



Geometrical Image Processing and Center for Graphics and Geometric Computing  
Computer Science Faculty, Technion

# Architecture Visualization VR

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# Table of Contents

<b>Introduction</b> .....	<b>3</b>
<b>Development Enviroment</b> .....	<b>4</b>
<b>Importing Architectual Models in Unity</b> .....	<b>5</b>
From SketchUp to Unity.....	5
From Autodesk Revit to Unity.....	7
<b>Improving Performance</b> .....	<b>10</b>
<b>Adding Furniture</b> .....	<b>12</b>
<b>Adding Lights</b> .....	<b>13</b>
<b>Application Overview</b> .....	<b>15</b>
The Exterior View.....	15
The Interior View .....	18
<b>Improving Quality</b> .....	<b>20</b>



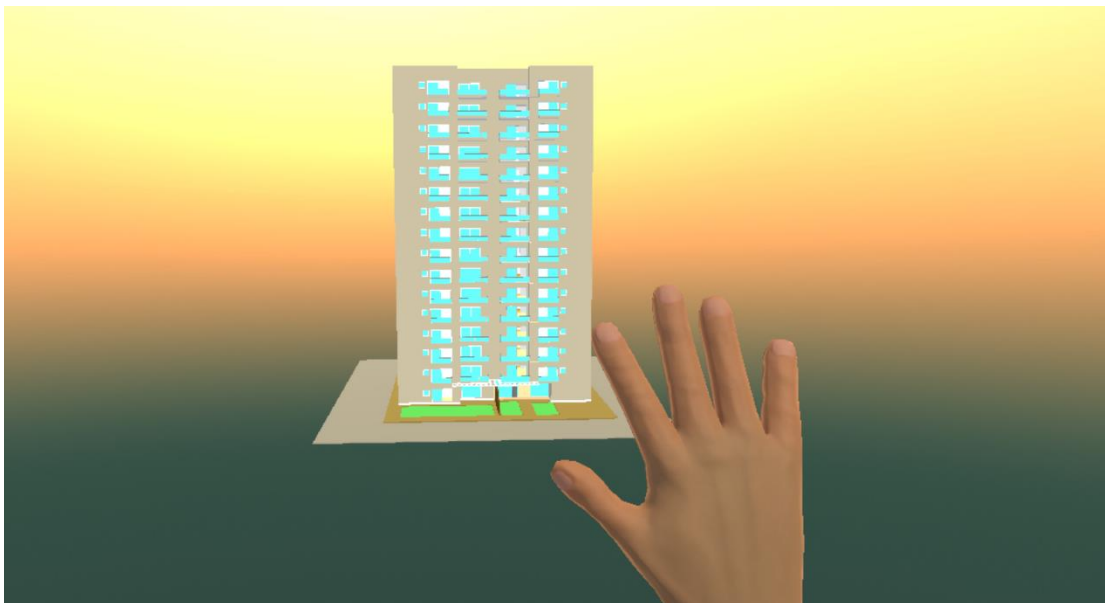
# Introduction

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For many architects, the biggest challenge is often giving the client a clear understanding of how the design will look in real life.

Floor plans, 3D renderings, and models are often used to convey the idea of the design, but no matter how talented the designer, it can take a leap of faith and a vivid imagination from the client to get them on board with a design idea.

The idea behind the project is to visualize the Interior and the Exterior design of an architecture model in VR, giving clients the opportunity to explore a virtual representation of a particular room, floor, or building design as a whole, so that they could gain an understanding of how a design will look to scale in a fully 3D environment.





# Development Environment

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We developed the project using Unity 2017 - graphic engine, scripted with C# in Visual Studio 2017.



**Unity** - is a cross-platform game engine that is used to develop video games for PC, consoles, mobile devices and websites.



**HTC vive** - a virtual reality headset developed by HTC and Valve Corporation. This headset is designed to utilize "room scale" technology to turn a room into 3D space via sensors, with the virtual world allowing the user to navigate naturally, with the ability to walk around and use motion tracked handheld controllers to vividly manipulate objects, interact with precision, communicate and

experience immersive environments.

## Virtual Reality setup

Download Steam:

<http://store.steampowered.com/about/Setup>

HTC Vive Environment:

<http://store.steampowered.com/steamvr>

Setup your room space:

[https://support.steampowered.com/kb\\_article.php?ref=2001-UXCM-4439](https://support.steampowered.com/kb_article.php?ref=2001-UXCM-4439)



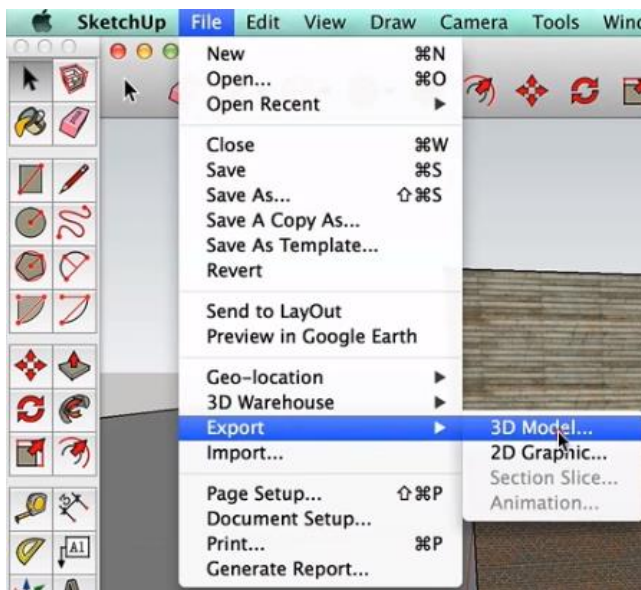
# Importing Architectural Models in Unity

In this section we will explain how to transfer the model from two different architecture modeling software into unity. In our project we used a SketchUp model.

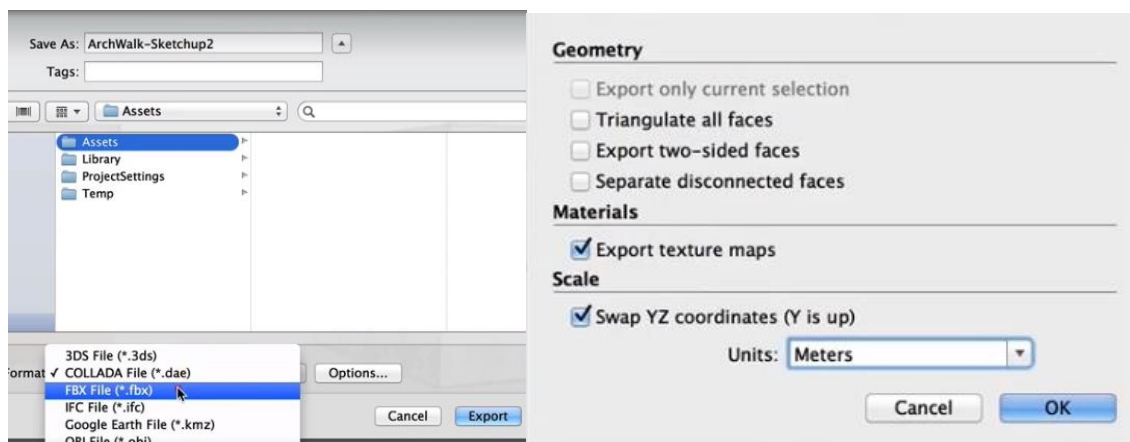
- From SketchUp to Unity:

**If you are not a SketchUp user, you may skip this part.** SketchUp is one of the commonly used software for architecture modeling. To use a SketchUp model for visualization in Unity, user will need to convert it to an intermediate format which Unity supports and use the converted format in Unity.

- Open the model in SketchUp, now from the *file-menu* export the 3D model.

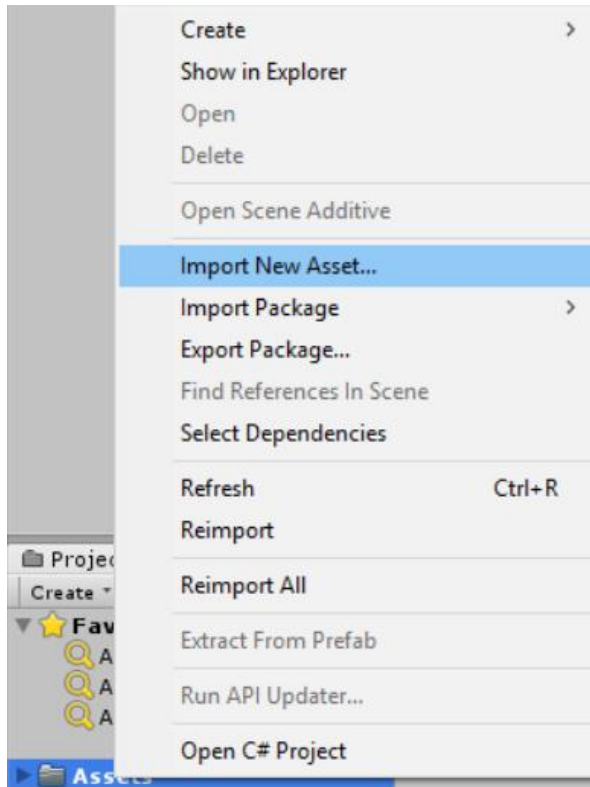


- Export the model as FBX and set the units to Meters so that the model can be imported at the correct scale.

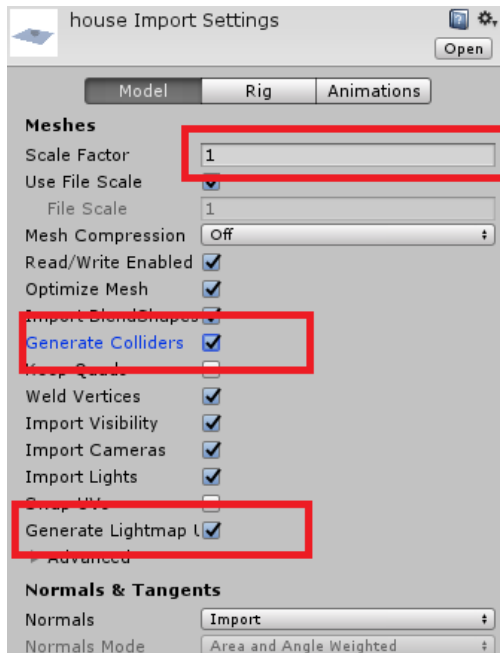




- Import the FBX model to Unity



- To Import the model from the assets to your scene make sure that the *Scale Factor* is set to 1 and that *Generate Colliders* and *Generate Lightmap* are checked.

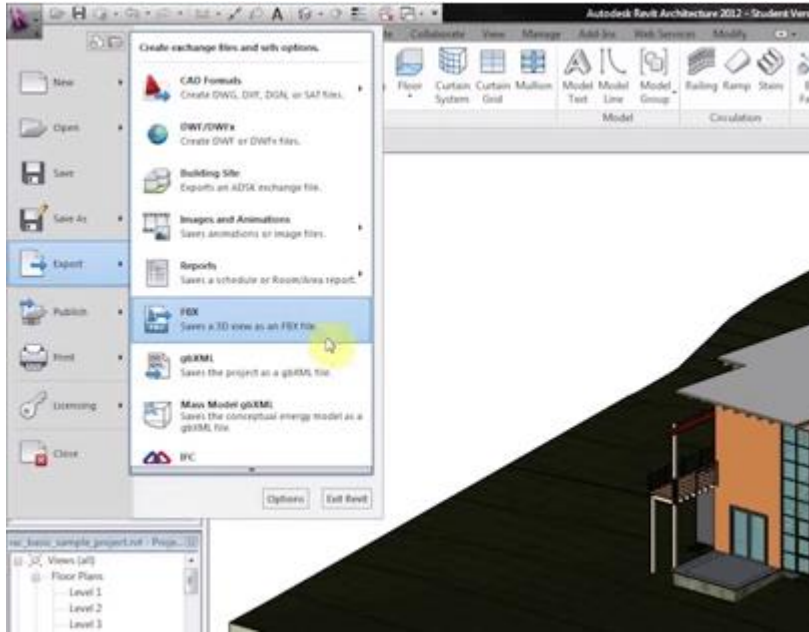




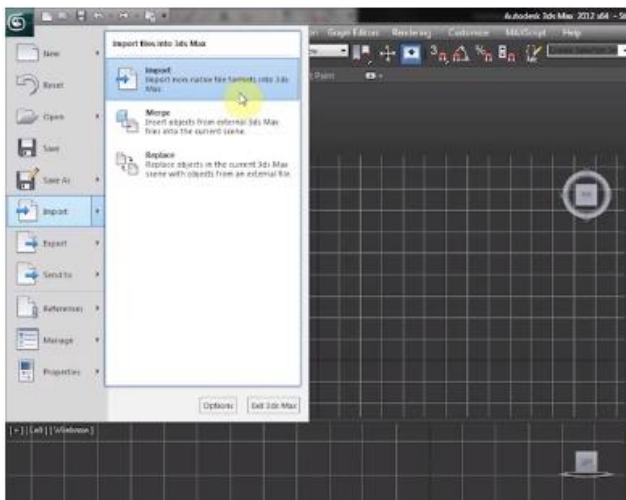
- From Autodesk Revit to Unity:

**If you are not a Revit user, you may skip this part.** Revit is one of the commonly used software for architecture modeling. Bringing materials to Unity can be a challenge, because Unity doesn't understand the Autodesk material library materials. For this we'll use the help of **Autodesk 3ds Max** to make the conversion.

- Open the model in Revit, click the *R* on the top left and export as FBX.

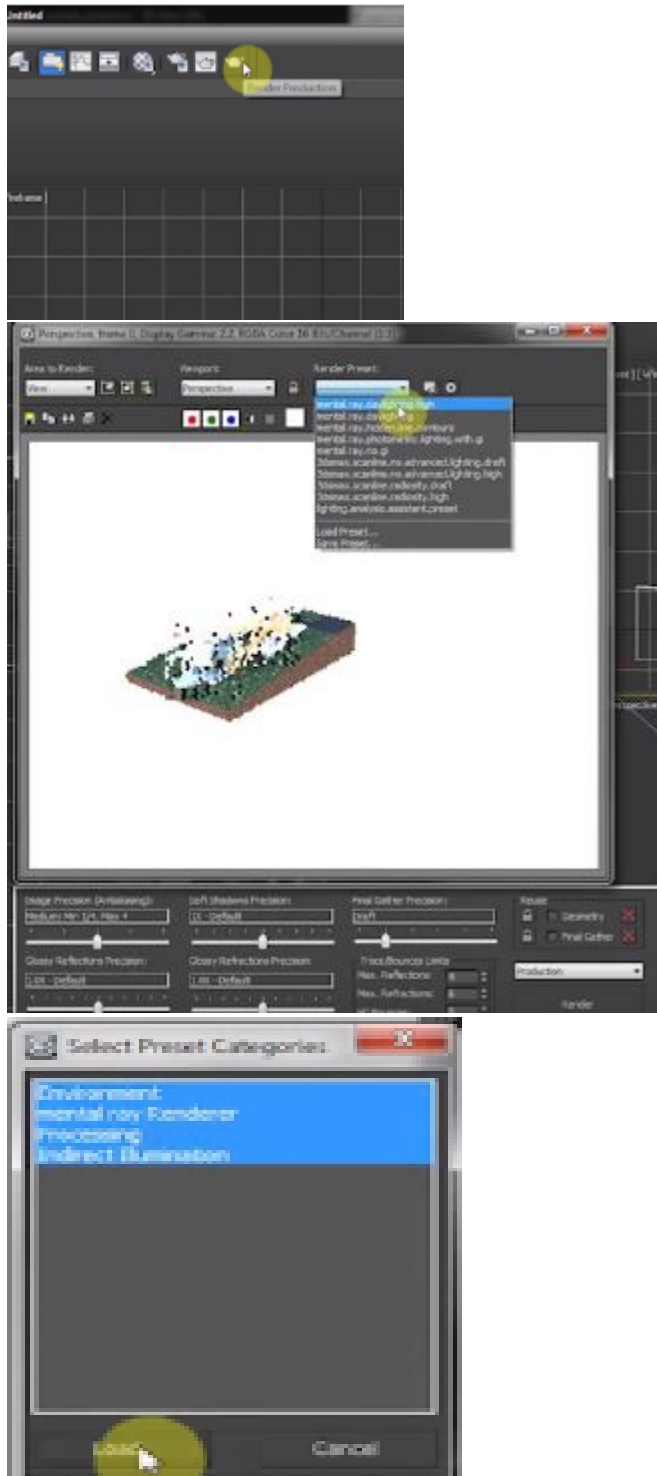


- Go to Autodesk 3ds Max and import the file you just exported.





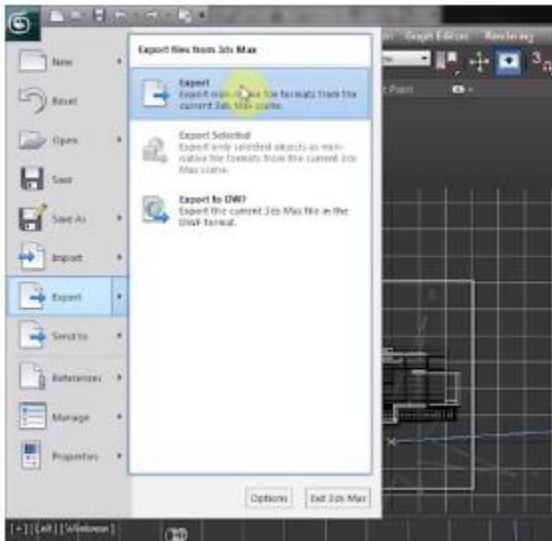
- Now, hit *render production* and look for a window to open. In the *render preset* choose *mental ray daylighting high* and hit *load*. This will add the materials back to the model.



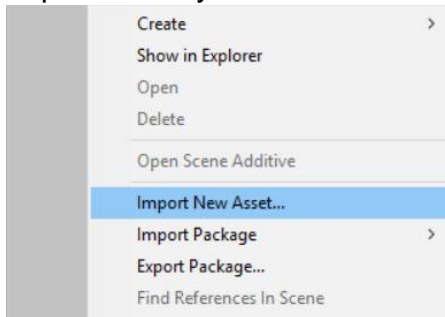




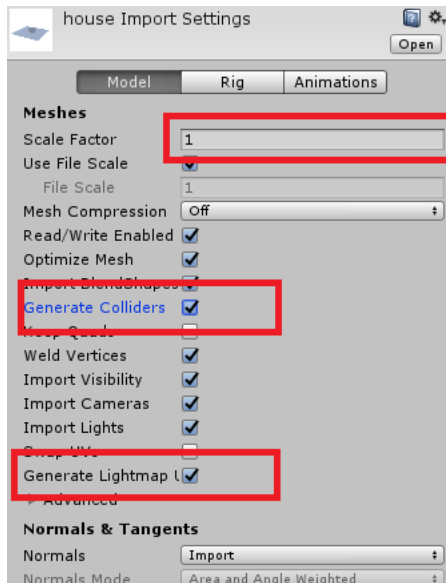
- And again, export the model as FBX file.



- Import to Unity.



- To Import the model from the assets to your scene make sure that the *Scale Factor* is set to 1 and that *Generate Colliders* and *Generate Lightmap* are checked.

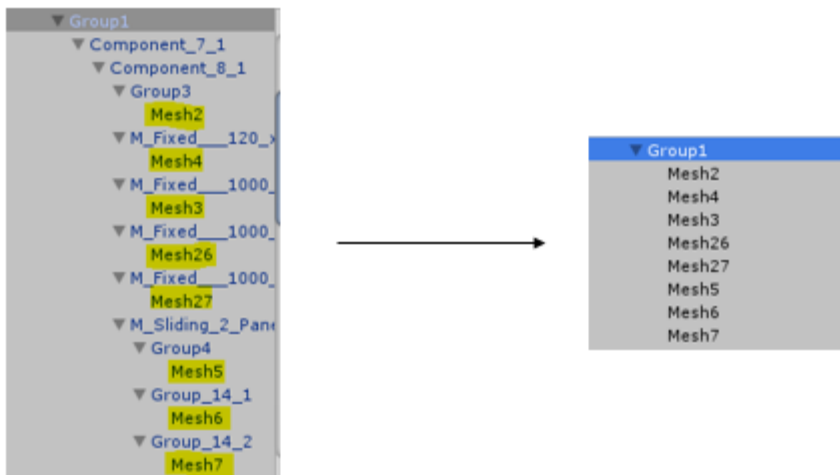




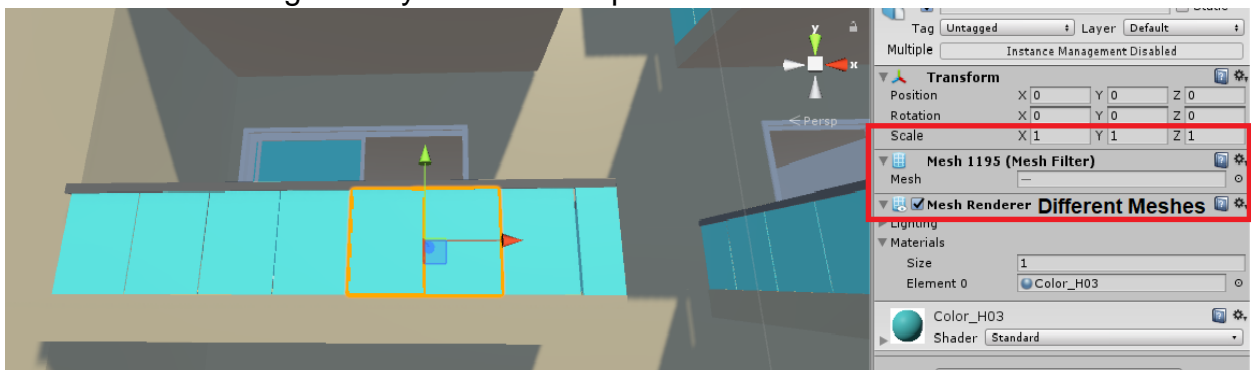
# Improving Performance

Architectural models tend to be quite large and can slow down real-time projects. In this section we'll explain how we can optimize the model in Unity.

- **Reduce the complexity of the original geometry's hierarchy.**  
The imported model might have a complex hierarchy, split the model in less number of chunks.

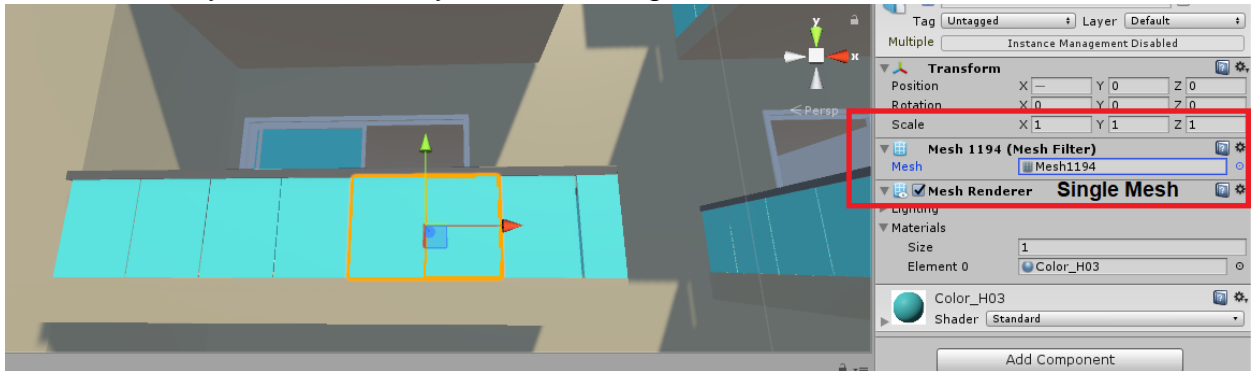


- **Replace equal meshes with instance of one mesh.**  
The Imported model will have different meshes for every geometry even for meshes that have the same geometry like the example below.

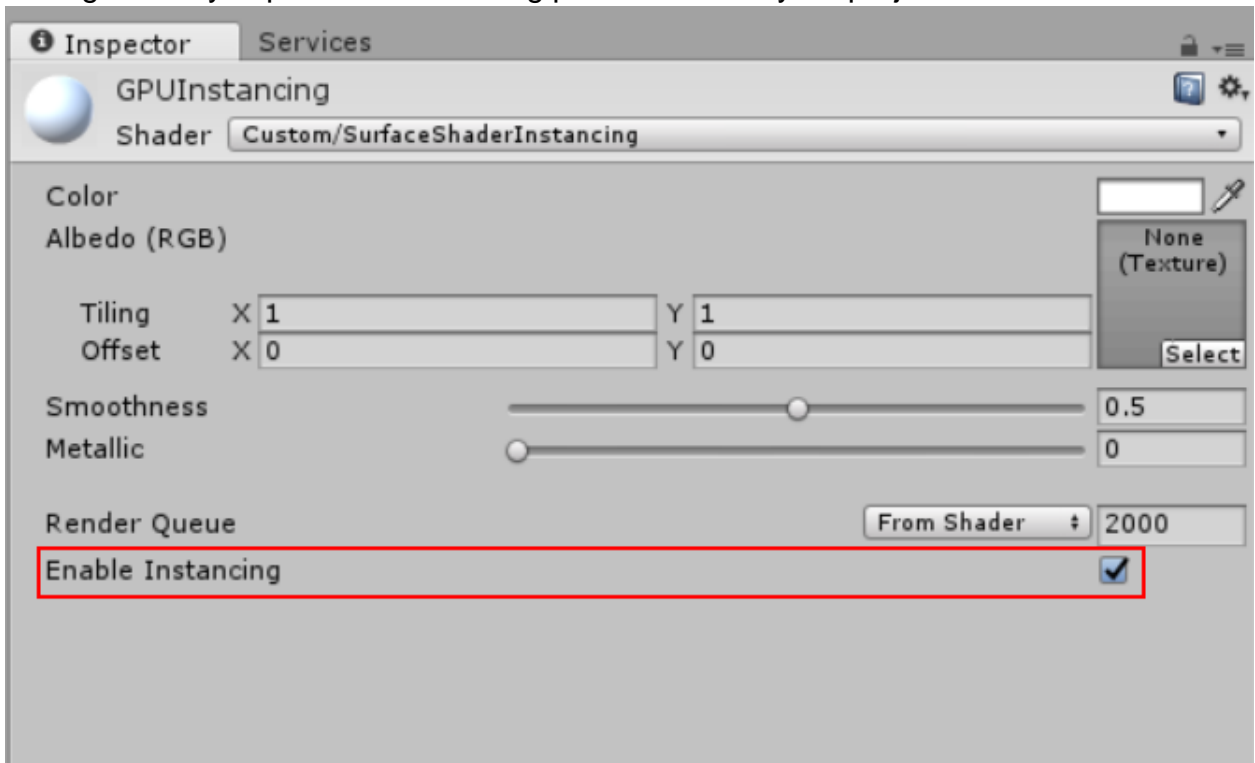




Replace those meshes with instance of one mesh to help unity reduce the number of draw calls by its static and dynamic batching.



If this wasn't enough consider using the Unity's GPU instantiation mechanism. This will significantly improve the rendering performance of your project.



- **Remove details that do not contribute to the real time project.**  
This especially useful for models that tend to include excessive geometry for every part of the building.



# Adding Furniture

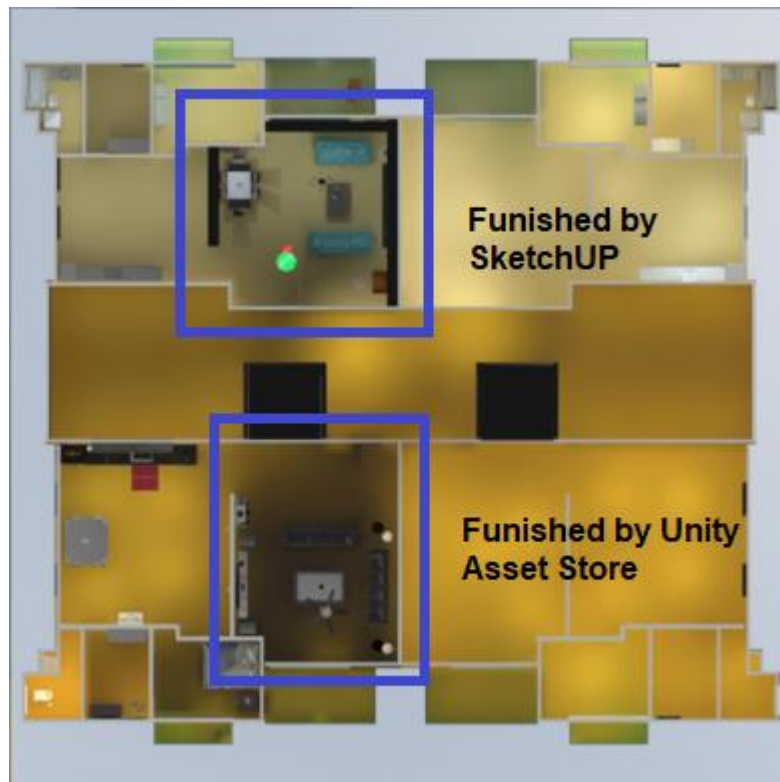
Prefer to add furniture imported from Unity Asset Store as they are usually in a better quality than furniture imported from architecture modeling software. In our project we have a room furnished with furniture imported from SketchUp and another room furnished with Asset Store furniture to demonstrate the differences.



Furniture imported from Sketchup



Furniture imported from Unity Asset Store





# Adding Lights

The model is not imported to unity with any kind of light, without any light the scene will look dark and dull. Add Lights for convincing and realistic feeling.

- Adding Ambient light.



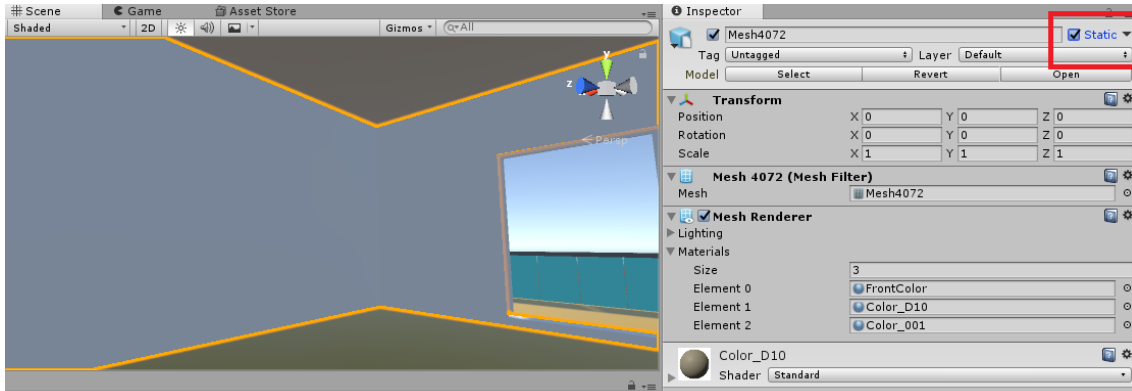
- Adding Directional and Point lights.



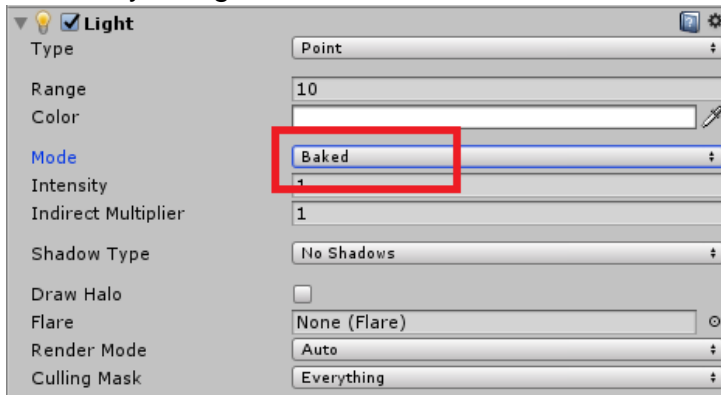


Use Unity's Lightmapping system instead on relying on real-time lights, especially for the interior part of the building where you'll need multiple lights to fully enlighten the rooms. Lightmapping is a technique were the lightening is calculated in advance and captured in additional layer of textures that are mixed with the regular material.

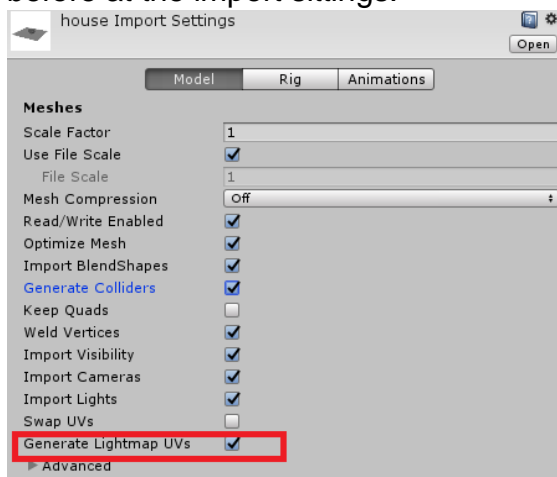
- For this we need to tell unity which objects are meant to be fixed by activating their *static* attribute.



- Choose your lights *mode* to be *Baked*.



- For this the unity will need a *Lightmap UV* for the model which we have generated before at the import settings.





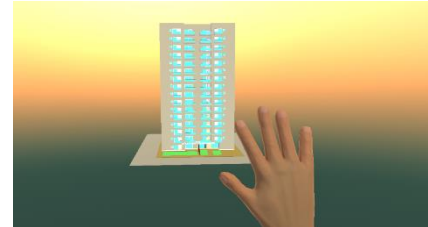
# Application Overview

The application has two scenes:

1. Exterior View – A view to the exterior part of the model.
2. Interior View – A view to the interior part of the model.

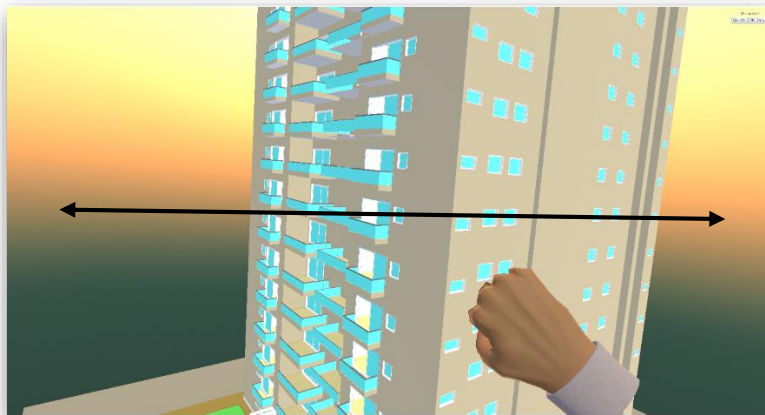
- **The Exterior View**

In this scene you can view the exterior part of the model and Interact with it by:

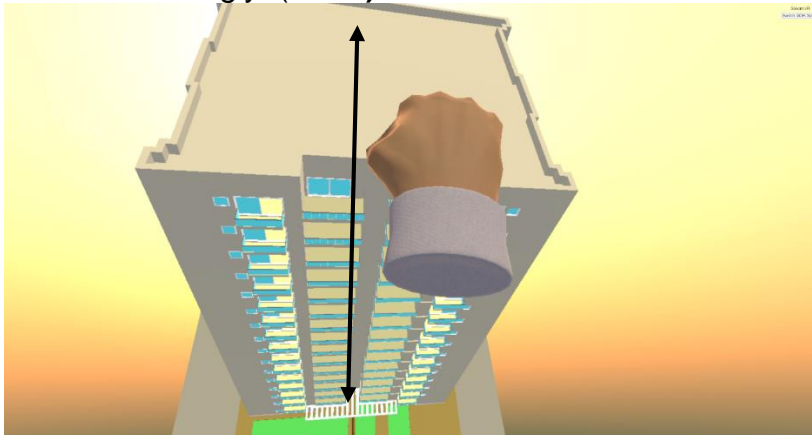


1. **Rotation:**

Hold the *Grip* button and move your hand along the horizontal axis to rotate the model accordingly. (**Yaw**)



Hold the *Grip* button and move your hand along the vertical axis to rotate the model accordingly. (**Pitch**)





Hold the *Grip* button and move your hand to the right edge or the left edge of your view to **auto-rotate** the model along the horizontal axis (yaw). Can be helpful if the user is looking for a general view of the model.

A hand model has been used instead of the HTC Vive controller model to help the user visualize the action of holding the *Grip* button.



All the rotations are pure local rotations so that the controller feels the same regardless of the current rotation of the model. As in any rotation a sequence of Pitches and Yaws might cause unwanted Roll or Twist. The application corrects that Twist gradually in every frame, by bringing the "Up" vector of the rotated model to a reference "Up" vector (Using Unity's [Quaternion.LookRotation](#) method). For more details about this issue, see the link below:

<https://gamedev.stackexchange.com/questions/136174/im-rotating-an-object-on-two-axes-so-why-does-it-keep-twisting-around-the-thir>

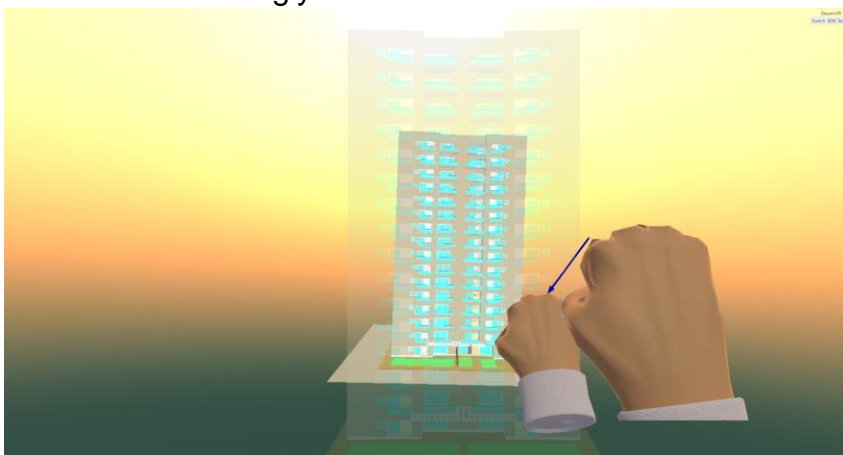
## 2. Reset:

Press the *Trigger* button to reset the model to its initial rotation.



## 3. Scale:

Hold the *Grip* button and move your hand along the depth or the Z axis to scale the model accordingly.





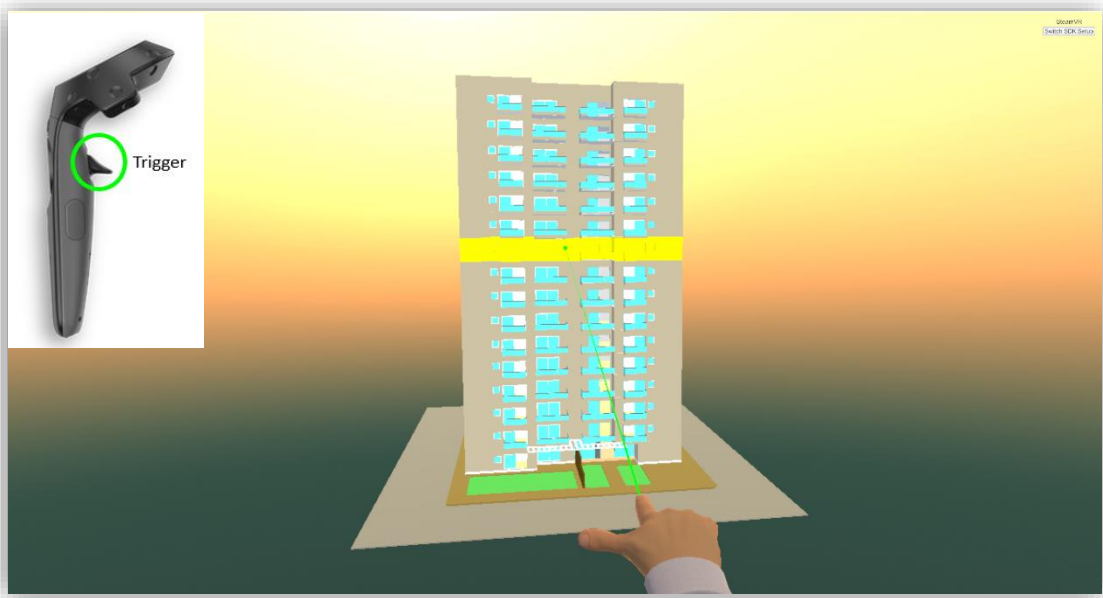


**4. Go inside:**

Press the *Touchpad* to activate a pointer to hover over a floor.



After hovering over the desired floor, press the *Trigger* to get inside it.





- **The Interior View**

In this scene you can view the interior part of the model and Interact with it by:



1. **Teleport:**

Provides the user the ability to move in building's interior without actually moving in the real world. For teleporting press and hold the *Touchpad* to activate a straight pointer, point the pointer to the desired point that you wish to go to and then release the press. In addition, there are illegal teleport locations (like walls and doors) that can be recognized by a red laser beam instead of a green one.



*Touchpad Walking vs. Teleport:*

At the beginning we tried to move in the space using the Vive touchpad control.

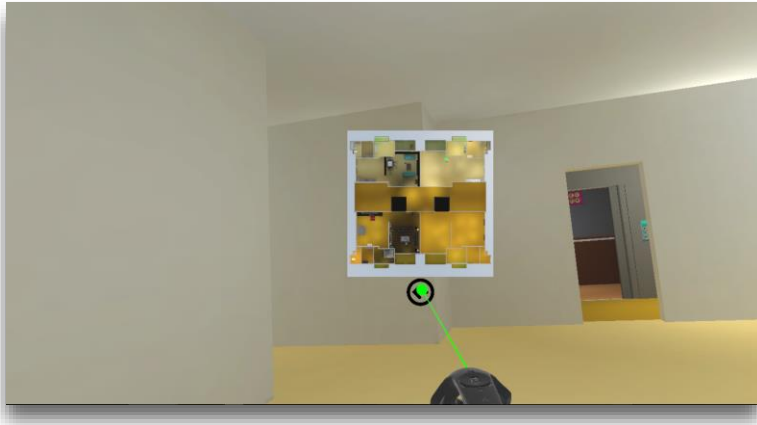
For this we used the help of VRTK scrips that are explained in the link below:

[https://vrtoolkit.readme.io/v2.2.1/docs/vrtk\\_touchpadwalking](https://vrtoolkit.readme.io/v2.2.1/docs/vrtk_touchpadwalking).

But people reported that this type of locomotion causes motion sickness, a form of nausea that occurs when your vision sensing motion but your ear and body are not sensing motion so it can throw your senses out of order. Not everyone we asked sensed it, but we personally did so we preferred to use teleportation for motion.

2. **The Menu:**

Can be enabled or disabled using the *Menu* button on the controller. Containing the floor map and a *Back* button to the exterior view of the building. To go back to the exterior view, press the *Touchpad* to activate the pointer, hover over the back button and select it by the *Trigger* button.



Hold the controller's grip button to move the menu away or towards the eye.

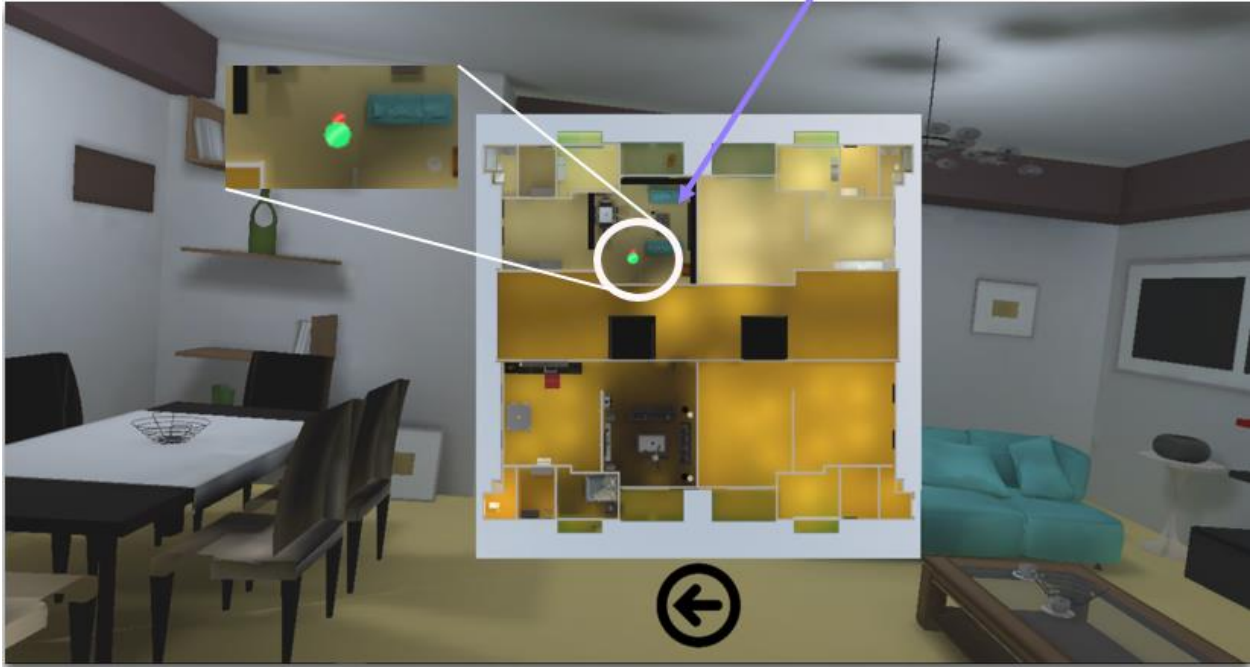


### 3. Floor Map:

A map of the floor can be found in the menu. Allows user to navigate the building's floor and keep tracking of his/her location. A green sphere is used to indicate user's location and a red sphere is used to indicate the direction that the user is looking at (head's orientation).



You're here





# Improving Quality

We've used Post Processing Stack package from asset store in order to improve the overall quality of the image and add more realistic and natural effect:

<https://assetstore.unity.com/packages/essentials/post-processing-stack-83912>

We've added anti-aliasing, motion blur, eye adaption and color grading.



**Before:**



**After:**





**Before:**

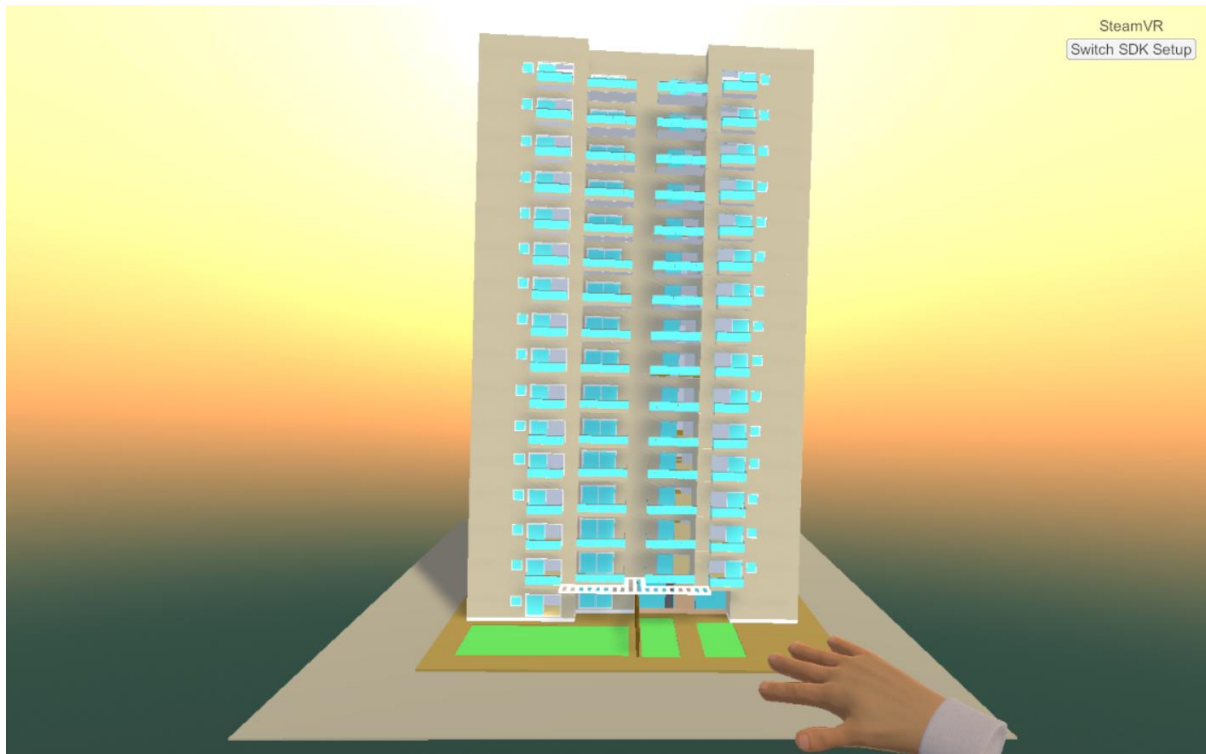


**After:**





**Before:**



**After:**

