3D HOUSE TOUR USING AR & AI

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ABSTRACT:
Virtual tours are really in demand nowadays as they present a complete experience of a 3D dynamic model building and many users want to see virtual home before buying a real one. This project will demonstrate the smart house with virtual tours and voice controlled. This tour is linked with augmented reality and artificial intelligence with voice-controlled bot and navigation tool. This app will let the client’s control 3D homes in real time using their smart phones and showcasing the plan of the house.

Index Terms: Augmented Reality, Unity 3D House, Voice controlled chat bot.

I. INTRODUCTION

1.1 About the project
Virtual Reality and Augmented reality are the modern Sort of visualizations. As the days are going by VR and AR are expanding their stronghold in the digital market more and more firmly. AR and VR are finding their use in various industries these days like gaming industry, movie industry as well as several other entertainment industries. VR also have seen its fair share of use in sports industry where by using a high resolution 360 degrees Virtual Reality camera, the live matches can be broadcast virtually so that the viewers will feels as if they are present in the stadium watching the game live, which is otherwise pretty hard as watching matches live in the stadium mostly requires oversees travelling and can cost a lot. Although AR and VR can be vigorously used for entertainment purposes, limiting it there would be a big waste of its vast repertoire of functionalities. Through this project we are trying to demonstrate the potential of AR and VR in the real estate business, we believe that the implementation of 3D AR and VR in real estate business can enhance the user experience manifolds. This 3D models help in understanding the Merchandise easily. These new technologies are often Utilized in development of 3d applications. Building 3d application using VR/AR has now become a trend.

Using VR/AR we Will provide virtual tours for products like Houses. Many big MNCs have generated 3D applications to visit certain premises that they want to demonstrate. We develop this 3d application in Unity 3D engine.

In our project we plan on enhancing the virtual experience by completely removing hardware cost.

By introducing AI we're making the project more complex but at the same time it also improves user experience massively.
1.2 Problem Statement

In this digital age, for renting or buying houses one has to visit each site physically before deciding upon one. This can both be cost ineffective as well as a huge waste of time. Also, due to current covid crisis its very unsafe to visit new places and meet new people physically. The number of different venues one has to visit before deciding upon a property can be very tiring and both physically and mentally draining. Therefore, the idea of this project is to help the us virtually visit different sites through their smart phone and thus decide which house he actually wants to buy or rent. To enhance the user experience, we will be providing voice-controlled Bot and manual navigation controls, as usual navigation’s can be very mechanical and robotic at times, ruining the user experience entirely.

II. LITERATURE SURVEY

2.1 Overview

Connecting 3D Engine Unity and Micro controller Arduino: A Virtual Smart House Cybernetics and Informatics, Lazy pod Makytou, (2018)”: The paper shows an involving 3-D experience that involving virtual excursion of the smart domestic house. This assignment is setup in Unity 3-D engine, it's far an synergistic application which gives output for the perceptions and various other kind of modifications from the encircling, it's far critical to attach it with outside hardware which gets the indicators from the surroundings and sends the enter to this system. In destiny projects, using this revel in and developing this project for combined/augmented truth could be able to communicate with real sensors and actuators. This paper represents the smart house with Arduino and micro controller. Thus, it will likely be very much acceptable to operate an actual smart domestic home using a combined/augmented truth application.

“3D Intelligent Home Design using Linguistic Descriptions Only, IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), Seattle, WA, USA, (2020)”*: 3D house technology from linguistic commands is nontrivial because of inherent complex nature of his. To check the correctness of the method, we conduct multiple experiments, consisting of qualitative plus quantitative evaluations, extirpation, and many others. Outputs display that the technique performs really good than many different comparable applications, which shows the value of this initiative. Thus, it will accept to provide a smart house with design of houses with a linguistic approach description.

“Augmenting a historic house: Villa Ciani 3D, 24th VSMM (2018), San Francisco, CA, USA, (2018)”*: Villa Ciani 3D, the first augmented revel in designed for a cultural visit in an effort to discover the cultural background of Lugano. For a number of the site visitors, it changed into their first experience with augmented fact. They learn no longer handiest approximately the content, however also about a brand new technology and an augmented enjoy. Patterns emerging from statistics confirmed that site visitors commented on this limit and a number of them stated that they would really like to apply extra augmented reality cultural studies at cultural sites, with the probability of interacting with visitors. This will be a project for designers to paint on: growing new augmented fact reviews in empty or ancient homes, taking content material from digital files, including the possibility of interplay between visitors all through the go to and enhancing the immersion.

"Dynamic 3D model construction using architectural house plans, 6th NCTM, Malabe, (2017)”*: In the given paper a tool to extract values from 2D blueprint of a home (architectural/hand-drawn) and create real time 3D models is presented. The goal of this research is to make 3D models dynamically and give users the ability to customize their house plan interiors while keeping the design of the exterior structure intact. Augmented Reality gives a real visualization of the final output for customers, enabling users to generate their dream houses. This project successfully proves that a 3D model can be generated dynamically from an architectural house plan, without human help to give values manually.

"Virtual Reality Experience for Interior Design Engineering Applications, 26th Telecommunications Forum (TELFOR), Belgrade, (2018)”*: VR programs are handy tools for creating virtual domains of any kind. Because of this tool, clients can check things of their liking’s. The implies that the project ours will allow altering frames to display more homerooms, change floor, roof, etc., and bring more varying interactions with house appliances and objects. Some kind of guide for amateurs to display all the different probable actions which can be done by them. The client will then just need some time to understand VR and its workings. One more future deployment can be the implementation of a business space where four or more person can interact virtually although they might be in opposite sides of the world.
2.2 Inference from Literature survey

After going through the above mentioned five search papers thoroughly and analyzing each method demonstrated we have drawn the advantages, disadvantages, input and output of each method followed. These advantages and disadvantages were drawn in considering some specific dynamics such as accuracy, computation power required to run the algorithms, feasibility in real world availability many other real-world scenarios. We also provided input and output to provide the resources and output in each paper. For an example Connecting smart houses of Arduino follows The Virtual Smart house by using Unity, Arduino, sensors, etc. There is no voice control and there is navigation and the design is very costly. After analysis of all paper, we find there is no properly voice controlled house.

We picked these paper as they differed entirely from each other and had their own unique application that they tried with virtual or augmented reality. Many papers that were based on virtual reality had mostly the same parts in all of them. In these papers we tried to pick the unique features that the author tried to use in their project and tried to instil them in our project in a different way, so as to have a different version of something that’s already existing. In all these papers the user experience has been not so smooth. They often can be monotonous and robotic, which hinders the user greatly while exploring in the virtual space and takes away the fun of being in a 3D virtual space. A virtual space should feel like an open world or space, restricting the user movement makes the applications very linear and forceful. Also, all the projects are very costly and less user understandable. All the paper are related to architectural and design related. The user of proper scripting language is limited.

Other papers involve the developing 3d houses using AR and Unity. Unity has a greater success rate due to its support for different functions and easier access to extra material on the platform. Users are always happy when they do not have to keep searching or installing additional software to run a particular code for minimal actions. One can load multiple preexisting 3D models and designs and can also alter them easily whenever he wishes to do so. We can directly create an app in unity as unity allows to create applications for any platform, be it Windows or macOS or Android. Unity also supports use of AR with the help of Vuforia SDK which is a go to software development kit in the market when it comes to Augmented Reality applications.

III. ENHANCED PROPOSED WORK

The vision of the project is to create a 3D house control in Augmented reality. Therefore, connecting Augmented reality with Artificial Intelligence to make a Voice controlled 3D house. Then the user will be able to take a virtual tour and navigate around the house. We will create an AI ecosystem in wit.ai and train the house and convert it into a smart house. Add a voice controlled bot and navigation controls using C# and unity cloud based app to create a 3D house Tour.

VR house tours can be tedious and robotic at times which can create a very unpleasant experience for the user, with our navigation system with voice command and first-person touch navigation mode, we are making sure that user experience is enriched to its maximum. Thus, with our new proposed work, we will enhance the user experience far more. We are also cutting the huge expense that comes along with the virtual gears by completely basing our project in Augmented Reality.

Advantages of our Proposed Work:

**Cost Effective:** Using Virtual gears can cost a lot, and often the user has to buy each gear separately. As such, to decrease the costs and make it affordable for larger audience, our projects do not use any virtual gears. Instead, we build it as a smartphone application with AR features.

**Enhanced User Experience:** Often the 3D application might seem a little robotic and do not give the user freedom of exploration, they just force the user to move in the way they want, which can be very linear at times. Our project comes with built in Navigation control bot which helps in enhancing the user experience.

**Saves time:** Going to multiple venues to hunt for houses can be both time and energy consuming. Also, it increases the cost of middleman a lot. Thus, we wanted to create an application that solves the tedious issue of visiting multiple venues. Our application will save a lot of time for both customers and vendors and cut the breakage costs. Thus, will completely remove the involvement of middle men.
**Smart House:** These days the houses come with inbuilt smart features, so we decided to add the same in our 3D models as well. We train our house in Artificial Intelligence such that it can interact with the users. This gives the house a humane feel as otherwise even though 3D, the models can feel a little mechanic and robotic.

IV. METHODOLOGY

4.1 Module Description

While dividing the project into various modules, we tried to design them in such a way that each module has equal number of tasks to be performed and focuses on different aspects of the project. We also made sure that after completion of each module, the application makes a solid amount of development and is completely stable and ready for next module to begin.

As this project deals with multiple different technologies and unifies them into one single entity, we divided the project into modules where each module essentially deals with a different kind of technology. Thus, we divided it into three different modules as shown in the figure below.

The first module deals with creating a perfect 3D house, which we create in Unity 3d engine. It’s a process of creating multiple smaller structures and assembling them in a way that the house is constructed without any glitches in the 3D structure.

The second module is about training the house in an attempt to make it a smart home. We do this with the help of machine learning algorithms. We use the online platform known as wit.ai to train the 3D constructed house to understand voice commands and perform required tasks accordingly. Thus, the user will be able to interact with the house through voice commands via the use of chat bot. We do that with the help of a software development kit called SDK Vuforia. Vuforia excels in creating an environment to develop application which fall under the domain of augmented reality. We also code the buttons in this module, which will allow manual navigation for the user, which comes as an alternative to the voice command chat bot.

The third module involves instilling the augmented reality feature of the application. After this module is over, we will have the application developed and ready to be used on smartphones devices.

The flow of module description:

- **Data collection and datasets preparation**
  This will involve collection of house datasets from various sources and pre-processing them for efficient 3d output. As there can be multiple type of houses and each house can differ from other drastically, it is upon us to figure each one out separately in 3D and AR. This process involves collecting all the 3D textures and entities that are involved in building the 3D house and combining them to have the 3D models of the houses ready for the later parts of the application.

- **Training the house in AI**
  We will train the datasets in Ai ecosystem using wit.ai. wit.ai is a platform that enables one to create their own voice banks which they can later use for building voice command bots. This allows us to give smart home attributes to our houses and adds that extra human touch to the 3D model. This gives the user way better experience while exploring the houses.

- **Manual Navigation**
  Manual navigation is also a necessary feature that needs to be added for the users who just do not want to use voice commands. We can provide this feature by programming a digital joystick in C#, this joystick can let the user roam around without relying on voice commands. We will also provide first-person experience, through which the user can navigate as well as turn around as in an open world platform. The user can touch on left side of screen for movement and on right side to turn.
• **Mesh Colliders**

For manual navigation, we need to treat every 3D entity in the house as a separate solid object. For example, we do not want our user to just pass through the walls or not able to climb the stairs. For this purpose, we add mesh colliders to those 3D entities, so when the user comes in contact with them, he either gets repelled or pushed above/below. We added one below the entire 3D model and on the fences so that user does not fall out of the 3D model entirely and crash the program.

• **Developing the Application for AR**

The main catch of this project is to bring the 3D model into reality, we achieve that feat with the help of Vuforia SDK. Vuforia is to go-to software when it comes to building AR application on Unity Engine. Vuforia provides all the libraries and methods one needs to code augmented reality attributes in their program, which makes it way easier for the programmer. Vuforia provides AR camera as an alternative to normal camera, the AR camera can identify hand and other body gestures and act accordingly.

![Module Block Diagram](image)

**Fig 1: Module Block Diagram**

### 4.2 Modules

#### 4.2.1 Module 1

This module is about creating the house in a 3D platform. We use Unity 3D engine to create the house. The house is designed and also provided with directional lights. Then we created a canvas to align the house and use a paper to align the house properly. So that the house will get superimposed on the paper and a 3d image will be provided in the AR camera. Then we create button to organize each function the house can perform. We create the button on the plane and in back end we write the code in C#, so when we click on the button, we can see the house reacting accordingly to the button clicked.

#### 4.2.2 Module 2

This module is all about training the house to convert it into a smart home. We use the online platform called wit.ai for the completion of this module. We create multiple voice commands that act as instruction which the house can react to. A voice bank is created which stores the multiple voice commands that we wish to train our house on. The house is then trained to act on those commands and perform a certain task. We then code the buttons which will allow the user to manually navigate around the house, if they do not want to interact via voice commands.

#### 4.2.3 Module 3

In this module after creating navigation control and voice chat bot we implement it on the 3d house. We provide different tools to navigate around the house. Also use chat bot to directly interact with the 3d house and the user can also use buttons as controls. We deploy all this in unity using standard characters package from unity. And use SDK vuforia to run unity codes. After this we deploy the whole project in the unity app which can be accessed in both phone and tablets. And have a 3d experience from your house itself.
V. IMPLEMENTATION

5.1 Software Requirement

Unity Engine: This engine is used to create applications for desktops and mobile devices. Unity engine can create as well as import 3D models required to build applications. It also supports Augmented and Virtual Reality. It is a one the best platform to build anything and everything 3D related and the addition of AR to it makes it perfect for this project.

Vuforia: Vuforia is a Software development kit which is used to create augmented reality. It enables the user to instil AR features to their applications. It contains all the required library packages and methods required to code the AR aspects to your application. It also offers AR camera as an alternative to usual camera, which can capture and recognize body gestures which are essential for AR application.

Visual code: To code the multiple virtual buttons that we used throughout the application for ease of operation and to enhance user experience, we used Microsoft Visual Studio. The back end of the application was completely coded in Visual Studio. It is developed by Microsoft and can for Windows, Linux and macOS. The code was completely done in C# language.

5.2 The Build

5.2.1 Setting up the 3D House Models

Unity Engine lets the user to build their own 3D models up from scratch, one can create multiple 3D entities with different texture packages and then assemble those entities to create one complete 3D model or just load the whole 3D model at a single go.

3D modelling and sculpting is way easier in unity as compared to several other similar engines. We set up our houses in a 3D void space where we can add or remove features as well as programme the entities to behave in a certain manner.

5.2.2 Augmenting the Houses

We can take a print of the sheet that we program the house to superimpose on. Then by switching to AR camera which is capable of reacting to human gestures, we can just point it towards the printed sheet and it will automatically superimpose the house on the sheet and you can interact with the house in Augmented Reality.

5.2.3 Adding Virtual Buttons

Virtual Buttons act and behave like normal buttons but do not exist in reality. We can add multiple virtual buttons which we then can code in C# in visual studio to perform certain tasks when user interact with them.

In this project we have implemented a few different virtual switches. One of which can either remove or restore the roof of the houses thus enabling the user to have a proper top view of the house, one can switch between daytime and night-time by altering the light source, there are few other switches performing similar tasks as well.

5.2.4 Adding Navigation Joystick

We added a navigation joystick to enable the user to move around inside and outside the houses freely. The navigation will let the user to roam and explore the house as he wishes. We added mesh colliders to object such as walls and ground surfaces so as the user cannot pass through them, we also added the same to outer fences so the user never falls out of the 3D space and messes up the application. Further it was also added to the staircase so it would push the user upwards when he walks on it.

5.2.5 Adding First-Person Navigation

Although the navigation joystick is a very good tool to roam around the space, it is not a perfect tool to explore the house as it has multiple limitation. Thus, we created an alternate navigation system which is popular among the various shooter gaming applications these days, known as the first-person navigation. This king of navigation does not require any joystick to be on the screen, instead it treats a certain part of the screen as joystick itself. The user can flick his finger in the direction he wants to go, he can also spin on different axes by using the other finger.
5.2.6 Adding Voice Control Features

Adding voice commands enhances the user experience manifold. The usual joystick or touch navigation can be tedious and robotic at times and thus can cause a lot of not serious but bothersome issues for user.

Adding a chat bot which can listen to user’s commands and work on it can add that extra bit of magic to the application and can make navigation so much easier and simpler.

5.2.7 Converting into Android Application

After the project is completed and all the alterations are finished, the user can compile it to create an application file. Unity offers creation of application of any platform be it Windows macOS or Android. As we are creating a smartphone application, we set the settings for an Android application. We tweak the settings to make the application run on Android Marshmallow and above, we do it so even users with old phones can install and enjoy the application.

VI. RESULTS DISCUSSION

Intro Scene:

We created an intro scene where the user can choose which house, he wants to take a 3D tour of. Experience the different houses in 3D AR world, and deciding which one looks best or rather which one is to his/her taste. Using navigation and voice control he will be able to roam in and around the houses and check its features, he also can control the lights, roof, floor, etc through provided chat bot or by just giving a voice command.

He will be able to enjoy the 3D tour with different navigation tools and look around to choose a perfect house.

We have a scrolling menu as well, where the user can choose between different houses.

![Fig 2: Intro Scene](image1.png)  ![Fig 3: 3D house View](image2.png)

After choosing the house from the scrolling menu, the desired house is displayed. You can view the house and have a rough idea of how it looks, what size it is, etc. To experience the house in 3D Augmented Reality, take a paper and superimpose the house on it. You can view the house superimposed on paper where you can see your desired house live in 3D. To superimpose an image, we have to download a database. We have to see the features. The features are highlighted. After the features are highlighted, we can see that we can superimpose an image in the highlighted area.

Now after superimposing the project now you can access different button and toggle around the house.

Replace Roof- We can toggle around the roof to replace the Roof.

Remove Roof - We can toggle around to remove the Roof of the house.

Replace 2nd Floor - We replace the 2nd Floor and toggle around. When we replace the 2nd floor, we replace the roof as well.

Remove 2nd Floor - We can remove the 2nd Floor and toggle around. When we remove the 2nd floor, we remove the roof as well.

Day Time - This button is used to toggle around the directional light to day or night accordingly.
Night Time - This button is used to toggle the directional light and set time of the day accordingly

Click any option to toggle around the house by superimposing paper. This way we can toggle around and check the buttons by just touching the sheet in front of us. Each button is coded in C# and given function to act accordingly when the button is touched. We provide two different types of Navigation Control to control the house and navigate around and have a first-hand experience. We provide a joystick and a Dual Touch Control, where anyone can use Navigation Control to navigate around the house. This provides additional mobility to the user to roam around freely in the 3D space without having any constraints.

**Joystick:**

You can Navigate around the house using the joystick and have a first-hand user experience. The four directional buttons are interconnected which enables the user to change direction by just swiping across the screen once he has touched the navigation pad, this saves user the trouble to constantly lift and place his fingers every-time he wants to switch directions.

**Dual Touch Control:**

You can Use this Dual Touch control to as an alternative navigation feature. This navigation feature is getting more and more prominent in the video game market because of its versatility. It enables the user to have an open world experience of the 3D space without facing any restraints. Also having two thumbs controlling the movement enables the user to move more freely. The left side button is Move Touch Area. This button is used to move around the house like a joystick.

The right-side button is Turn/ Look Touch Area. This button is used to Look around turn the camera and explore all area of the house.
Voice Control Bot:

We have created 8 entities to train the bot: daytime, nighttime, hide, play, replace, remove, show, Stop

We training each entity using the utterances

- **daytime (entity)**: change to day time, day time, daytime, Please make it daytime.
- **nighttime (entity)**: night time, please night time, nighttime.
- **hide (entity)**: please hide second floor, can you hide the second floor, hide second floor, hide second floor.
- **play (entity)**: can you play the video please, play the video, play video, play video please.
- **replace (entity)**: replace the roof, can you replace the roof, replace roof.
- **remove (entity)**: remove the roof, can you remove the roof, remove roof.
- **show (entity)**: can you show the second floor, show second floor.
- **stop (entity)**: stop the video, stop video, can you stop the video.

Creating utterances and sorting them into different entities. Training them to convert speech to text.

Creating Entities in wit.AI to train the bot. By adding entities and training the bot rigorously in different ways so that it identifies different formation of sentences. Saving all the entities and utterances then training them. After that we use the server Access token and HTTP API to connect the wit.AI to the 3d house.

Sending audio to AI: It will listen to audio and send the audio to AI. We train each entity to perform many numbers of times with different texts so that it trains more and perform with greater accuracy. We have written many C# script in back end to support the 3D house to perform various functions.

The following are a few back-end scripts which are used to connect the functions in 3d house:

1. **vbButton**: This script is used to provide navigation buttons so that we can toggle around the house.
2. **housescript**: This script is used to create function for lights, roof, floor, etc. where these functions are used to toggle the whole house.
3. **Wit3D**: This script is used to convert the trained voice control chat bot to the 3d house. Using wit.ai speech to text is converted then saved in json file.
4. **Gamecontroller**: This script is used to provide all the basic front-end work to exit or change scene.
5. **handle.cs**: This script is used to return all user demand which are provide by wit.3d. So, when the user demands a speech it converts to text and handle return text. The proposed operation is provided for the user’s demand.

All these scripts provide to maintain a functioning smart house. The back end code make the front end 3d house react when users want to perform a required action. Script for connecting voice controlled of car. This returns the wit script. The questions asked by the user to interactive bot are resolved. If the user records the audio “remove roof”. The bot will commend the operation and remove the roof.

We copied the server Access token and HTTP API and connected it to the script so that it retrieves the data from wit.AI and run the voice control bot. The action appears according when the entities are called the action starts and the data is converted from wit.AI and the bot retrieves data and send the commands back and interact with the users. All of these will be converted to an app by build setting an APK and downloading it using Android player setting. The apk can be downloaded and then you can experience 3d house right at your phone. We can set the player setting accordingly in android and download by clicking build and run.
You can also change the build setting accordingly. We choose android and then created 3 scenes to complete the whole setup. The three setups of the 3d AR house are:

Intro scene: The front end when you can choose which house to view from the scrolling menu.

Second scene: where we created the buttons and the house to superimpose on a paper. Use buttons to toggle around the house. Use voice control voice to give commands.

fpvH1 scene: In this scene we created a first-person view where the user can experience the whole house by navigating around the house. The user can use a joystick or a dual touch control.

In this way we created three scenes using unity. Coded the back end in C#. Used AI to train the voice control bot.

Then retrieve the app from unity in Android. After the build and run. We will allow to download in android. The unity will download an apk file. The apk file can be downloaded in the phone or tablet. After you download the apk in phone or tablet you can experience the whole setup in mobile device through an app. We can superimpose and toggle around the house. Use voice control to talk with the house. Experience first person view through phone.

With this app we can access 3d view and voice control of a house without going to the field.

VII. CONCLUSION AND FUTURE WORKS

Because of the ongoing COVID-19 global pandemic, a lot of people are forced to stay and work from home. So, many people are not able physically visit to any locations. But we can virtually be there without stepping out. We can have a virtual tour from our home without physically going there. There are many unsatisfying software's which cannot properly give the virtual user experience properly. A virtual experience needs good data sets which are clear with good graphic quality and proper sound. In this state of point going out to see houses is not safe. So, our app will provide 3d AR of the house with a voice-controlled chat bot which will help in navigating around the house.

In future not just single properties but large buildings as well as big skyscrapers can be presented to customers before they are even built. People can check the hotels, check what features they offer, how their rooms feel to be in, and then decide if they want to book a room there, which sound a lot more assured than to refer from some travel website. One can even go above and beyond and create a whole city where travelers can explore before deciding if they want to visit the city in reality. As many rovers have been sent and are being planned to be sent to different planets, attaching VR or AR cameras on them will enable people to feel as if they were to be walking on those celestial bodies. The virtualization of space stations is also a possibility though VR and AR.

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