots and doctors. Devices like google cardboard and oculus rift have advanced the virtual reality experience. Virtual reality is a static model, it does not require any real world input. Augmented Reality, in which 3-D virtual objects are integrated into a 3-D real environment in real time [1]. Augmented reality inherits the features of virtual reality and combines it with the real world environment.

Augmented reality is the complete renaissance in approach to technology, convergence in seen through mobile device, the ability to see elements with it the floor, the wall. Augmented reality is when digital information is overlaid onto the actual real world. The camera detects the target image and figure out how closer and at what angel the target is from the cameras using sensors and then it projects the digital image onto that target image and hence creates augmented reality. Some of the earlier usages of augmented reality were in the heads-up displays used by fire jets, allowing piolets to see important information projected in front of their wind shields. This technology in gaming is used now in Google hololense , the hololense uses the advanced sensors and hardware to scan the room and created images based on our physical space the Augmented reality has also between the internet and reality. There are various applications of Augmented reality such as in military training [2], medical systems [3, 4, 5], engineering and consumer design [6], robotics [7], as well as manufacturing, maintenance and repair [8, 9].



Fig. 1: VR View in Day Light Scene



Fig. 2: VR View in Night Scene

In this paper the application of virtual reality in the field of building automation is discussed. The virtual reality has given the platform to integrate the virtual objects. The hardware used are google cardboard and the android smart phone. The software used are blender/3D max/Maya, unity 3D, and an android application. The model is modelled, and then is imported in the unity 3D software where the different operations are performed on it.

### B. System Architecture

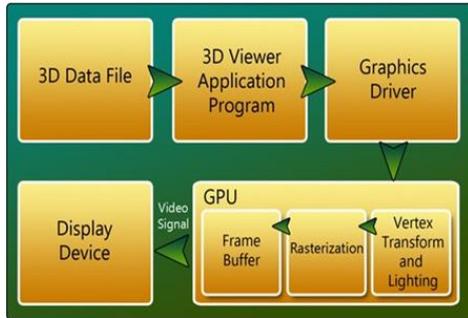


Fig. 2: System Architecture

The software architecture is what and where of the software. The system architecture shows the internal working and the communication between various components. Initially the 3D module is created in blender/3D max/Maya software and then it is imported in the unity game engine where the static module is given various movements and different features can also be added. The system architecture includes a 3D data file which is being given as an input to the 3D application program (mobile). The 3D app program or the mobile devices contains the inbuilt graphics driver and GPU. After taking input 3D data as an input file from graphics driver, GPU will perform three operations: vertex transform, rasterisation, and frame buffer. Vertex transform and lightning will includes repositioning of pixels and texturing of objects. In rasterisation process the object pixels are scanned line by line and after ray casting, the view is visible to the end user. In frame buffer we are storing the 3D models, these models get displayed on display device through the video signal when respective model get called from the end user.

#### 1) 3D Data File

This file is the model, with various features like colour changing, object picking etc, is imported in the android application.

#### 2) Graphics Driver

A program that controls the working of graphics components work with the rest of computer software.

#### 3) Graphics Card

The graphics (pictures, videos, programs, animation, and 3D) when displayed on the computer screen at that time the graphics component which is the part of computer, called as graphics card, controls the enhancement of these features.

#### 4) GPU

NVIDIA makes GPU which is similar to CPU, but they differ in the type of computations they are designed to do. GPU supports graphics applications in our computer.

#### 5) Vertex Transform

When you transform a vertex by the model view matrix, the vertex is considered to be in eye space. Note: The model view matrix is actually 2 matrices in 1. The world matrix

which transforms from object space to world space and the view matrix which transforms from world to eye space.

#### 6) Rasterization

Rasterisation is the process in which an image which is described in vector graphics format and is converted into pixels and dots for output.

#### 7) Frame Buffer

RAM has a portion called as frame buffer which contains a bitmap that is drive to a video display from a memory buffer which contains a complete frame of data.

#### 8) Display Device

The output device is called as display device which presents the information in visual or tactical form.

The system architecture includes a 3D data file which is being given as an input to the 3D application program (mobile). The 3D app program or the mobile devices contains the inbuilt graphics driver and GPU.

### C. Flow of System

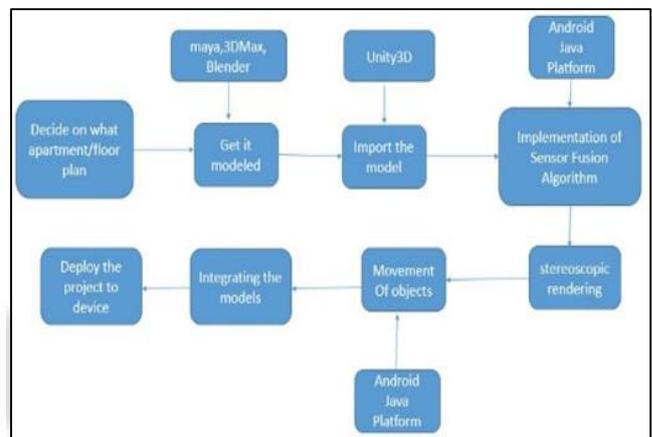


Fig. 2: Flow of System

The prerequisites for this application is the prior requirement collection by the developer from the user, so, that the developer will be able to make a confirm decision about the modelling of the flat/building. The modelling is done in blender/max/Maya and then the “.fbx” file or the “.obj” file generated is imported into unity software which is a game engine. With the software platform like Unity 3D, the democratization of applications development is well underway. Different sensors like magnetometer, gyroscope, accelerometer etc. which are already present in the smart mobile devices are used for head tracking of objects.

#### 1) Rendering

Rendering is the name given to a process in three-dimensional graphics whereby a geometric description of an object is converted into three dimensional image-plan representation that looks real

## II. IMPLEMENTATION

In the development of virtual reality system, we need both hardware and software sophistications. While designing the virtual reality application, the platform provided to the user is simple and easily understandable.

In the first phase of implementation, the developer is given the users requirement and then as per the requirements given, the developer will build a model. The modelling part and the implementation part is done using different platforms.

In the second phase of implementation, the model built is imported in unity software where actual implementation part is done

#### A. Tools and Technologies

##### 1) 3D Max

Autodesk 3ds Max, formerly 3D Studio, then 3D Studio Max is a professional 3D computer graphics program for making 3D animations, models, games and images. It is developed and produced by Autodesk Media and Entertainment. It has modeling capabilities, a flexible plugin architecture and can be used on the Microsoft Windows platform. It is frequently used by video game developers, many TV commercial studios and architectural visualization studios. It is also used for movie effects and movie pre-visualization. To its modeling and animation tools, the latest version of 3ds Max also features shaders (such as ambient occlusion and subsurface scattering), dynamic simulation, particle systems, radiosity, normal map creation and rendering, global illumination, a customizable user interface, and its own scripting language.

##### 2) Unity 3D

Unity is a cross-platform game engine developed by Unity Technologies and used to develop video games for PC, consoles, mobile devices and websites. First announced only for OS X, at Apple's Worldwide Developers Conference in 2005, it has since been extended to target more than fifteen platforms. It is the default software development kit (SDK) for the Wii U.

Five major versions of Unity have been released. At the 2006 WWDC trade show, Apple Inc. named Unity as the runner up for its Best Use of Mac OS X Graphics category.

With an emphasis on portability, the engine targets the following APIs: Direct3D on Windows and Xbox 360; OpenGL on Mac and Windows; OpenGL ES on Android and iOS; and proprietary APIs on video game consoles. Unity allows specification of texture compression and resolution settings for each platform the game engine supports, and provides support for bump mapping, reflection mapping, parallax mapping, screen space ambient occlusion (SSAO), dynamic shadows using shadow maps, render-to-texture and full-screen post-processing effects.[6] Unity's graphics engine's platform diversity can provide a shader with multiple variants and a declarative fallback specification, allowing Unity to detect the best variant for the current video hardware; and if none are compatible, fall back to an alternative shader that may sacrifice features for performance. Unity is notable for its ability to target games to multiple platforms. Within a project, developers have control over delivery to mobile devices, web browsers, desktops, and consoles. Supported platforms include Android, Apple TV, BlackBerry 10, iOS, Linux, Nintendo 3DS line, OS X, PlayStation 3, PlayStation 4, PlayStation Vita, Unity Web Player, Windows Phone 8, Windows, Xbox 360, and Xbox One. It includes an asset server and Nvidia's PhysX physics engine. Unity Web Player is a browser plugin that is supported in Windows and OS X only. Unity is the default software development kit (SDK) for Nintendo's Wii U video game console platform, with a free copy included by Nintendo with each Wii U developer

license. Unity Technologies calls this bundling of a third-party SDK an industry first.

##### 3) 3D MAYA

Maya 3D animation, modelling, simulation and rendering software offers artists a comprehensive creative tool set. These tools provide a starting point to realise your vision in modelling, animation, lighting and VFX.

Maya was originally a next-generation animation product based on code from The Advanced Visualizer by Wavefront Technologies, PowerAnimator by Alias Research, Inc., and Alias Sketch!. The code was ported to IRIX and animation features were added; the porting project codename was Maya. Walt Disney Feature Animation collaborated closely with Maya's development during its production of Dinosaur. Disney requested that the User interface of the application be customizable so that a personalized workflow could be created. This was a particular influence in the open architecture of Maya, and partly responsible for it becoming so popular in the industry.

Wavefront's next-generation technology (then under development) was merged into Maya. SGI's acquisition was a response to Microsoft Corporation acquiring Softimage, Co.. The new wholly owned subsidiary was named "Alias|Wavefront".

In the early days of development, Maya started with Tcl as the scripting language, in order to leverage its similarity to a Unix shell language. But after the merger with Wavefront, Sophia, the scripting language in Wavefront's Dynamation, was chosen as the basis of MEL (Maya embedded language).

Maya 1.0 was released in February 1998. Following a series of acquisitions, Maya was bought by Autodesk in 2005. Under the name of the new parent company, Maya was renamed Autodesk Maya. However, the name "Maya" continues to be the dominant name used for the product.

##### 4) Android SDK

The Android software development kit (SDK) includes a comprehensive set of development tools. These include a debugger, libraries, a handset emulator based on QEMU, documentation, sample code, and tutorials. Currently supported development platforms include computers running Linux (any modern desktop Linux distribution), Mac OS X 10.5.8 or later, and Windows XP or later. As of March 2015, the SDK is not available on Android itself, but the software development is possible by using specialized Android applications. Until around the end of 2014, the officially supported integrated development environment (IDE) was Eclipse using the Android Development Tools (ADT) Plugin, though IntelliJ IDEA IDE (all editions) fully supports Android development out of the box, and NetBeans IDE also supports Android development via a plugin. As of 2015, Android Studio, made by Google and powered by IntelliJ, is the official IDE; however, developers are free to use others. Additionally, developers may use any text editor to edit Java and XML files, then use command line tools (Java Development Kit and Apache Ant are required) to create, build and debug Android applications as well as control attached Android devices (e.g., triggering a reboot, installing software package(s) remotely). Enhancements to Android's SDK go hand in hand with the overall Android platform development. The SDK also supports older

versions of the Android platform in case developers wish to target their applications at older devices. Development tools are downloadable components, so after one has downloaded the latest version and platform, older platforms and tools can also be downloaded for compatibility testing. Android software development is the process by which new applications are created for the Android operating system. Applications are usually developed in Java programming language using the Android software development kit (SDK), but other development environments are also available.

### III. ALGORITHM

In mathematics and computer science, an algorithm is a step-by-step procedure for calculations. Algorithms are used for calculations, data processing and automated reasoning. In this project mainly two projects are used: Sensor fusion algorithm and A\* algorithm.

#### A. Sensor Fusion

The data derived from disparate sources or the combination of sensory data which has less uncertainty than would be possible when these sources were used individually. For example, whenever we are using navigation in our smart phone and we suddenly enter into a tunnel and suddenly loses GPS signal. At that time our smart phones continues to track the position through the tunnel, using the technique called dead reckoning. Dead reckoning calculated the position in real time when we loses signal. To calculate the position changes the smart phone uses the built in sensors, specifically the accelerometer, and gyroscope. The concept of combining the data from accelerometer and gyroscope is called sensor fusion.

#### B. A\* Algorithm

A\* is an algorithm that allows a computer to find the optimal path between two nodes. A\* is an informed search algorithm, or a best-first search, meaning that it solves problems by searching among all possible paths to the solution (goal) for the one that incurs the smallest cost (least distance travelled, shortest time, etc.), and among these paths it first considers the ones that appear to lead most quickly to the solution. It is formulated in terms of weighted graphs: starting from a specific node of a graph, it constructs a tree of paths starting from that node, expanding paths one step at a time, until one of its paths ends at the predetermined goal node.

At each iteration of its main loop, A\* needs to determine which of its partial paths to expand into one or more longer paths. It does so based on an estimate of the cost (total weight) still to go to the goal node. Specifically, A\* selects the path that minimizes

where  $n$  is the last node on the path,  $g(n)$  is the cost of the path from the start node to  $n$ , and  $h(n)$  is a heuristic that estimates the cost of the cheapest path from  $n$  to the goal. The heuristic is problem-specific. For the algorithm to find the actual shortest path, the heuristic function must be admissible, meaning that it never overestimates the actual cost to get to the nearest goal node.

Typical implementations of A\* use a priority queue to perform the repeated selection of minimum (estimated) cost nodes to expand. This priority queue is known as the

open set or fringe. At each step of the algorithm, the node with the lowest  $f(x)$  value is removed from the queue, the  $f$  and  $g$  values of its neighbours are updated accordingly, and these neighbours are added to the queue. The algorithm continues until a goal node has a lower  $f$  value than any node in the queue (or until the queue is empty). The  $f$  value of the goal is then the length of the shortest path, since  $h$  at the goal is zero in an admissible heuristic.

The algorithm described so far gives us only the length of the shortest path. To find the actual sequence of steps, the algorithm can be easily revised so that each node on the path keeps track of its predecessor. After this algorithm is run, the ending node will point to its predecessor, and so on, until some node's predecessor is the start node.

As an example, when searching for the shortest route on a map,  $h(x)$  might represent the straight-line distance to the goal, since that is physically the smallest possible distance between any two points.

If the heuristic  $h$  satisfies the additional condition  $h(x) \leq d(x, y) + h(y)$  for every edge  $(x, y)$  of the graph (where  $d$  denotes the length of that edge), then  $h$  is called monotone, or consistent. In such a case, A\* can be implemented more efficiently—roughly speaking, no node needs to be processed more than once (see closed set below)—and A\* is equivalent to running Dijkstra's algorithm with the reduced cost  $d'(x, y) = d(x, y) + h(y) - h(x)$ .

Additionally, if the heuristic is monotonic (or consistent, see below), a closed set of nodes already traversed may be used to make the search more efficient.

### IV. RESULT

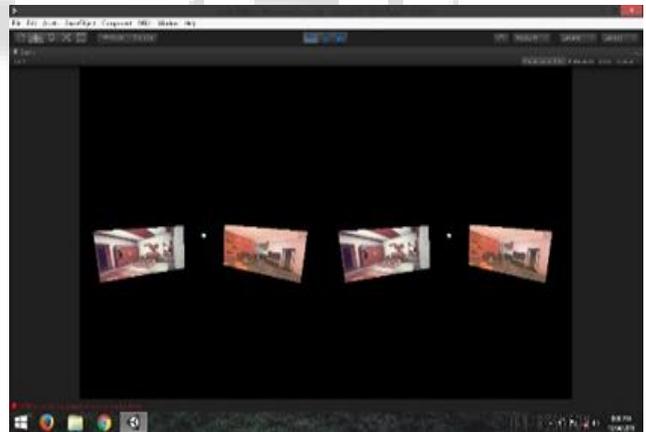


Fig. 1: Start Window

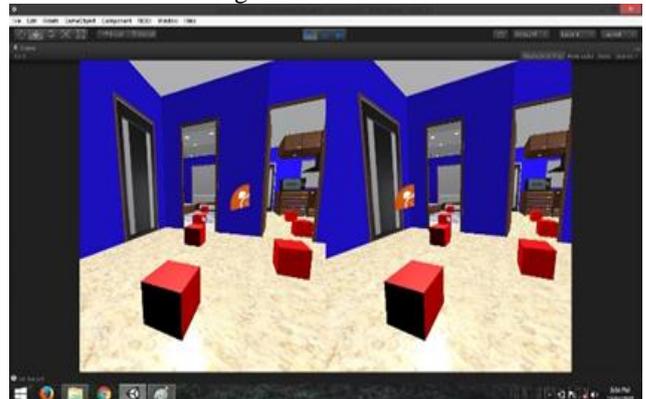


Fig. 2: Entered into Selected Module

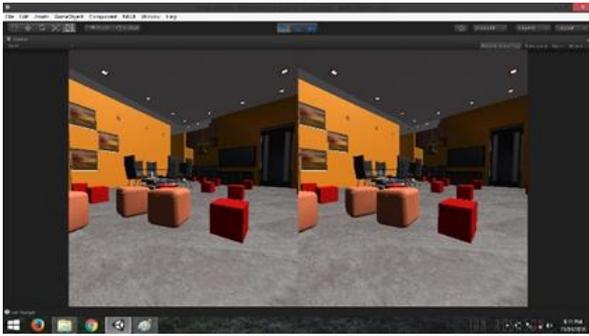


Fig. 3: Entered into Another Module

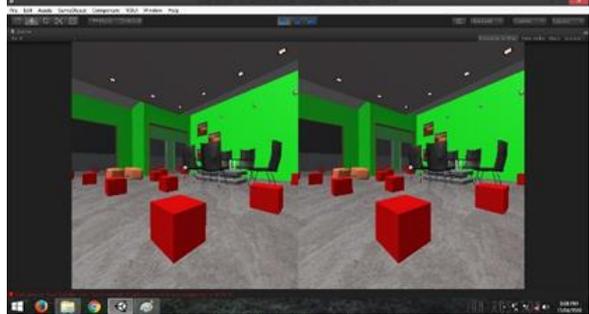


Fig. 4: Moving towards Nodes into Module



Fig. 5: Exit from the Module

A. Graphical Comparison

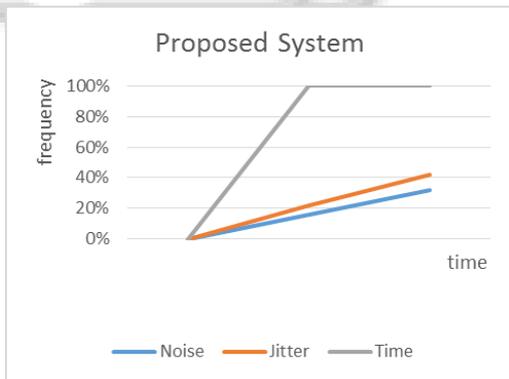


Fig. 6: Proposed System

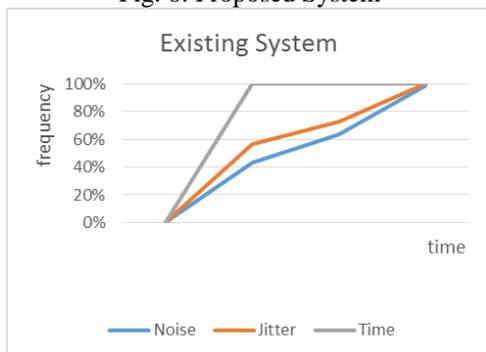


Fig. 7: Existing System

V. EXPERIMENTAL EVALUATION

The system is implemented in c# script and executed on a smart phone, which is an embedded mobile device with android platform and 4GB of RAM. Average ray casting (included feature tracking front end) computation takes about 3 seconds. This amount of delay is accurate for a normal user for tracking of nodes. The delay can be increased or decreased as per user's requirement. Our experimental evaluation consists of two parts: modelling and ray casting. The first part will demonstrate the modelling of the flat/building as per user's requirement. The modelling is done in the software like, blender, Maya, 3D max. In the second part the model is imported in the unity 3D game engine where the motion and the features are added into it. In our application we have added two features which are colour changing and object movement

VI. CONCLUSION AND FUTURE SCOPE

Based on virtual reality the concept for sense of feel would be implemented in future for the better visualisation for the buyer along with sense of feel stereoscopic view can be added as an option to the VI0 1-Glasses in order to make the three dimension symbols more realistic.

Our next step will be expanding the algorithm such that it can measure the position in three dimension of the images and will help to recreate the historical scenes which were taken place before thousands of years.

ACKNOWLEDGEMENT

The authors would like to thank their project guide Prof. Snehal kanade for sharing her knowledge during the project preparation. We would like to thank our head of department Prof. Vikas Thombre, for his valuable guidance, and for providing all the necessary facilities, which were necessary for this experiment. We are also thankful to all the staff members of the department of Computer of SNSITS College of engineering, for their valuable support and suggestions.

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