National Autonomous University of Mexico

Faculty of Engineering

Computer Graphics and Human-Computer Interaction

Group: 05 - Semester: 2023-1

Documentation:

User Manual

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Professor:

Carlos Aldair Román Balbuena.

Alumn:

Cruz Rangel Leonardo Said

Index

1. Objectives

- For the final project in Computer Graphics and Human-Computer Interaction, the student will apply the concepts learned throughout the course.
- The project will display the facade of a house, as well as the recreation of 10 elements that will be distributed throughout the composition.
- The student will use modeling and texturing techniques to create realistic and detailed three-dimensional objects of the house facade and the various objects that make up the house.
- The student will use lighting techniques to give realism to the materials that make up the house and its environment.
- The student will use animation techniques to create the effect of movement on different 3D objects and add dynamism to the scene.
- The student will use 3D visualization techniques to create an interactive model of the house and rooms that allows users to explore the different spaces of the house.

2. Requirements

Make a virtual tour in OpenGL 3 that includes the following elements:

- A PDF document containing reference images of 2 rooms and a real or fictional facade, excluding any space from C.U., Rick & Morty, The Simpsons, Kame House from Dragon Ball, and Courage the Cowardly Dog's house.
- This document must be accompanied by reference photos and a list of the 5 elements to be recreated in each room, whose artistic style must match that of a real or fictional space according to the reference photos. The laboratory project can be used as long as the corresponding reference images are presented.
- Integrate synthetic camera.
- It must contain 4 animations.
- The project must be documented (Gantt chart, user manual outlining the objectives and interaction of the project, and technical manual).
- The documentation must be in both Spanish and English, and Google Translate should not be used 100% for translation as this will lower your score.
- A cost analysis of the project must be carried out (This analysis must include how much it costs you and how much you would sell it, arguing these costs and prices).
- The delivery of documentation must be done in digital format.
- An executable file must be delivered (note, the executable is not in the debug folder).
- The realism of the space will be evaluated.

- The project must be on GitHub.

3. Introducción

Computer graphics is a field of computer science that is dedicated to the development of techniques and technologies for generating and manipulating images and graphics on display devices such as computer screens and mobile devices. Computer graphics are essential for visualizing data in a wide range of fields, including science, engineering, medicine, architecture, and graphic design.

The history of computer graphics dates back to the 1960s, when the first computer-aided drafting (CAD) machines and the first three-dimensional data visualization systems were developed. Since then, the technology has advanced significantly, and it is now possible to generate high-quality images and graphics in real-time on a wide variety of devices.

One of the most well-known applications of computer graphics is in the field of video games, where it is used to create high-quality and realistic graphics. It is also commonly used in the film and entertainment industry, where it is used to create visual effects and animations. In addition, computer graphics have applications in fields such as science and medicine, where it is used to visualize and analyze data and create 3D images and models.

In everyday life, computer graphics are important in a wide range of applications, including creating graphics and presentations in office applications, visualizing maps and navigation on mobile devices, and creating images and videos for social media and online video platforms. Overall, computer graphics are an essential technology in the current digital age and have an impact on almost every aspect of our daily lives.

In this project, we have chosen to model the facade of a fictional house that is referred to in the following video: https://www.youtube.com/watch?v=aSDx3ErWmtM

This video can be found on the YouTube channel "Planos de Casas" (House Plans), which offers a wide variety of plans in .pdf and .dwg formats without copyright, as well as videos showing a 3D visualization of the houses for reference in terms of their design, size, and construction.

I have selected this facade because the plans provided by the YouTube channel significantly facilitate its 3D modeling of it. This is because they include measurements and a real and well-founded arrangement of each room that makes it up. In addition, the video allows for visualization from different angles of the house facade and even its interiors.

The house has a floor area of approximately 9 meters by 9 meters, and inside it has three bedrooms, two bathrooms, a kitchen, a living room, a dining room, and parking. Additionally, a sidewalk, bushes, a road, and a backyard with a pool were added to give atmosphere to the project.

Below are the images that were taken as references for the project.

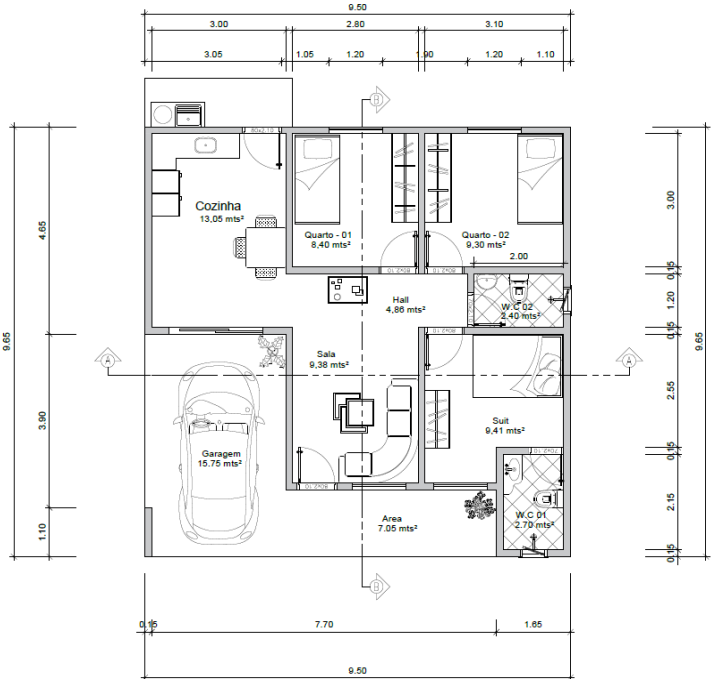

Figure 1. House plan

Figure 2. House facade.

Figure 3. Top view.

Figure 4. Living room.

Figure 5. Kitchen.

Figure 6. Bathrooms.

Figure 7. Bedrooms.

Likewise, the 10 elements that were recreated and distributed throughout the house and 3D space are also listed, along with the image that was taken as a reference for their modeling.

1. Beds: There are a total of 3 beds, one for each bedroom.

Figure 8. Bed reference.

2. Wardrobes: There are a total of two wardrobes for the adjacent bedrooms.

Figure 9. Wardrobe reference.

3. Dining room:

Figure 10. Dining room reference..

4. Stove

Figure 11. Stove reference.

5. Refrigerator

Figure 12. Refrigerator reference.

6. Kitchen cabinet (sink)

Figure 13. Kitchen cabinet reference.

7. Wall cabinets

Figure 14. Wall cabinet reference.

8. Furniture for the sink

Figure 15. Furniture reference.

9. Mirror for the bathroom

Figure 16. Mirror reference..

10. Pool

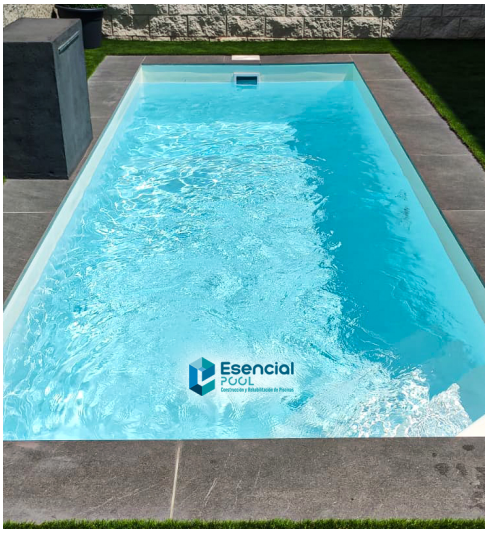

Figure 17. Pool reference.

It is important to note that these images were only used as a reference, that is, the models generated from them include modifications that simplify their 3D modeling with a small number of polygons or low-poly.

4. Development

4.1. Model information

Below are the download data for the models obtained from the internet and some details of the models created by me for this project.

4.1.1. Models downloaded from the internet.

Model: Coche Low Poly - Opel Rekord Caravan 1967 modelo 3d
Author: tedpermana
Website:
https://www.turbosquid.com/es/3d-models/3d-low-poly-car-opel-rekord-caravan-1967-model-1767474
Animation: "Vehicle animation", this animation was built with code. Consult the technical manual for more information.

There was no restriction or license for its use found on the download page.

Figure 18. Car downloaded from Turbosquid.

Model: Blender
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

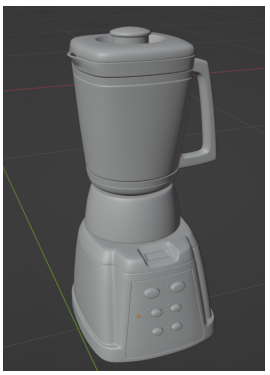

Figure 19. Blender.

Model: Microwave
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

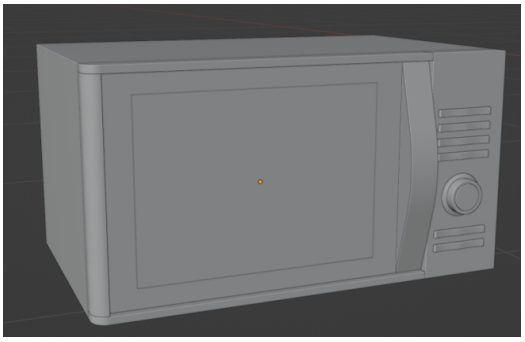

Figure 20. Microwave.

Model: Kitchen paper roll
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

Figure 21. Kitchen paper roll.

Model: Dishes
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

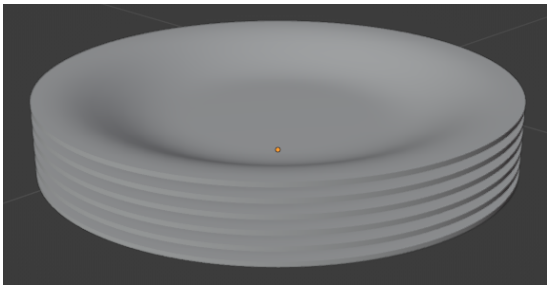

Figure 22. Dishes.

Model: Rabbits
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

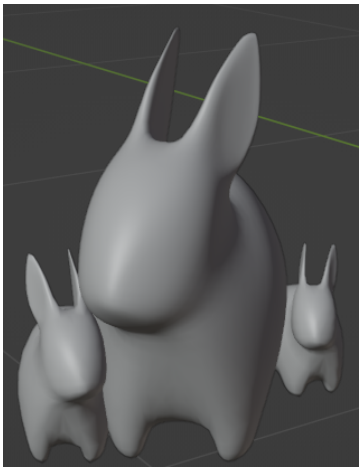

Figure 23. Rabbits.

Model: Plant pot
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

Figure 24. Plant pot.

Model: Furniture for bedroom.
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

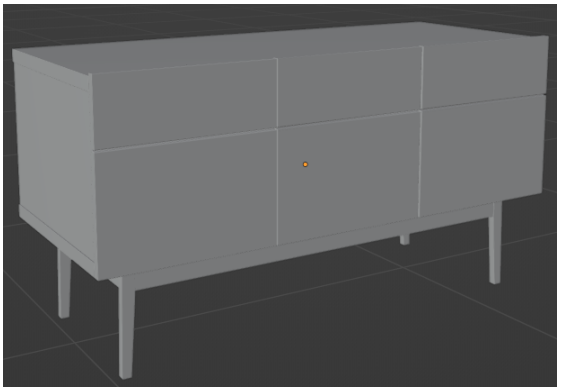

Figure 25. Furniture for bedroom.

Model: Clothing and other accessories
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

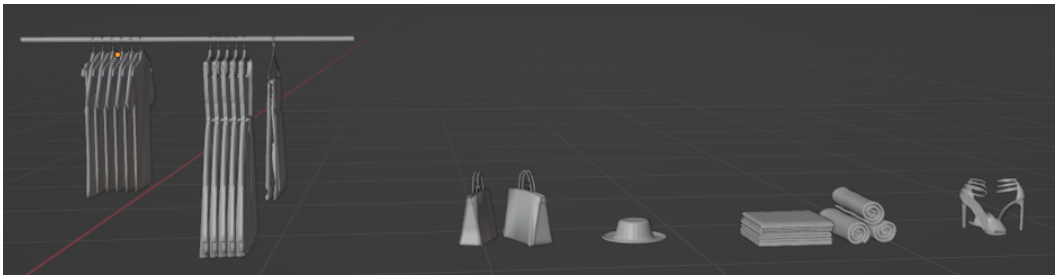

Figure 26. Clothing and other accessories.

Model: TV for bedroom
Author: sydney-cel
Website: https://www.cgtrader.com/free-3d-models/electronics/video/older-tenjin-tv

There was no restriction or license for its use found on the download page. The model came without textures.

Figure 27. TV for bedroom

Model: Men's clothing
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

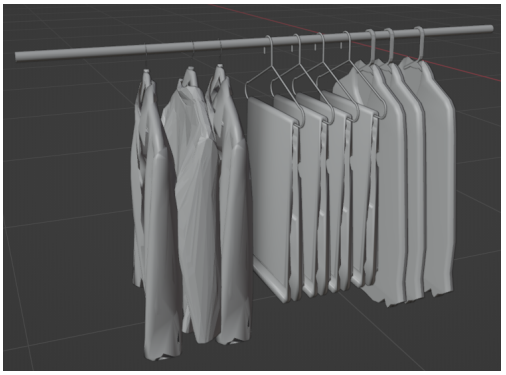

Figure 28. Men's clothing.

Model: Socks
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

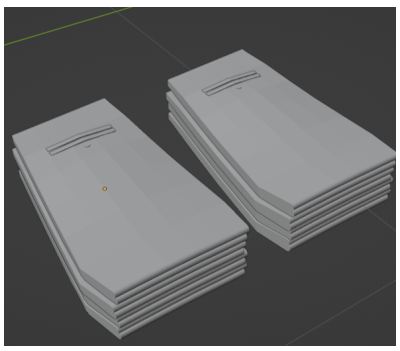

Figure 29. Socks.

Model: T-shirts
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

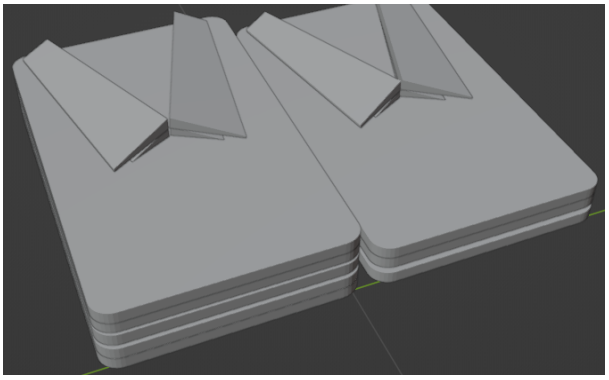

Figure 30. T-shirts.

Model: Towels.
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

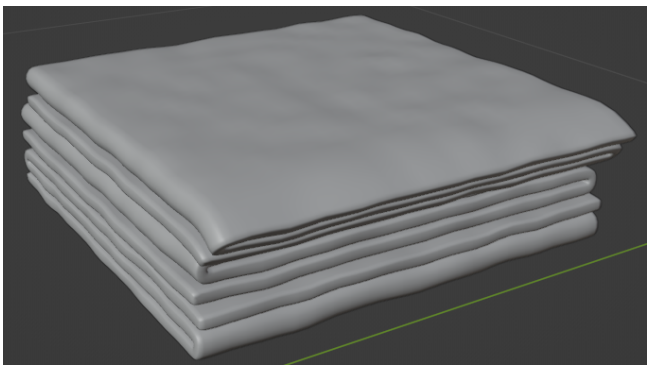

Figure 31. Towels.

Model: Shoes
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

Figure 32. Shoes.

Model: Toy car
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

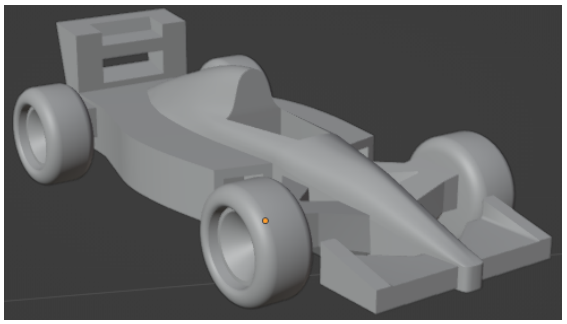

Figure 33. Toy car.

Model: PS4
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

Figure 34. PS4.

Model: Books for bedroom.
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

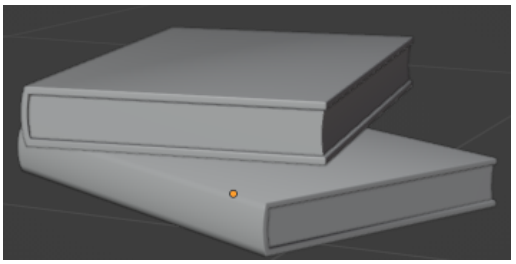

Figure 35. Books for bedroom.

Model: Decorative ducks
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

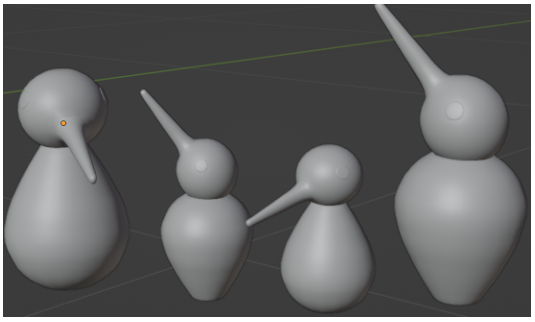

Figure 36. Decorative ducks.

Model: Laptop
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

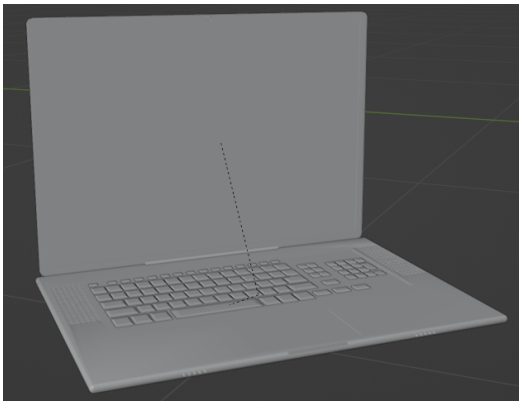

Figure 37. Laptop.

Model: Escritorio - Low Poly - Game Ready -Ar / Vr modelo 3d
Author: mizomostafa
Website: https://www.turbosquid.com/es/3d-models/desk-blender-3d-model-1232007

On the download page, no restrictions or licenses were found for its use. Other textures were applied to the model.

Figure 38. Desk.

Model: Silla Vitra EA 108 Aluminio modelo 3d
Author: 2in1studio
Website:
https://www.turbosquid.com/es/3d-models/free-max-model-ea-108-aluminium-chair/620426

On the download page, no restrictions or licenses were found for its use.

Figure 39. Desk chair.

Model: Juego de cajones corona modelo 3d
Author: Neilvan

Website:
https://www.turbosquid.com/es/3d-models/free-set-corona-drawer-3d-model/887282

On the download page, no restrictions or licenses were found for its use. Other textures were applied to the model.

Figure 40. Furniture with drawers for the bedroom.

Model: Victor table lamp Free 3D model
Author: darkroomstudio
Website: https://www.cgtrader.com/free-3d-models/furniture/lamp/victor-table-lamp

On the download page, no restrictions or licenses were found for its use. Other textures were applied to the model.

Figure 41. Desk lamp.

Model: Pictures door - Landscape and Portrait Free 3D model
Author: c-fferreira

Website:
https://www.cgtrader.com/free-3d-models/architectural/decoration/pictures-door-landscape-and-portrait

On the download page, no restrictions or licenses were found for its use. Other textures were applied to the model.

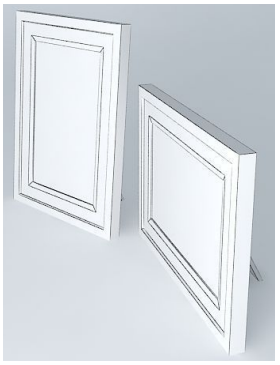

Figure 42. Picture frames for the bedroom.

Model: Shannon
Author: Mixamo
Website: https://www.mixamo.com/
Animation: "Animation of the athlete," said animation was also downloaded from mixamo where a loop of the character running is shown. The character's route was carried out with code, for more information consult the technical manual.

On the download page, no restrictions or licenses were found for its use.

Figure 43. Athlete running.

Model: PUBG Mobile - Falcon modelo 3d
Author: falah01
Website: https://www.turbosquid.com/es/3d-models/3d-pubg-mobile-falcon-1812506
Animation: "Animation by KeyFrames of the Bird", this animation was created with code transformations and using KeyFrames. For more information see the technical manual.

On the download page, no restrictions or licenses were found for its use.

Figure 44. Falcon.

Model: Camcopter S 100 modelo 3d
Author: HuNtEr_3DdD
Website: https://www.turbosquid.com/es/3d-models/3d-camcopter-s-100-1585663
Animation: "Remote Control Helicopter Animation", this animation was created with code transformations. For more information see the technical manual.

On the download page, no restrictions or licenses were found for its use.

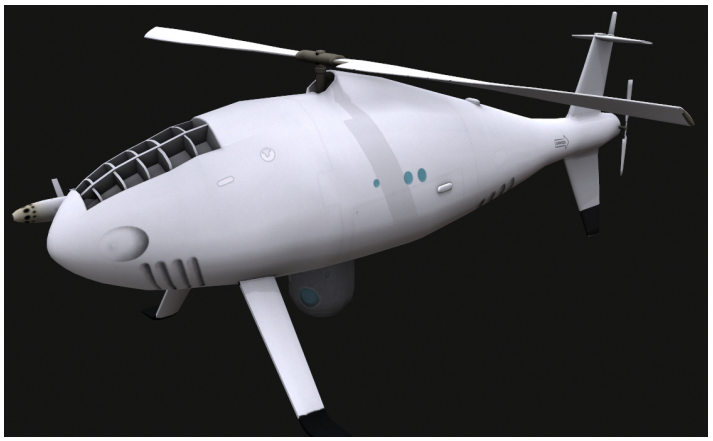

Figure 45. Helicopter.

Model: basic door Free 3D model
Author: Predayorche
Website: https://www.cgtrader.com/free-3d-models/interior/bedroom/basic-door

On the download page, no restrictions or licenses were found for its use. Other textures were applied to the model.

Figure 46. Bedrooms door.

Model: Garofoli doors Miraquadra collection Free 3D model
Author: bentanji3dmodels
Website:
https://www.cgtrader.com/free-3d-models/various/various-models/garofoli-doors

On the download page, no restrictions or licenses were found for its use. Other textures were applied to the model.

Figure 47. Bathrooms door.

Model: Interior Door Free 3D model
Author: barbualex2997
Website:
https://www.cgtrader.com/free-3d-models/interior/other/interior-door-b4d79006-1552-41e7-86d4-e3227d532584

On the download page, no restrictions or licenses were found for its use.

Figure 48. Puerta principal.

Model: Couch
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

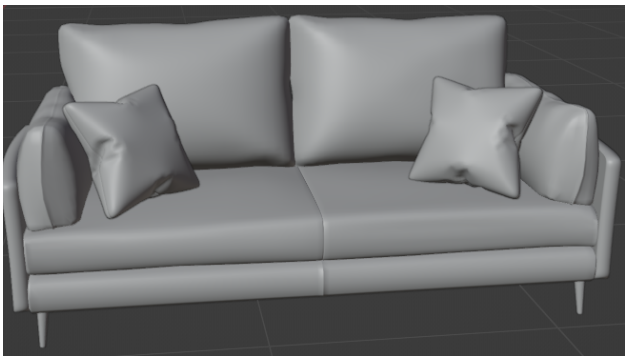

Figure 49. Couch.

Model: Shelf for the living room
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

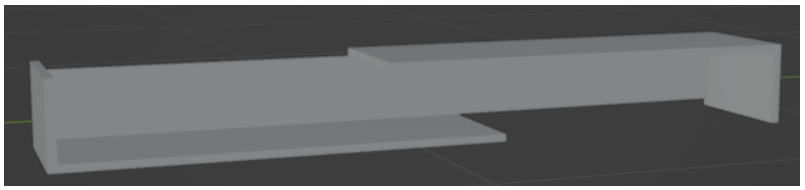

Figure 50. Shelf for the living room.

Model: Decoration for the living room.
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

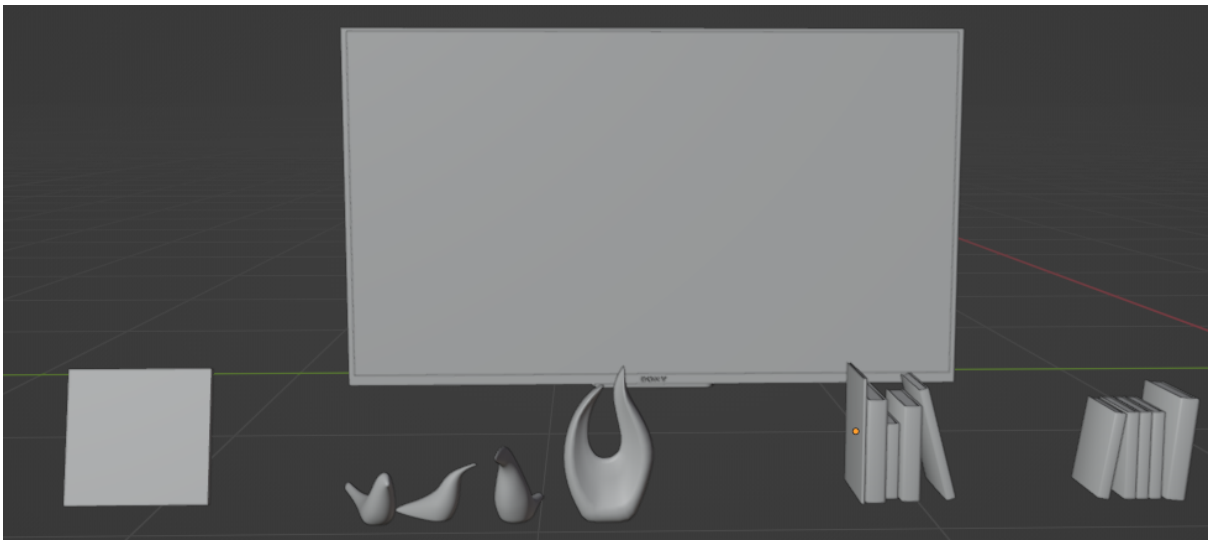

Figure 51. Decoration.

Model: Carpet
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

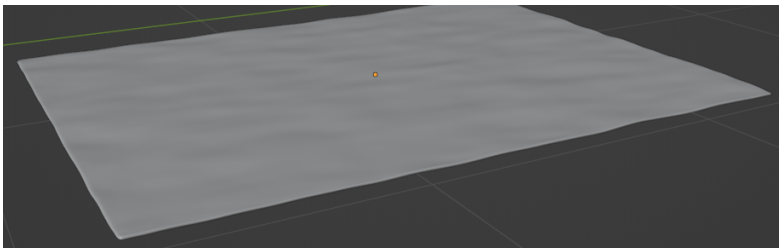

Figure 52. Carpet.

Model: Window Frame Free 3D model
Author: arqnovacion
Website:
https://www.cgtrader.com/free-3d-models/architectural/window/window-frame-a11586c1-01a8-424c-8589-f6328be415cd

On the download page, no restrictions or licenses were found for its use. Other textures were applied to the model.

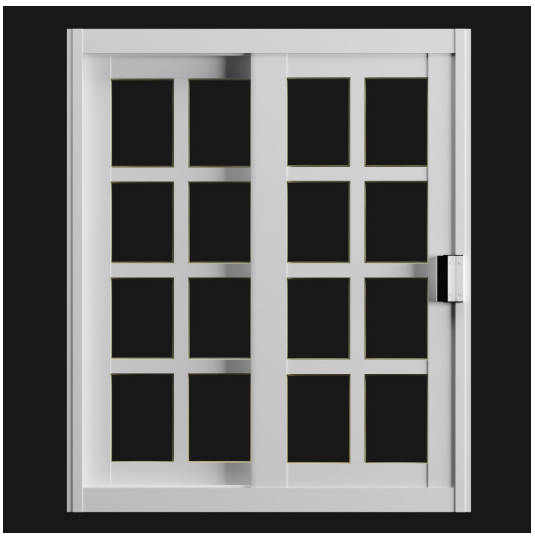

Figure 53. Sliding door

Model: Ventana abatible de plástico 01 modelo 3d
Author: xotab658
Website:
https://www.turbosquid.com/es/3d-models/free-dxf-mode-window-casement-plastic/1077656

On the download page, no restrictions or licenses were found for its use. Other textures were applied to the model.

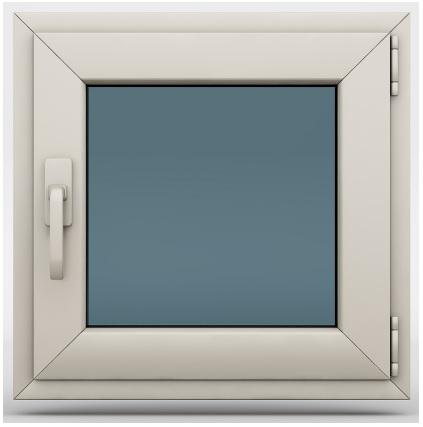

Figure 54. Bathrooms window.

Model: two windows Free low-poly 3D model
Author: WolfgangNikolas
Website:
https://www.cgtrader.com/free-3d-models/various/various-models/two-windows

On the download page, no restrictions or licenses were found for its use. Other textures were applied to the model.

Figure 55. Bedrooms window.

Model: Toilet
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

Figure 56. Toilet.

Model: Shower head
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

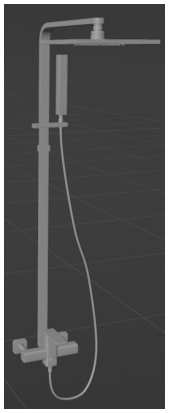

Figure 57. Shower head.

Model: Toilet paper
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

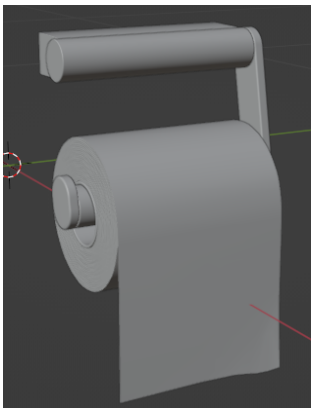

Figure 58. Toilet paper.

Model: Bathroom sink.
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

Figure 59. Bathroom sink.

Model: Soap dispenser
Author: Heber Villalta
Website:
https://www.mediafire.com/file/lsde89udh94gdsl/Models3DApartamento.zip/file

The author provides different 3D models in .blend format, untextured and without any type of use license on his YouTube channel:
https://www.youtube.com/watch?v=lekcqJNMGHA&t=7490s

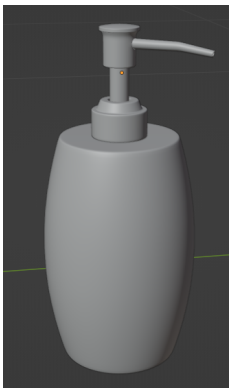

Figure 60. Soap dispenser.

Model: Shower curtain
Author: hippostance
Website:
https://www.cgtrader.com/free-3d-models/furniture/other/bathtub-with-shower

On the download page, no restrictions or licenses were found for its use. Other textures were applied to the model.

Figure 61. Shower curtain.

Model: Hyophorbe Lagenicaulis Short modelo 3d
Author: StiffMe1steR
Website:
https://www.turbosquid.com/es/3d-models/short-hyophorbe-lagenicaulis-max-free/835906

On the download page, no restrictions or licenses were found for its use.

Figure 62. Palm tree.

4.1.2. Models of my own authorship.

Model: Shrubs.

Aplicación de diseño: Blender

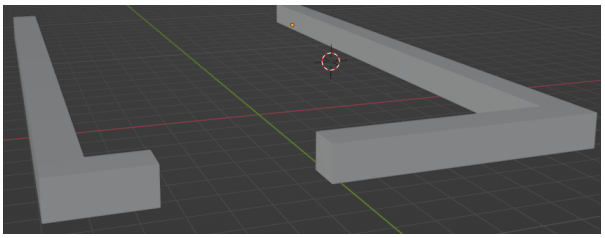

Figure 63. Shrubs.

Texturing: A texture image of the leaf type was used. The projection used was the "Smart UV Project" because it gave a better result than cubic projection even though the model was created from cubes.

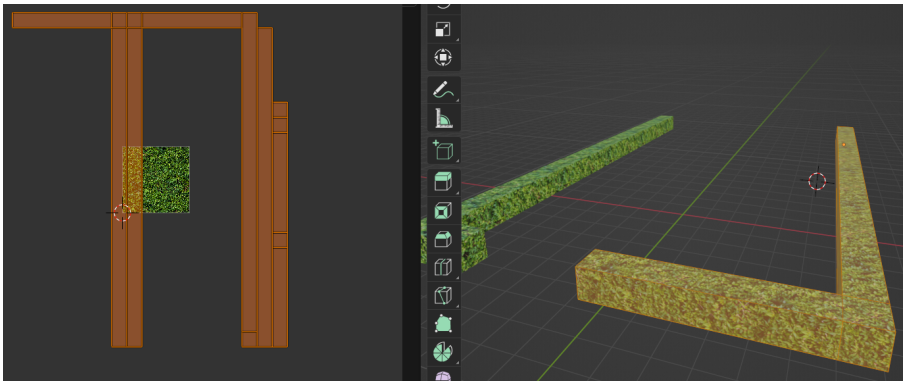

Figure 64. Texturing technique for shrubs.

Model: House facade

Aplicación de diseño: Blender

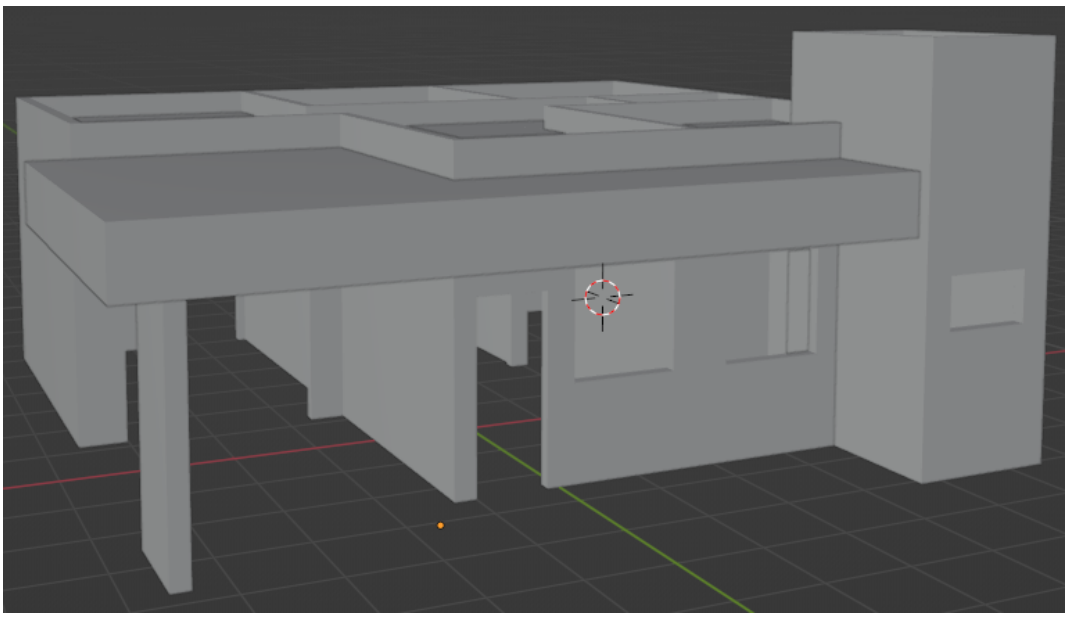

Figure 65. House facade.

Basic modeling techniques such as extrusions, surface division modifiers, and face, edge, and vertex-level modeling were used to model the house. Some parts of the house were handled as separate objects to facilitate their texturing, for example, the walls were separated into their outer and inner faces to have different textures on each one.

Texturing: Different images that emulate painted walls, kitchen panels, bathroom panels, bricks, etc. were used. In most surfaces, "Smart UV Project" was used as projection so that each of the texture edges coincided at their ends and the texturing was not cut off.

Below are just some examples of texturing applications and the final result:

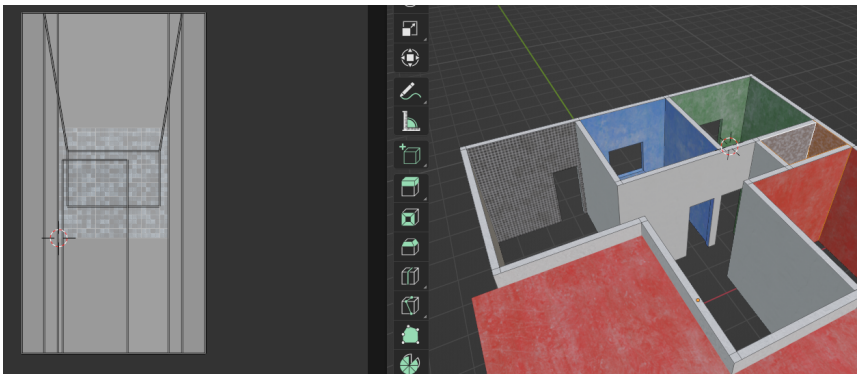

Figure 66. Texturing technique for the bathroom walls.

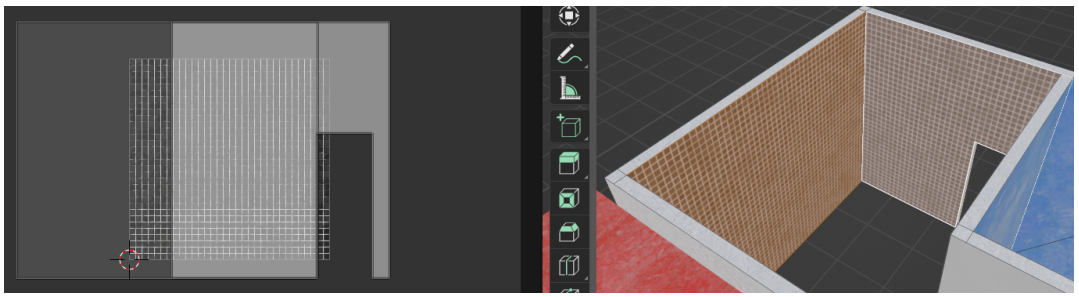

Figure 67. Texturing technique for the kitchen walls.

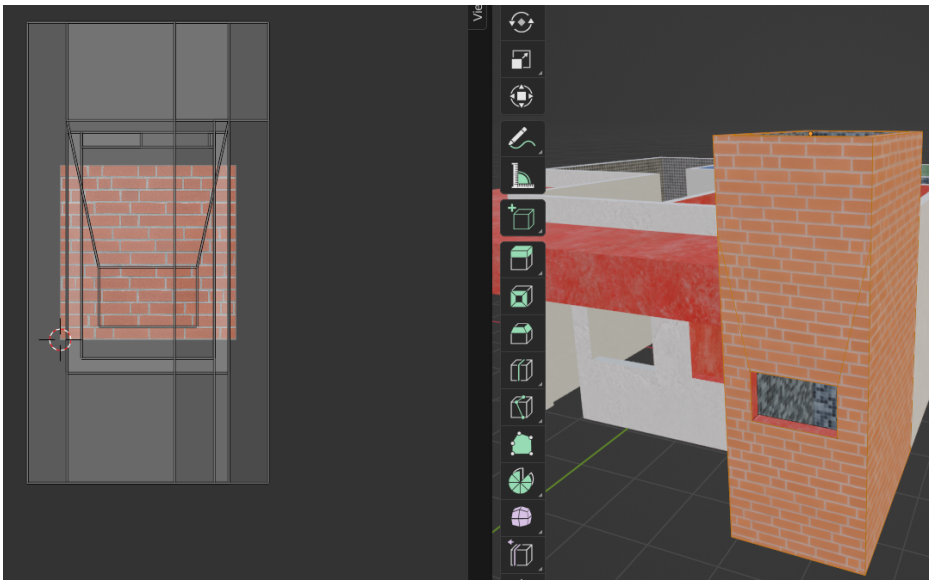

Figure 68. Texturing technique for the brick wall.

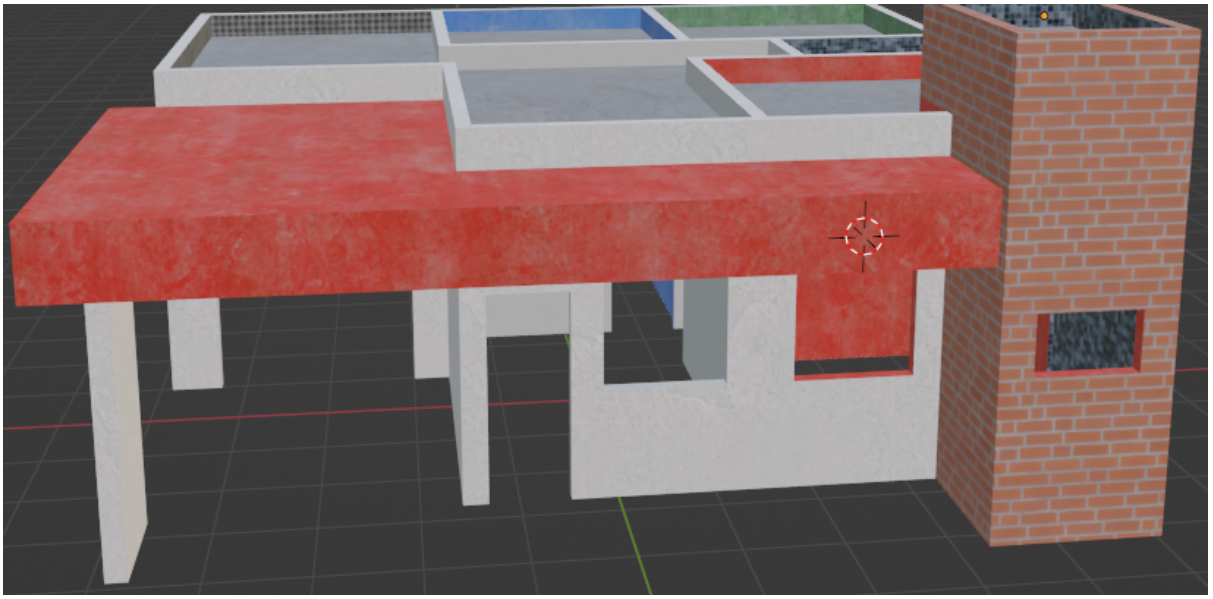

Figure 69. Final result after texturing each of the walls of the house.

Model: Dining room
Aplicación de diseño: Blender

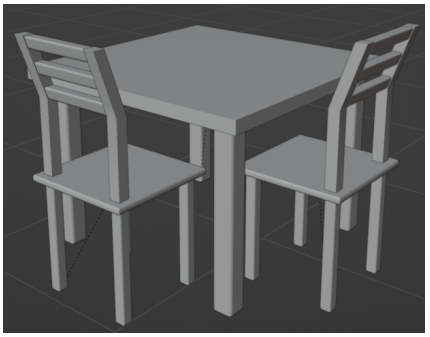

Figure 70. Dining room.

Texturing: A texture image of wood type was used. The projection used was "Smart UV Project" because it gave a better result than cubic projection despite the fact that the model was created from cubes.

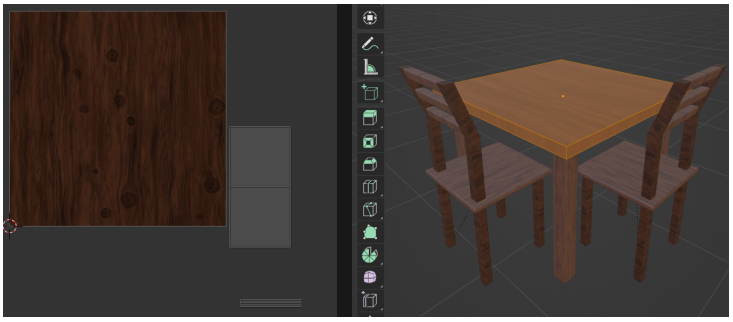

Figure 71. Texturing technique for the dining room.

In some parts of the dining room, a different type of wood was used to give a more realistic and contrasting result.

Model: Stove
Aplicación de diseño: Blender

Figure 72. Stove.

Texturing: A texture image of silver and black metal was used. The projection used was "Cubic" because the object was mostly created from cubes.

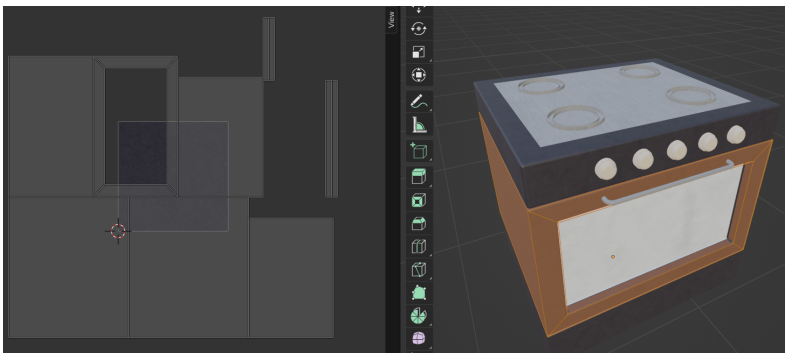

Figure 73. Texturing technique for the stove..

Model: Refrigerator

Aplicación de diseño: Blender

Figure 74. Refrigerator.

Texturing: A texture image of reflective metal was used. The projection used was "Cubic" because the refrigerator was created from cubes.

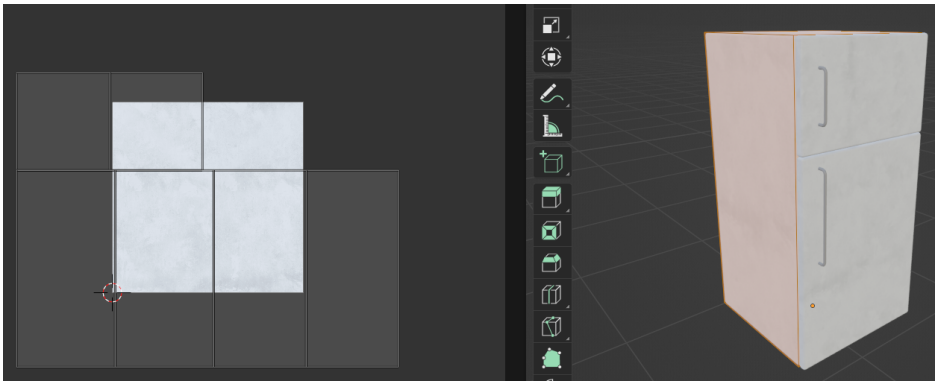

Figure 75. Texturing technique for the refrigerator.

Model: Tablecloth for the dining table
Aplicación de diseño: Blender

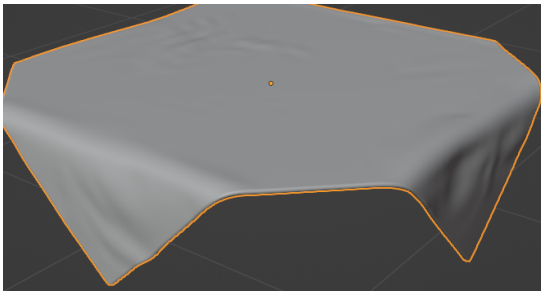

Figure 76. Tablecloth.

A plane was created for the tablecloth to which fabric and collision properties were added. Then, it was animated to fall onto another collision object, resulting in what is seen in Figure 75.

Texturing: A texture image of fabric with a decorative pattern was used. The projection used was "Smart UV Project," because it generated the least distortion in the texture when applied to the tablecloth.

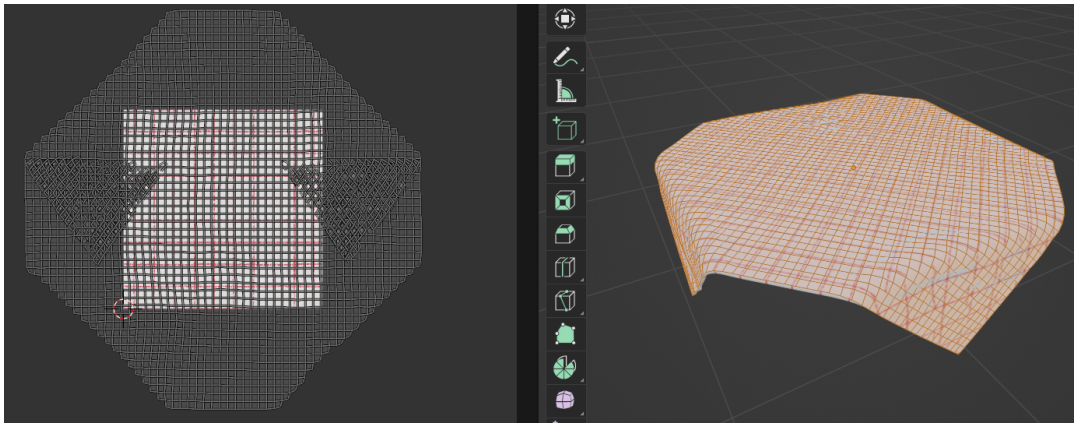

Figure 77. Texturing technique for the tablecloth.

Model: Furniture for the kitchen (sink)
Aplicación de diseño: Blender

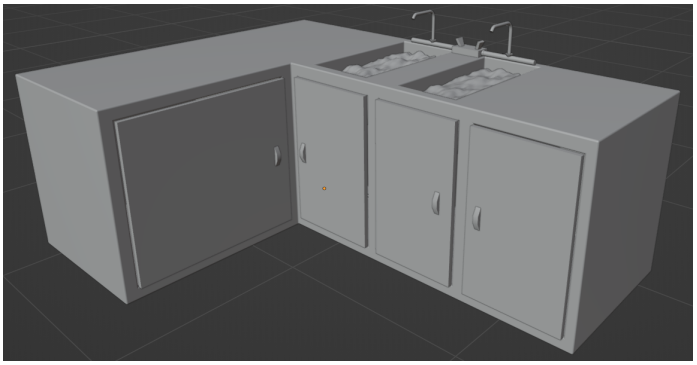

Figure 78. Furniture for the kitchen (sink).

Texturing: Images of wood and marble texturing were used for the furniture, metal for the sink, and blue with white waves for the water. The projection used was "Smart UV Project," because it generated the least distortion in the texture when applied to the objects.

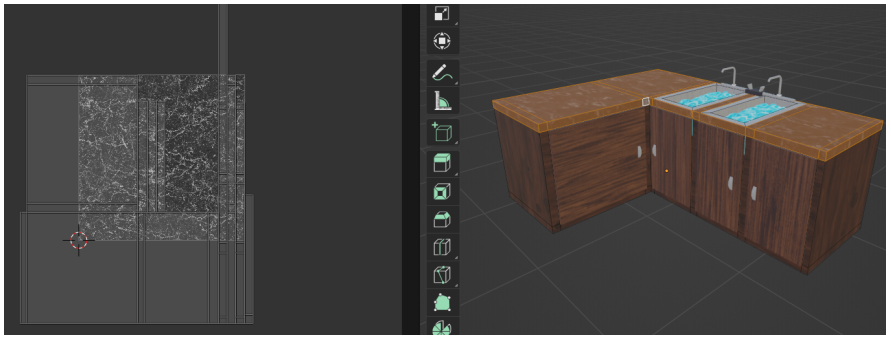

Figure 79. Texturing technique for the furniture.

Model: Wall cabinets

Aplicación de diseño: Blender

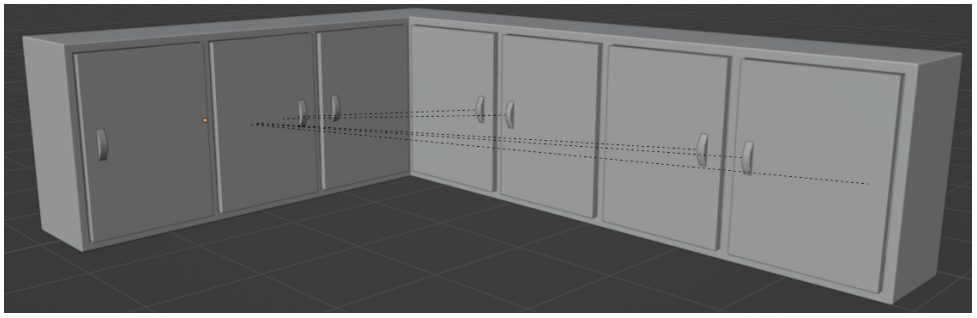

Figure 80. Wall cabinets.

Texturing: Images of wood texturing were used for the furniture. The projection used was "Cube Projection," because the object was created from a cube.

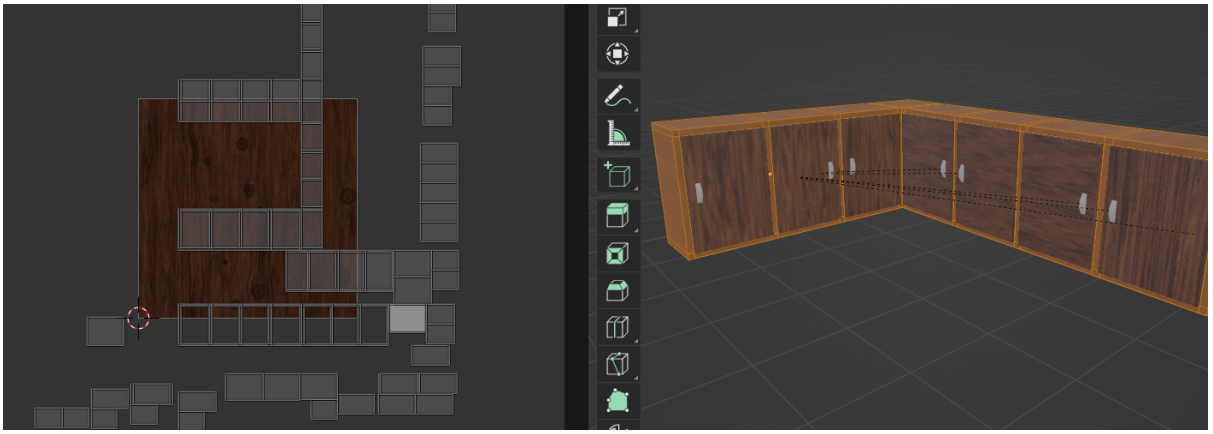

Figure 81. Texturing techniques for the wall cabinets.

Model: Wardrobe

Aplicación de diseño: Blender

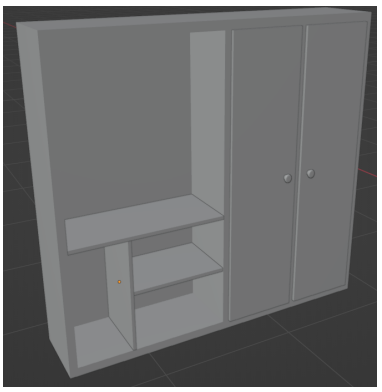

Figure 82. Wardrobe.

Texturing: Images of wood texturing were used for the furniture, it is worth mentioning that different types of wood were used for some parts of the furniture such as the doors. The projection used was "Cube Projection," because it generated the least distortion in the texture when applied to the objects.

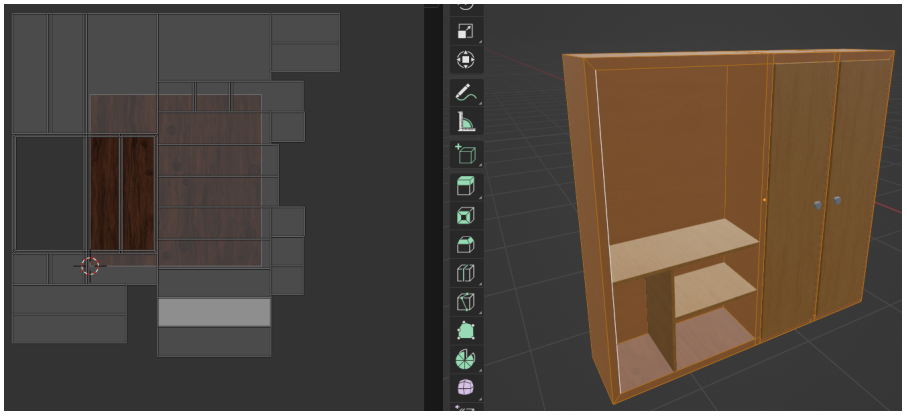

Figure 83. Texturing technique for the wardrobe.

Model: Bed
Aplicación de diseño: Blender

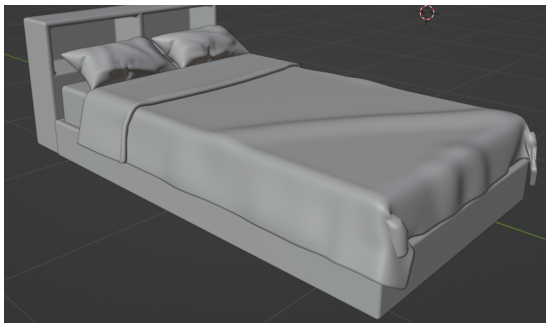

Figure 84. Bed.

Basic modeling techniques (transformations, extrusions, etc.) applied mostly to cubes and planes were used to model the bed. Each part of the bed was modeled separately to facilitate

its texturing. Both the pillows and the blanket were given fabric properties that give them the effect of wrinkles and other particular characteristics that can be seen in the fabrics.

Texturing: Images of fabric texturing were used for the mattress, blanket, and pillows; for the headboard, an image with light wood texture was used. The projection used was "Smart UV Projection," as fabrics tend to distort textures if other types of projections are used due to their wrinkled shape.

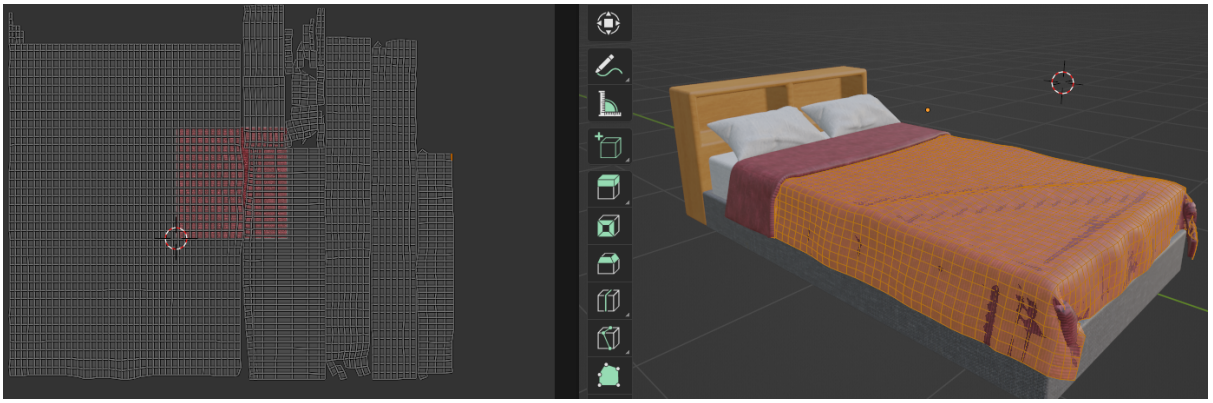

Figure 85. Texturing technique for the bed.

Model: Patio, sidewalks and road.
Aplicación de diseño: Blender

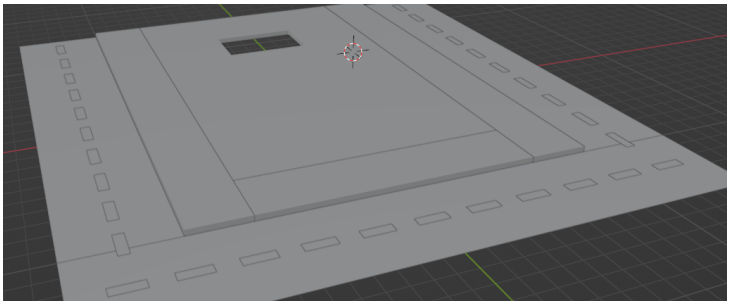

Figure 86. Floor model.

Texturing: Images of grass, asphalt, and paving texturing were used to texture the different parts that make up the floor. The projection most used was "Cube Projection," because the floor is mostly made up of modified cubes and planes.

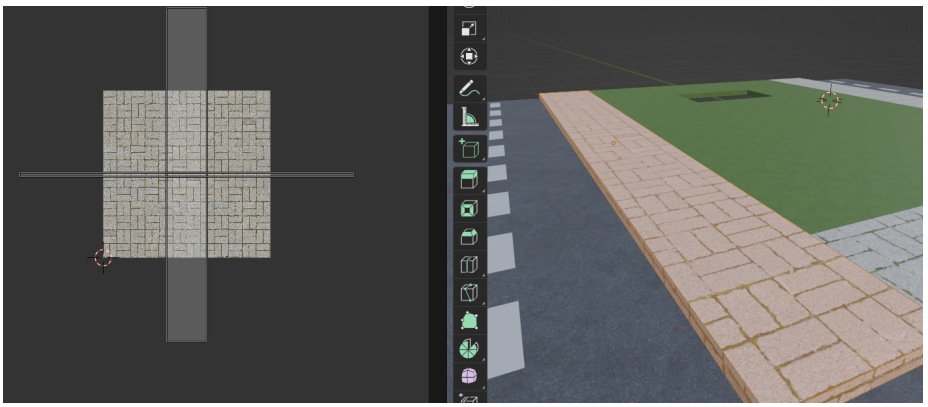

Figure 87. Texturing technique for the floor.

Model: Pool

Aplicación de diseño: Blender

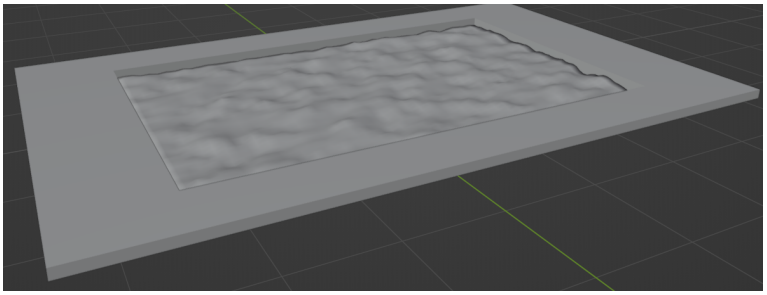

Figure 88. Pool.

Texturing: Images of marble texturing were used for the edges of the pool and a blue texture with white waves for the water. The projection used was "Smart UV Projection," as the modeling of the water has roughness on its surface that complicates its texturing a bit with other types of projection.

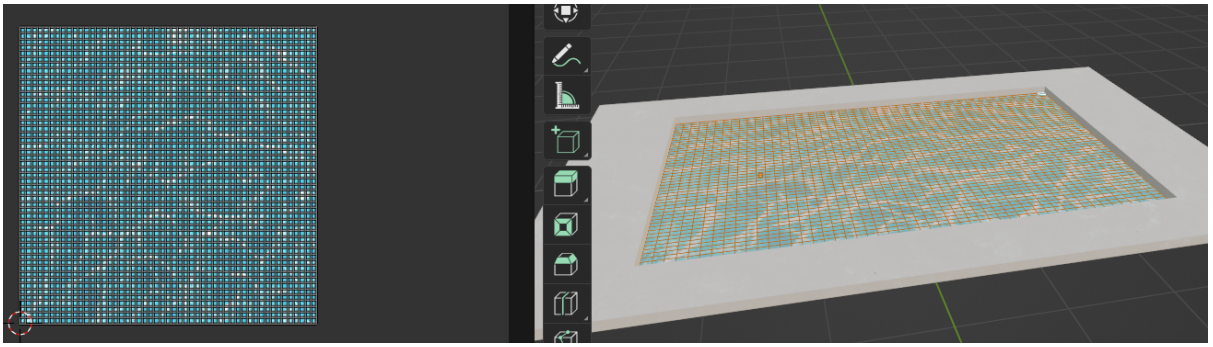

Figure 89. Texturing technique for the pool.

Model: Furniture for the bathroom

Aplicación de diseño: Blender

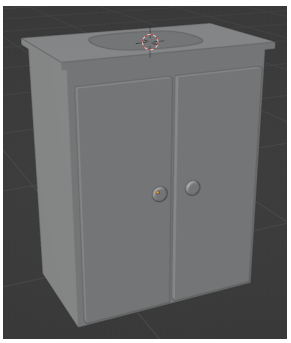

Figure 90. Furniture for the bathroom.

Texturing: Images with patterns that emulate wood, marble, and metal were used for the texturing of the furniture. These textures were applied to different parts of the model to give it a more realistic style.

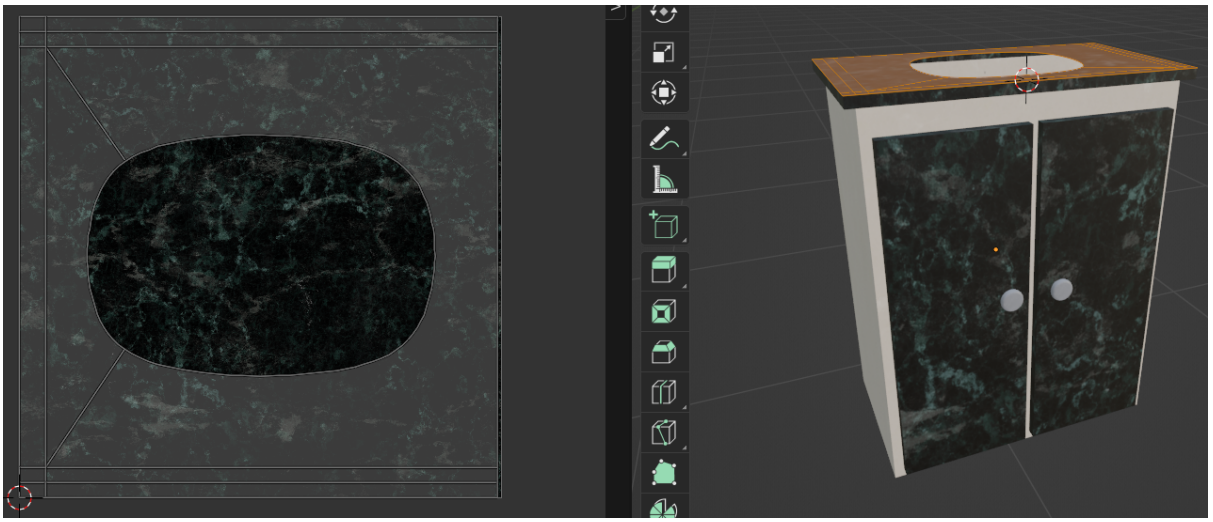

Figure 91. Texturing technique for the furniture..

Model: Bathroom mirror
Aplicación de diseño: Blender

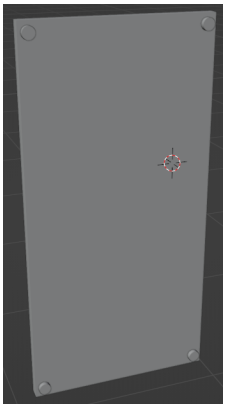

Figure 92. Mirror.

Texturing: It is difficult to texture a mirror, as reflections are not compatible with the type of lighting we work with in the laboratory, that is why a silver metal image was chosen.

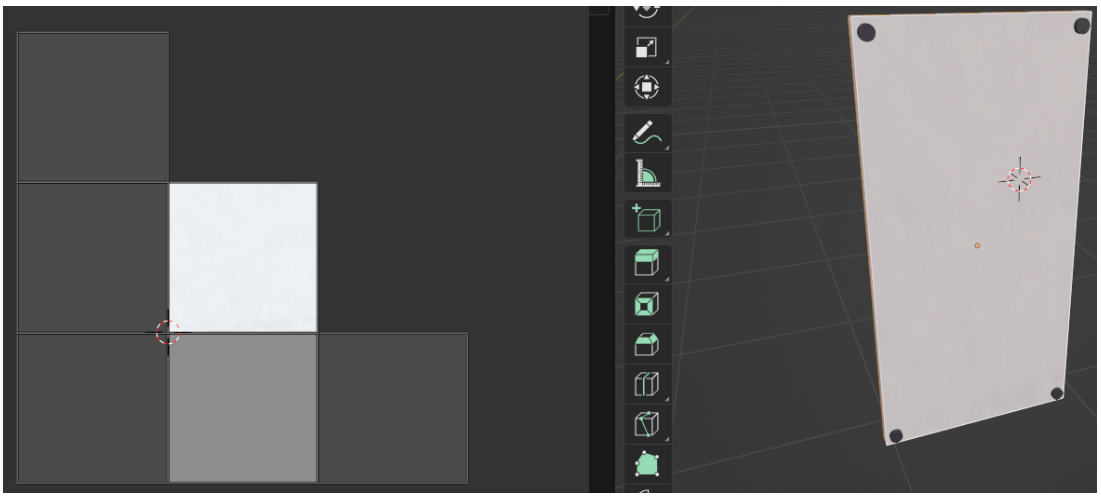

Figure 93. Texturing technique for the mirror.

Model: Floors of the different rooms in the house and edges

Aplicación de diseño: Blender

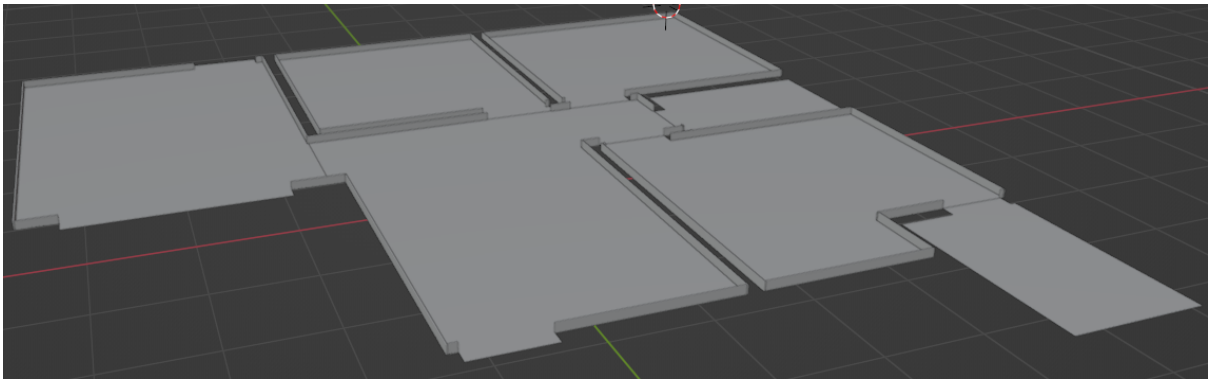

Figure 94. Floors of the different rooms in the house and edges.

Texturing: Different patterns were used for the texturing of the floor for each room, for example, a texture image of laminate flooring was used for the living room, tiles for the kitchen, etc. The type of projection used is "Smart UV Projection" so that the edges coincide at their ends.

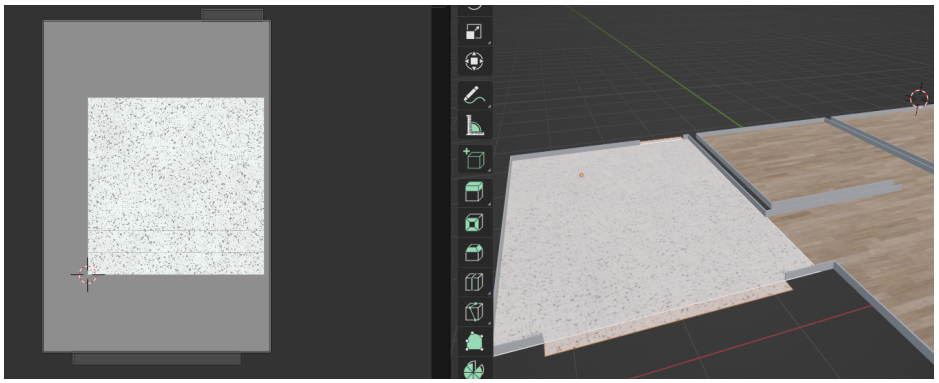

Figure 95. Texturing techniques for the different floors.

4.2. Explanation of activities

The project began by searching the internet for different house plans that met certain requirements, such as having three bedrooms, two bathrooms, a kitchen, a dining room, and a living room. These characteristics are essential for a realistic house.

Once the house plan was selected, the modeling of the house began using the Blender modeling program. This significantly facilitated the creation process. Basic modeling techniques, such as extrusions, surface division modifiers, and face and vertex-level modeling, were used to develop the elements shown. In addition, the translations, rotations, and scale transformations were widely used to position the created models in relation to the reference axis.

In total, the following elements were developed for the first stage of practical progress:

- Facade and exterior of the house.
- Furniture for the kitchen (Stove, Refrigerator, Wall cabinets, Furniture with sink and Dining room).
- Floors for the rooms of the house

Subsequently, the following elements to be developed were:

- Pool
- Shrubs
- Furniture for the rooms (Beds and wardrobes).
- Furniture for the sink.

Once the modeling of the objects created by me was finished, additional models were downloaded from the internet to complete the decoration of the house. Some of these models were downloaded from the Turbosquid and Cgtrader websites, where free objects are not subject to use licenses, others were acquired from the creations shared by the YouTube channel Heber Villalta.

Below is a brief description of the modeling of some of the objects of my own creation:

- Wardrobes:
  The way to model this object started from a cube sized to a rectangular prism, which would represent the dimensions of the furniture, subsequently creating subdivisions on each face to create positive and negative extrusions creating sections in the

wardrobe. In addition, the handles were created from the extrusion of circles in different directions to give that rounded effect.

- Bed:
  To create the bed, a similar process was followed. Several cubes were modified, using one for the base, another for the mattress, another for the headboard and two for the pillows. To create the blanket, fabric properties were added to a plane and then dropped onto a collision object to generate a realistic blanket.
- Stove:
  Modeling the stove was simple. It consisted of a cube with a negative extrusion in the center to create the oven and extruded circles to create the stove knobs and burners. Modified cylinders were also used to create the oven handle.
- Refrigerator:
  The refrigerator was created by using a rectangular prism to which subdivisions were added to create the doors. The oven handle was copied to create the handles for the refrigerator doors.
- Dining room:
  The dining room is made up of several cubes to which scaling operations were applied to create the legs of the table and chairs, as well as to create the tabletop and chair seats.
- Kitchen furniture (sink):
  To create the piece of furniture, a process similar to that of the cabinet was followed. A suitable-sized cube was modified to represent the piece of furniture, and then negative extrusions were created on some of its faces to create each of the sections of the piece of furniture. Finally, doors were created for each of these sections.

  To create the sink, the piece of furniture had to be modified first to be able to place it on its surface, and then a cylinder was modified to create the pipes representing the faucet. A cube was also added inside the sink to emulate water.
- Wall cabinets:
  The wall cabinet is practically a copy of the kitchen furniture but without the sink and scaled down to make it smaller.
- Bathroom mirror:
  The mirror is a scaled cube that was given a flattened and slightly thick appearance, to which extruded circles were added on each of the corners to generate the supports that hold it attached to the wall.

- Furniture for the washbashin:
  This piece of furniture is a scaled replica of a section of the wardrobe, specifically the part with the door. An extruded plane was added on the Z axis on its surface to create the base of the sink, which was then modified through a boolean operation to allow for the installation of the sink.
- Pool:
  The pool is an extruded plane at the level of edges to which a scaled cube was added in the center to represent the water.

Once the modeling was completed, the texturing process began, which proved to be very tedious due to the need to find textures that fit the artistic style proposed in the project. In addition, different types of projection had to be experimented with to get the textures to apply correctly to the surfaces of the objects and obtain realistic and satisfactory results. The explanation of the texturing on the objects created by me was explained in section 4.1.2.

The next step was lighting, which, for optimization purposes, only used a white directional light source that affects differently exposed and less exposed faces to generate opaque areas within the project.

As a final step in the process, the animations for each of the characters were added: athlete, falcon, car, and helicopter. Of these, the athlete is the only dynamic model in the project, that is, one that comes with an animation already assigned before being imported into the OpenGL scene. This athlete was downloaded from Mixamo along with its running animation in .dae format, the only compatible animation format according to the specifications of the code provided by the laboratory professor.

Figure 96. Animation of the athlete running through the scene.

The animation of the falcon is also interesting, as in the laboratory we work with a version of the timeline of some modeling programs that stores the properties of an object at a particular time (keyframe). This allows us to create not very complex animations but that include basic transformations such as rotation and translation. Thanks to this version of the timeline provided by the professor, I was able to add additional code that would load the properties of an object from a text file for each keyframe, which allowed me to create a hierarchical animation of the falcon's wings to simulate it flying.

To run the animation, the user must press the 'P' key.

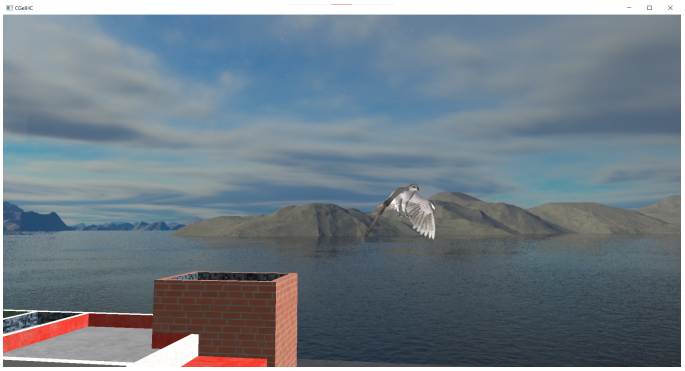

Figure 97. Animation of the falconthrough Keyframes.

The car's animation involves translations of the body and wheels throughout the scene, so it is a hierarchical model. The wheels were given a rotation on the x-axis so that they would move along with the body and give a more realistic effect.

To run the animation, the user must press the 'SPACE' key.

Figure 98. Cara animation.

The helicopter and its animation follow a very similar process to that of the car. However, the helicopter's animation is more complex due to the curves and different speeds that the helicopter faces at each moment of its animation.

To run its animation, the user must press the number '5'.

Figure 99. Helicopter animation.

For more information on the animations, please consult the technical manual.

Below I show photos of the final result obtained after importing the textured objects to OpenGL, applying the lighting technique, and importing each of the animations.

Figure 100. House facade.

Figure 101. Living room.

Figure 102. Kitchen.

Figure 103. Bedroom 1.

Figure 104. Bedroom 2.

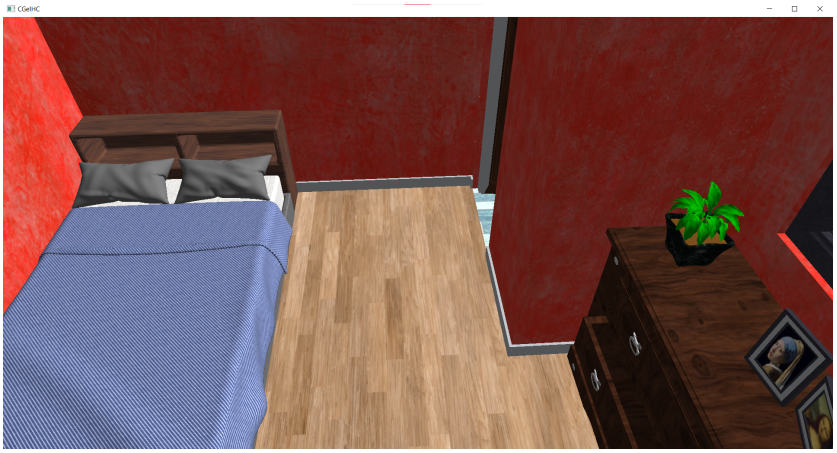

Figure 105. Bedroom 3.

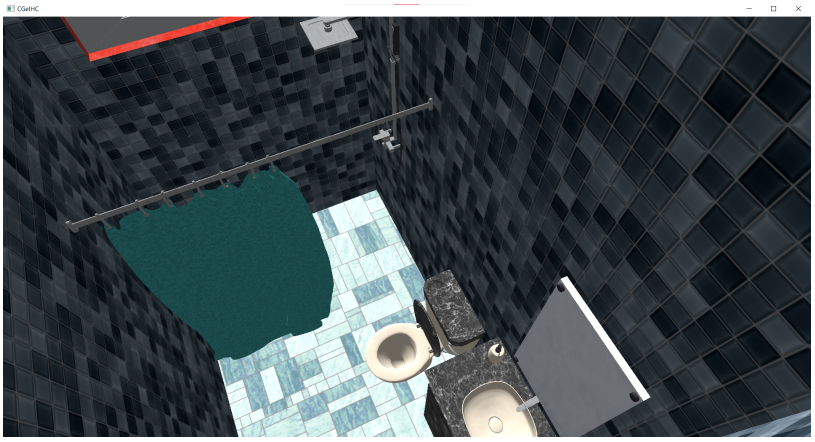

Figure 106. En-suite bathroom

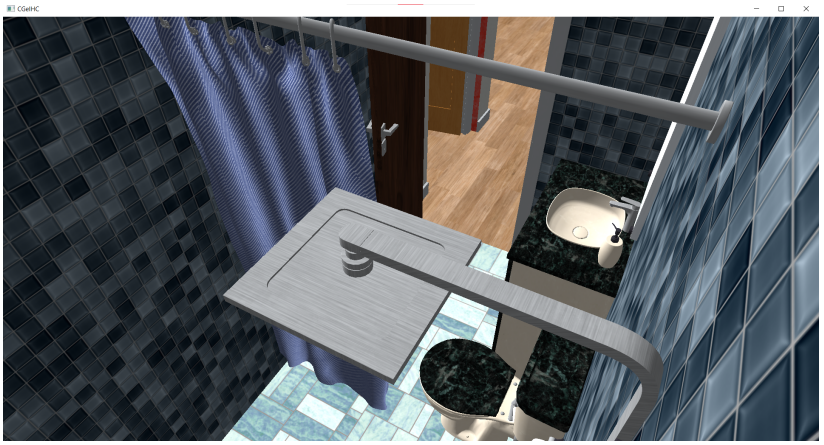

Figure 107. General bathroom.

Figure 108. Backyard with swimming pool.

4.3. Project opening and execution

To download the project from GitHub, click the green "Code" button and select one of the options.

Link: https://github.com/chow-chow/ProyectoFinal-CGeIHC

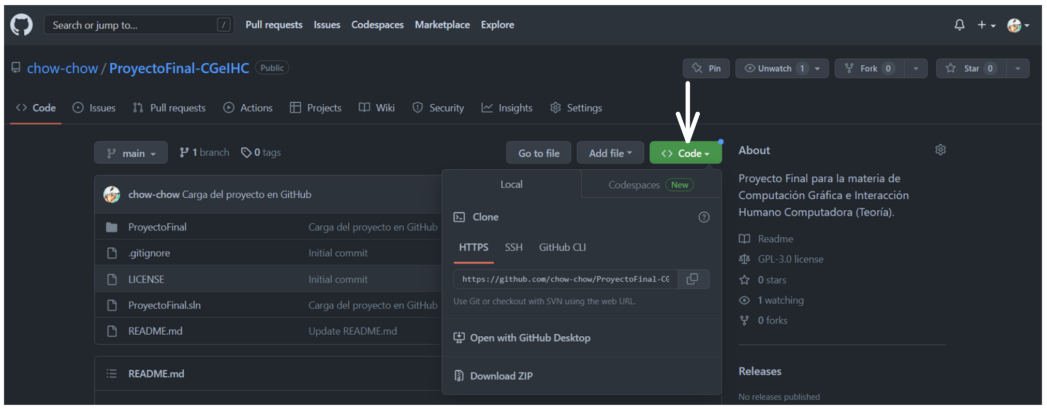

Figure 109. Project download from GitHub.

If you select "Open with GitHub Desktop," you will need to have the GitHub Desktop application installed on your computer and follow the steps to clone the repository locally. Once the repository is cloned, skip to "Execution of the .exe file."

If you select "Download ZIP," it will download a .zip file of the project. You will need to extract the file on your computer, return to this manual, and skip to "Execution of the .exe file."

Execution with Visual Studio. 💻

If you wish and have the Visual Studio IDE installed, you can run the application by following these steps: download the project from GitHub and extract the zip folder. Once this is done, open Visual Studio and select the option "Open a project or solution".

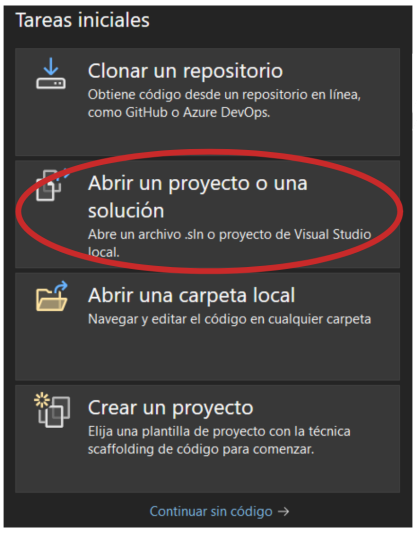

Figure 110. Open a project with VS.

Search for the 'ProyectoFinal.sln' file within the extracted folder and click the 'Open' button.

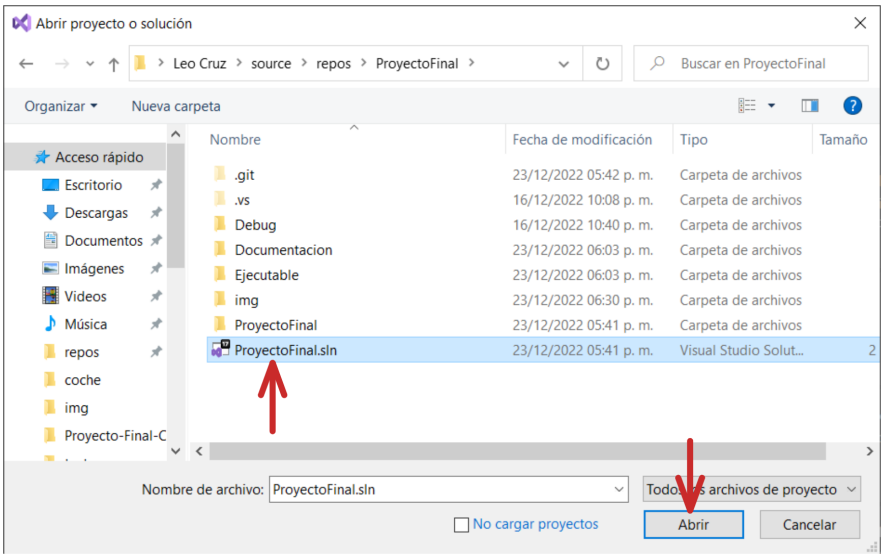

Figure 111. Open a Solution.

Before running the program, it is important to check that all libraries and configurations are loaded correctly. To do this, you should go to the solution explorer, right-click on the project name, and select the properties option.

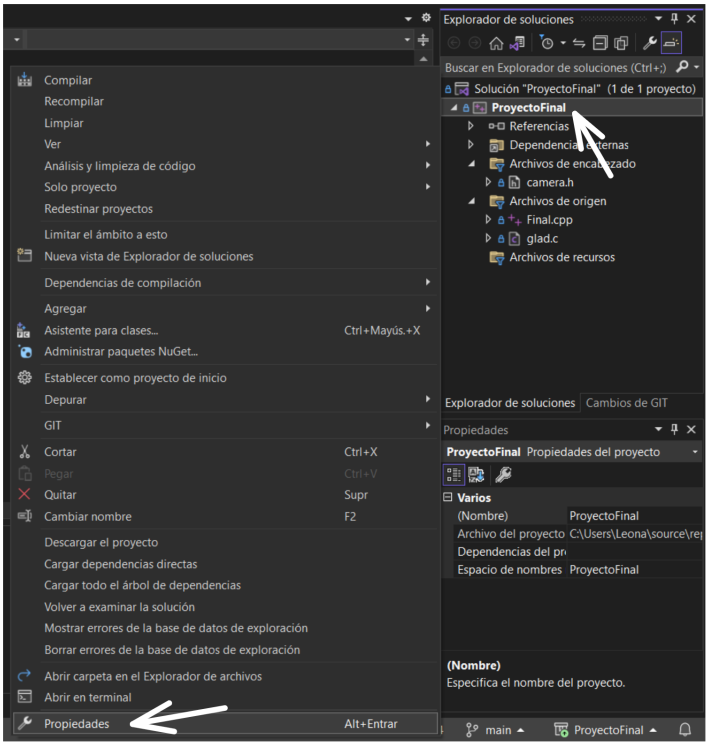

Figure 112. Project properties.

In the "General" section, verify that the Platform Toolset is one that you have downloaded, it can be v142 or v143.

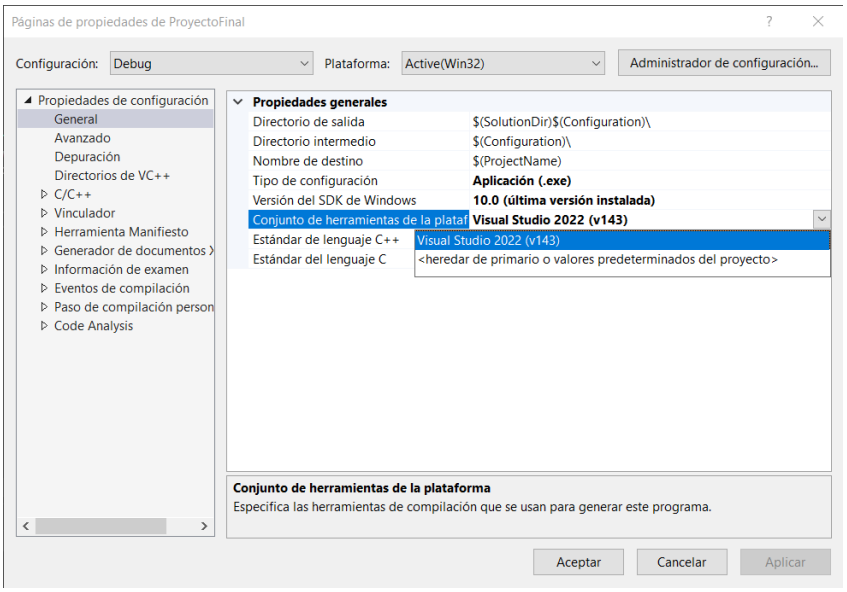

Figure 113. Platform Toolset.

Inside "C/C++ --> General", verify that the word "include" is located in "Additional Include Directories".

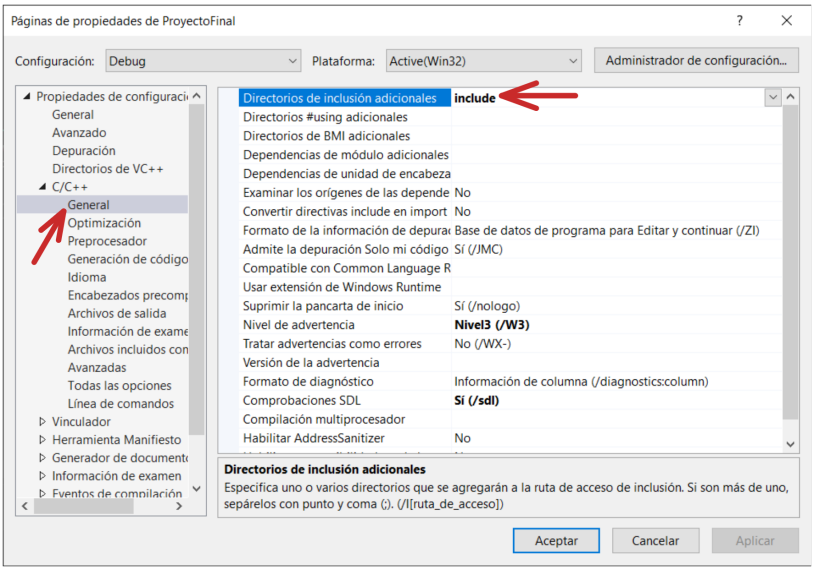

Figure 114. Include verification.

In "Linker --> General", verify that the word "lib" is located in "Additional Library Directories".

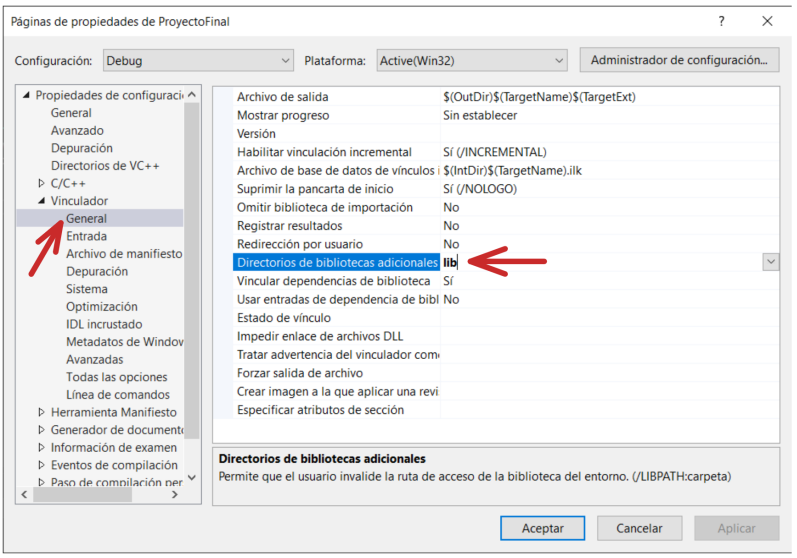

Figure 115. Lib verification.

Finally, in "Linker --> Input", verify that the dependencies **SDL2.lib; SDL2main.lib; assimp-vc141-mtd.lib; opengl32.lib; glfw3.lib;** are included in "Additional Dependencies". If not, paste the bold text in that section, without deleting any dependencies that you already have.

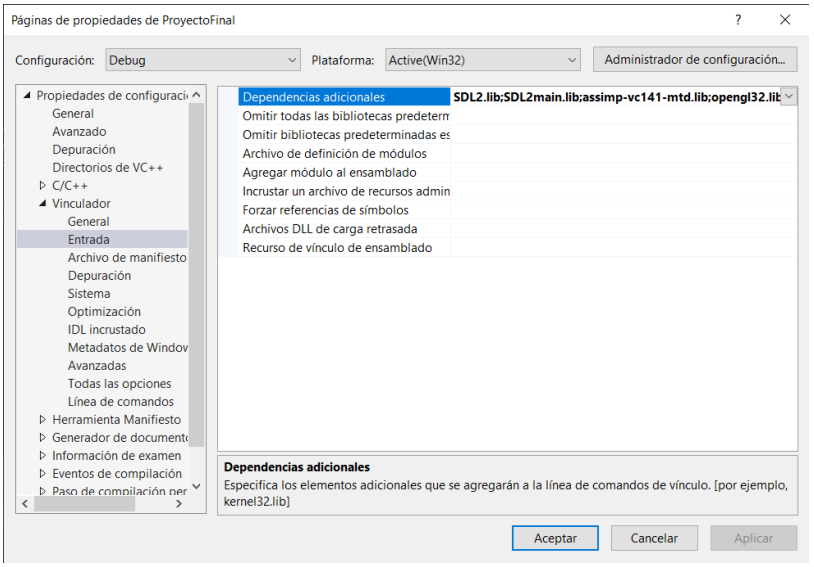

Figure 116. Dependencies verification.

To run the project, you must select the "x86" option in the top bar and verify that the "Debug" option is selected, as shown in the following image.

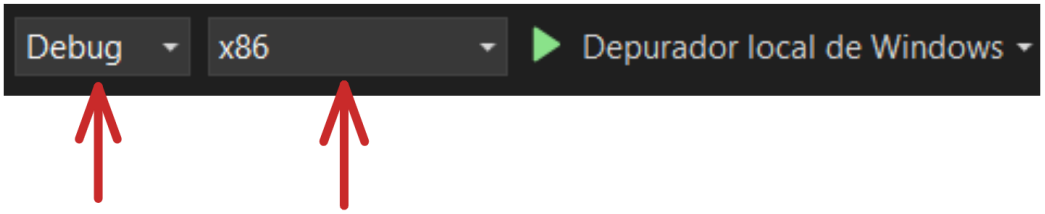

Figure 117. Execution with VS.

You can now run the project by clicking the "Windows Local Debugger" button, this will open the program window.

Execution of the .exe file. 🚀

Once the project has been cloned or the .zip file has been decompressed, you should open the generated folder or repository location on your computer and go to "ProyectoFinal\Release". Then, locate the "ProyectoFinal.exe" file and double-click on it to run the program.

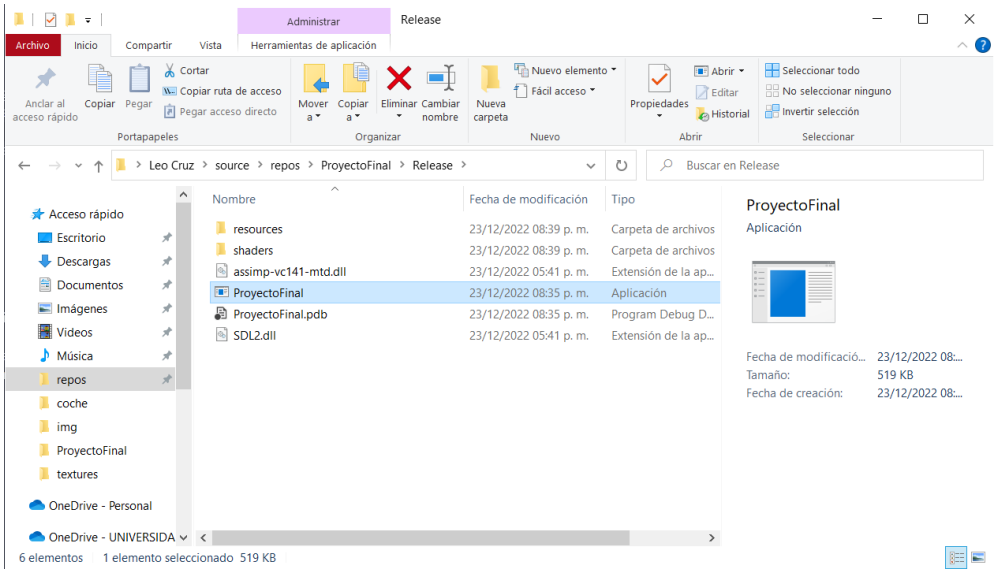

Figure 118. Location of the .exe file.

Note: There are times when the .exe file does not run correctly and closes unexpectedly, in those cases you should go to ProyectoFinal/ProyectoFinal and click on the executable located in that folder, which also has the name ProyectoFinal.exe.

In case that executable also generates an error, please contact me by email at the following address: leonardochow20@gmail.com, and as an additional measure you can try running the project with Visual Studio.

Interacting with the environment🏠

Once the window is open, the mouse is captured so that it only works within the virtual space. As a result, the cursor is not visible and mouse movement is only possible within the window. Interaction is carried out through the computer's keyboard and mouse.

Keyboard Functions:

- "Esc": To exit the window/terminate the program. ❌
- Simulating the forward ⬆️, backward ⬇️, left ⬅️, right ➡️ movement keys as in video games:
    - "W": move the camera forward ⬆️.
    - "S": move the camera backward ⬇️.
    - "A": move the camera to the left ⬅️.
    - "D": move the camera to the right ➡️.

- Mouse movements:
    - Sliding the mouse 🔁 to the left or right, up or down performs the camera 📷 rotation in that sliding direction, the field of view 🔍 moves as the computer cursor does.
    - Mouse scroll performs zoom + 🔍 by moving it forward and zoom - 🔍 by moving it backward.

- Animations:
    - **"SPACE":** Activates the vehicle 🚗 animation
    - **"R":** Resets the vehicle animation once it has finished and the car 🚗 has disappeared
    - **"5":** Activates the remote control toy helicopter 🚁 animation
    - **"P":** Activates the KeyFrames animation of the bird 🦅
    - The athlete animation does not require user input 🏃

4.4. Gantt chart

The Gantt chart developed considers a time for the completion of the project of 6 weeks from the publication of the project requirements.

Activities	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Project Proposal						
Model development						
Model texturing						
Loading models in OpenGL						
Iluminattion						

Animation						
Documentation						

Figure 119. Gantt chart.

4.5. Cost estimation and sale price of the project

The analysis presented below aims to simulate the approximate costs of developing a formal project with more advanced development features, thinking about a professional job for a client, organization, or company that requires a product with a theme like the one presented in the project.

Obviously, the scope of my project is not as ambitious as to require such high costs. This simulation considers a project with a similar theme but with greater scope and much more advanced production techniques used professionally, which is why 120 days are considered for its completion. It also considers the costs of the personnel employed for the project as well as the equipment and software used by each individually.

Resource	Type of resource	Quantity	Price per unit ($)	Disponibility (%)	Price per day ($)	Days	Total ($)
Project Manager	Work	1	N/A	100%	$850.00	120	$102,000.00
Designer	Work	2	N/A	100%	$230.13	120	$55,231.20
Programmer	Work	4	N/A	100%	$683.33	120	$327,998.40
Tester	Work	1	N/A	100%	$533.33	120	$63,999.60
Computing equipment							
CPU: Intel i3-10100F	Material	6	$1,799.00	N/A	N/A	N/A	$10,794.00
GPU: NVIDIA 1650	Material	6	$4,100.00	N/A	N/A	N/A	$24,600.00
RAM: 16 GB DDR4 Kingston de 3200 Mhz	Material	6	$1,600.00	N/A	N/A	N/A	$9,600.00
Motherboard: Asus Prime B460M-A R2.0	Material	6	$1,600.00	N/A	N/A	N/A	$9,600.00
Power source: XPG Pylon 550W	Material	6	$1,000.00	N/A	N/A	N/A	$6,000.00
Cabinet: Yeyian Shadow 2200 + 3 Fans	Material	6	$1,200.00	N/A	N/A	N/A	$7,200.00
Storage: Kingston A400 960 GB SATA	Material	6	$1,800.00	N/A	N/A	N/A	$10,800.00
Wireless keyboard	Material	6	$1,300.00	N/A	N/A	N/A	$7,800.00
Wireless mouse	Material	6	$600.00	N/A	N/A	N/A	$3,600.00
Monitor	Material	6	$1,200.00	N/A	N/A	N/A	$7,200.00
Internet	Material	6	N/A	N/A	$25.00	120	$18,000.00
Licenses and software							
Windows Pro	Costs	6	$2,700.00	N/A	N/A	N/A	$16,200.00
Visual Studio	Costs	6	N/A	N/A	N/A	N/A	$0.00
M. Office 365	Costs	6	$464.00	N/A	N/A	N/A	$2,784.00
Blender	Costs	6	N/A	N/A	N/A	N/A	$0.00
OpenGL	Costs	6	N/A	N/A	N/A	N/A	$0.00
GIMP	Costs	6	N/A	N/A	N/A	N/A	$0.00
						Total cost:	$683,407.20

Figure 120. Cost estimation and sale price of the project.

6. Conclusions

The result obtained from this project has left me satisfied, since through the tools and skills acquired during the course it was possible to adequately reflect the idea captured in the proposal; creating a facade of a house with the essential elements and their respective exteriors to give it realism.

The project required a significant investment of time and effort due to the complexity of modeling, texturing, and animating models to meet the project requirements. However, I consider that there is the opportunity to add more details to the house, such as increasing the number of models, adding different types of lighting and animations, among others.

In conclusion, the objectives set out in this project have been achieved by succeeding in capturing the ideas developed in the proposal and applying the knowledge acquired during the laboratory and theory course. This experience will undoubtedly be valuable for my development as a Computer Engineer, since graphics have a wide presence in everyday life and it is important to have the necessary skills to perform effectively in the profession.

7. References

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8. Link to virtual tour

https://www.youtube.com/watch?v=XWHkK6jfjIg

9. Link to animation demonstration

https://www.youtube.com/watch?v=0kX-gMDSoKM