

3D Drawing with Augmented Reality

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Abstract - 3D Drawing with Augmented Reality has been developed to bridge the gap in communicating a concept or presenting an idea in the real-world space. Such ideas when presented on paper would require the designer to empathize with the user and have a fair assumption that the idea would need to be imagined just as done by the creator. It allows content creators to draw in the air, treating the world as their canvas. A connection is established between the users to view each other's drawings or notes in the 3D space. This requires the users to be on the same network. This application is going to help content creators a great deal in helping them present their ideas better. It is also going to replace sticky notes and other messages on paper with messages left in air on the world canvas. This can also act as a doodling app where users draw lines or doodles in the 3D space in air.

Key Words: Augmented Reality, 3D Drawing, Unity 3D, ARCore, Point Clouds

1. INTRODUCTION

Virtual reality is a completely computer-generated simulation where the entire view is virtual. This means that one can manipulate this virtual world to whatever they would like it to be and produce some really amazing things. Since Virtual Reality applications are compute intensive, a parallel domain called Augmented Reality gained popularity. Augmented reality (AR) is an interactive experience of a real-world environment where the objects that reside in the real-world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities.

Augmented reality is used to enhance natural environments or situations and offer perceptually enriched experiences. With the help of advanced AR technologies (e.g. adding computer vision and object recognition) the information about the surrounding real world of the user becomes interactive and digitally manipulatable. Information about the environment and its objects is overlaid on the real world. This information can be virtual or real, e.g. seeing other real sensed or measured information such as electromagnetic radio waves overlaid in exact alignment with where they actually are in space. Augmented reality also has a lot of potential in the gathering and sharing of tacit knowledge. Augmentation techniques are typically performed in real time and in semantic context with environmental elements. Immersive perceptual information is sometimes combined with supplemental information like scores over a live video

feed of a sporting event. This combines the benefits of both augmented reality technology and heads up display technology (HUD). In Augmented Reality, the computer uses sensors and algorithms to determine the position and orientation of a camera. AR technology then renders the 3D graphics as they would appear from the viewpoint of the camera, superimposing the computer-generated images over a user's view of the real world. Solutions which allowing humans to explore fully immersive computer-generated worlds (in VR), and overlay computer graphics onto our view of our immediate environment (AR) are both increasingly being adopted in both entertainment and industry.

Over the next year, both VR and AR applications will become increasingly sophisticated, as devices get more powerful and capable of creating higher quality visuals. Our understanding of how humans can usefully navigate and interact within virtual or augmented environments will also evolve, leading to the creation of more methods of interacting and exploring virtual space.

- **Wearable:** Although augmented reality technology designed exclusively for mobile devices can certainly provide users with exciting, unique experiences, these devices place certain limits on the quality of those experiences.
- **Improved Tracking:** Augmented reality software must achieve a difficult goal: tracking objects in the real world and seamlessly presenting an AR experience to the user. The more objects, software can track the more options AR development teams have.
- **Moving Away from Markers:** Currently, the vast majority of AR products use markers to trigger AR experiences. However, developers for augmented reality products want the ability to use targets that can shift due to real-world variables.

3D drawing with augmented reality provides a platform for the user to treat the world as a canvas and draw anywhere in air. 3D drawing with augmented reality lets multiple users to draw on a common real-world location at the same time with real-time display of each other's work.

Rest of the paper is organized as follows, Section I contains the introduction of Augmented Reality and 3D drawing with

AR, Section II contain the related work of Unity 3D, SLAM, HCI, OpenLobby and Bare-Handed 3D Drawing in Augmented Reality, Section III contains design and techniques used, Section IV describes results and discussion, and Section V concludes research work with future directions.

2. Related Work

Title: Review on simultaneous localization and mapping (SLAM)

Problem statement: To convert data from the sensor reading into SLAM Map based on the results obtained in mapping and localization

Objectives: Mapping (Environment Representation): Mapping gives capabilities for mobile robot to generate a map of the environment using the hardware sensor to receive the data of the environment. Localization (Location Estimation): Localization is one of the SLAM features as the mobile robot able to calculate and estimate landmark position and mobile robot trajectory based on the generated map from the mapping process.

Title: Human Computer Interface- Augmented Reality

Problem statement: To convert text, voice, sensor readings and gestures into a virtual experience to create man-machine interaction

Objectives: The input given to Human Computer Interaction (HCI) module is text, voice, sensor readings and gestures (hand or head movements). The HCI module, has different modes like, Information visualization, Internet of things, augmented reality, Virtual reality. Finally, it provides virtual experience and a sophisticated man-machine interaction

Title: Openlobby: an open game server for lobby and matchmaking

Problem statement: The web server is responsible in receiving and processing request from client and sending the appropriate response to client.

Objectives: The first basic function of the server is to register a new player who would like to join a multiplayer game session. When a client is requesting to join a multiplayer game, it sends a request to join to the server. The server is then kept the basic information related to the request such as request arrival time and client's IP address. The second basic function is to inform the client whether the client has been joined to a multiplayer session. Our system follows a pull-notification method to perform this function; clients send a request to get the update from the server. The third function is to update the player's information related to the game such as score, win/lose, rank, etc. This information is sent after a multiplayer session has completed.

Title: Research on key technologies base Unity3D game engine

Problem statement: Understanding hierarchy for organizing objects in Unity3D game project

Objectives: The component model is applied in the Unity3D game development, which provides a scalable programming architecture. A GameObject represents a game object, which has the characteristics of a container. According to the needs of a game, many different components are added into a GameObject. Programmers can create an empty GameObject with the information about position, rotation and scale of an object, and then add scripts or other components into it. In order to facilitate the same type of game object management, Unity3D affords the Prefab that is a technology like a template. A script is a class controlling the behavior of a game, which should inherit a base class called MonoBehaviour.

Title: Bare-Handed 3D Drawing in Augmented Reality

Problem statement: To allow users to draw lines in 3D space

Objectives:

Freehand: The Freehand technique allows the user to draw continuously as directed by hand movements. To start a line the user performs the air-tap gesture. The line is drawn continuously at the index cursor position until the user terminates the line by performing a second air-tap.

Tapline: The Tapline technique allows the user to draw a line by specifying control points. Tapline seeks to accommodate the design principle of Promote Spatial Awareness in allowing the user to move and look around in between designating control points. To add a control point, the user directs the index cursor to the desired location and performs an air-tap. GoGo-Tapline: The GoGo-Tapline represents an extension of the Tapline technique. The user places sequential control points to construct a line as per Tapline. However, the GoGo-Tapline control points are placed at the GoGo-cursor position rather than at the index cursor.

3. Methodology

Problem statement: Develop a collaborative application for users to overlay their virtual designs over the real-world canvas and share it with others.

Objectives: Develop a mobile application that runs on Android devices and lets the user draw on the world, treating it as a canvas, implement real-time sync of the drawing on all instances of the application running in the same network room and provide a tool for creative content producers to quickly sketch their ideas in 3D spaces.

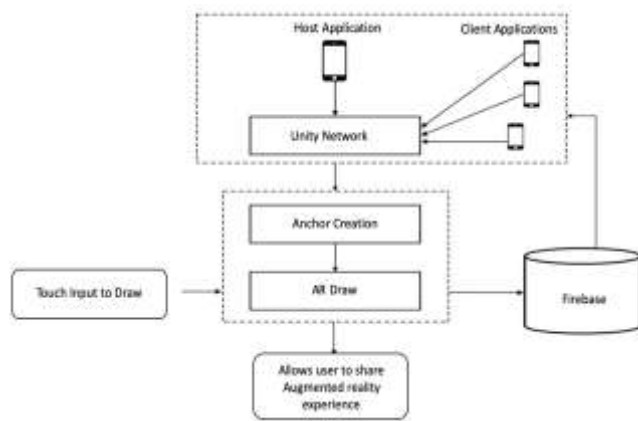


Fig 1: System Architecture

The Architecture as shown in Fig.1 is composed of:

Host: The host is the one that starts a game by providing name of the game, which is then made visible (list of servers) to all the clients connected to the same network as the host and looking to join a game. The host can start and can also act as a client in a single-user environment.

Client: These are the remote clients connected to the same network as that of the host. They have an option to join any of the game hosted in the network from the 'list of servers'.

Unity Network: This is the module where process of matchmaking occurs.

Anchor Creation: This is the module where the current position of the host is created as an anchor and shared among the clients.

AR Draw: This is the module where any user's (host/client) free hand drawing is rendered in 3D space and shared among others.

Firebase: Firebase provides a real-time database and backend as a service. The service provides application developers an API that allows application data to be synchronized across clients and stored on Firebase's cloud.

The System has the following modules:

Unity Network: Unity's Multiplayer Service is the easiest way to set up real-time, networked games for Unity. It's fast to implement and highly customizable. Unity-provided servers and matchmaking services ensure that your players can easily find and play with each other. **Matchmaking:** From the lobby, players can choose to host and create a new room or join an existing room. Every user is given a unique id with which he is recognized on the network. Host also acts as Local Client and Server. The multiplayer networking feature includes services for players to play with each other over the internet without needing a public IP address. Users can create games, get lists of active games; and join and leave games. When playing over the internet, network traffic goes

through a relay server hosted by Unity in the cloud instead of directly between the clients. This avoids problems with firewalls and NATs, allowing play from almost anywhere.

Anchor Creation: The steps for anchor creation are:

Step 1: When a host creates a new room, he has to scan the environment to generate a SLAM map with generated point cloud data.

Step 2: This SLAM map is then used to create an anchor object on the host instance, which is then uploaded to the firebase real-time database. Firebase real-time database is an unstructured database where the user can upload data as nodes in the form of a tree.

Step 3: This anchor object then has to be resolved on the client instance of the application which join the same room as host

AR Draw: This module works on creating line renderers in the world space from the screen space coordinates of the users touch on his mobile. This requires the user to provide a touch input and it translates the same into a 3d point in the world space. The Graphics class allows drawing a mesh directly without the overhead of creating game objects and components to hold it. Since meshes are composed of surfaces rather than lines or points, in 3D space a line is best rendered as a very thin quad. A quad is described with 4 vertices, and usually we will only have the start and end points and a width. First, you get the normal of the plane on which both start and end vectors lie. This will be the plane on which the line-quad will located. The cross product of the normal and of the difference between end and start vectors gives you the side vector (the "thin" side of the quad). It needs to be normalized to make it a unit vector. Finally calculate all 4 points of the rectangle by adding the side vector multiplied by half width to both start and end points in both directions. In the source code all this happens in MakeQuad and AddLine methods.

4. Results and Discussion



Fig 2: Drawing 3D images



Fig 3: Viewing 3D spiral

Snapshots are shown in Fig. 2 and Fig. 3.

Performance Analysis: The application was developed on a game engine called Unity3D. Testing is the process of evaluating a system or its components with the intent to find whether it satisfies the specified requirements or not. Unity3D provides a tool that helps evaluate the same. Unity profiler is the tool which helps you analyze the performance of the application. The Unity Profiler Window helps you to optimize your game. It reports for you how much time is spent in the various areas of your game. For example, it can report the percentage of time spent rendering, animating or in your game logic. It can be noticed that the major CPU utilization is taken by the Camera. Renderer which is a total of 71%. This is also the reason why AR applications drain so much battery. Another measure of performance is Frame Rate per Second (FPS). For most mobile applications accepted FPS is 40-60 FPS. And the observed FPS of our application is 45 FPS.

5. Conclusion and Future Scope

Conclusion: 3D drawing with augmented reality is a mobile application for all content creators irrespective of the genre they work in. It provides unique techniques of presenting content and ideas. The application works on Android leveraging the AR capabilities of AR Core. It is a real-time multiplayer and allows two users to view content simultaneously and updates the new content generated real-time.

Future Work: The degree of accuracy of re-localizing the content placed on the world canvas can be greatly improved. Technical limitations are the reason this couldn't be achieved as of now. Volumetric training and point cloud data classification can be added to the application. This would eliminate the need to make a rest call to any cognitive service and can be done locally.

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