

Interactive 2.5D Scene for Illustrations of Islamic Architecture

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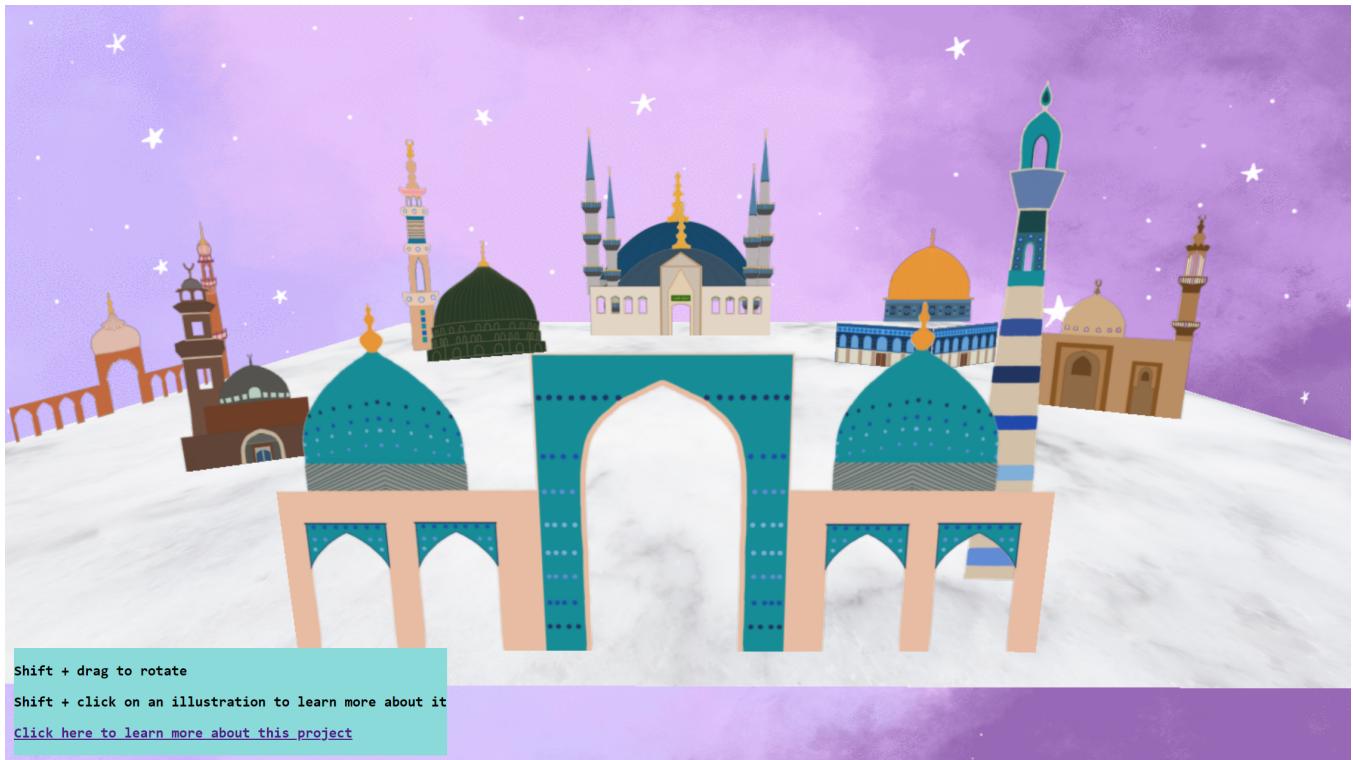


Figure 1: Snapshot of the final 2.5D scene

ABSTRACT

For the final project in CS 460: Computer Graphics, I have created a 2.5D scene by rendering 2D images onto a 3D space. I designed this project to be educational and user-interactive by providing information on various mosques built throughout centuries of Islamic history.

KEYWORDS

WebGL, Visualization, Islamic Architecture, ThreeJS, Digital Humanities

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1 INTRODUCTION

Islamic architecture is diverse and widespread, spanning centuries and witnessing the rises and falls of empires and dynasties. Since the first year of the Islamic calendar, 1 AH (622 CE), building mosques has been a practice upheld through each generation of Muslims, implementing the saying of the Prophet Muhammad (peace be upon him):

"Whoever builds a masjid (mosque) in which the Name of Allah (God) is mentioned, Allah will build a house for him in Paradise." [6].

The various architectural structures of mosques are often influenced by their specific contexts, both in terms of geography and time period, infusing social, political, religious, and artistic concepts together. For example, the designs of Ottoman mosques were often inspired by Christian architecture from the Byzantine period, such as the Hagia Sophia [2]. Similarly, Indian Muslim architecture often

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draws upon styles established in the Hindu construction of temples [1].

To showcase the beauty and diversity of Islamic architecture in an interactive, educational, and artistic environment, I used ThreeJS to render representations of a selection of mosques built in different time periods and various regions across the world. By creating this graphics scene, I hope to advocate for an awareness and appreciation for the beauty exhibited in cultural and religious architecture expressed through the religious tradition of Islam.

2 RELATED WORK

This 2.5D scene was built using the Three.js framework, which builds upon WebGL[3]. The creation of a 2.5D scene was inspired by various projects that involved rendering images drawn in 2D onto a 3D space. Two particular examples that have inspired me are "Short Trip" by Alexander Perrin and "Subway" by Abby Carter. "Short Trip" is an interactive scene rendered using ThreeJS involving pencil sketches [9]. "Subway" is a 2.5D scene that allows users to explore 2D images that make up a 3D space [4]. There are multiple projects that serve as archival and educational repositories for Islamic art and architecture, including Archnet from MIT Libraries [8].

3 METHOD

In order to showcase the beauty and diversity of Islamic architecture in the construction of mosques, I have created a graphics scene using a combination of tools to render a selection of representations of notable mosques built around the world throughout history. Working in a 3D environment, I have created a scene in 2.5D using 2D images. This scene incorporates user interaction for an educational experience that allows users to click on specific images to learn more about their histories and locations.

This work involved researching various important and historical mosques throughout Muslim history. Because the diversity of Islamic architecture is much broader than can be captured in this project, I was required to limit the selection of mosques represented in this project. Ultimately, this project's featured mosques were chosen due to a number of reasons, including fame, beauty, and religious sacredness. The selected mosques are displayed in Table 1, along with their respective locations and founding years. Additionally, in a few cases, the mosques were chosen due to my own personal experiences in them. For example, the Islamic Society of Boston Cultural Center is hardly world-famous or historical (yet, anyway), but I chose to display it due to my personal connection through visiting it after college classes on Fridays. This is certainly not a conclusive list, and arguably not representative of the diversity of Muslim architecture as a whole, nor is it reflective of the most important mosques to Muslims religiously, traditionally, or culturally. However, I hope these selections are enough to spark interest in the beauty and inter-connectivity of some significant mosques in history.

After the research phase, I then drew the distinguishing features of each of the selected mosques in a 2D sketching app, SketchBook [7]. An example of the various illustration pieces drawn is shown in 2.

Once all the images were drawn, I loaded them onto the Windows app Paint 3D to make transparent cut-outs, as shown in figure 3

Table 1: Selected Mosques for Illustration

Mosque	City	Year Founded (CE)
Prophet's Mosque	Medina	622
Dome of the Rock Mosque	Jerusalem	692
Al-Rifa'i Mosque	Cairo	1361
Poi Kalan Mosque	Bukhara	1514
Sultan Ahmed (Blue Mosque)	Istanbul	1616
Jama Mosque	Delhi	1656
Al-Rifa'i Mosque	Cairo	1661
ISBCC	Boston	2009



Figure 2: Pieces of the illustrations drawn using SketchBook

[5]. This also allowed for windows and doorways to be transparent, enabling the users to see other objects through them.

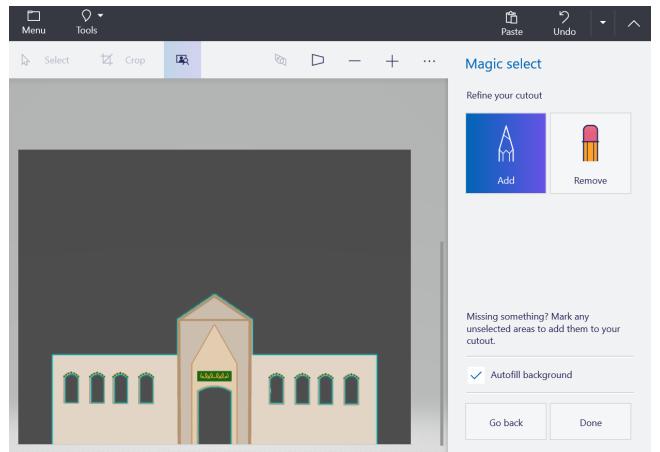


Figure 3: Creating images with transparent doorways and windows using Microsoft's Paint 3D

Creating transparent images allows for a more immersive experience, giving the scene the feel as though all the mosques are in close proximity to each other. For example, Figure 4 is a screenshot showcasing an example of a transparent doorway. The transparency that gives this interconnected illusion emphasizes both the uniqueness and the unity of Islamic architecture. Specifically, it shows

how different architectural styles signify the uniqueness of culture, geographic, and temporal contexts, while also being representative and symbolic of the global Muslim community as a whole.

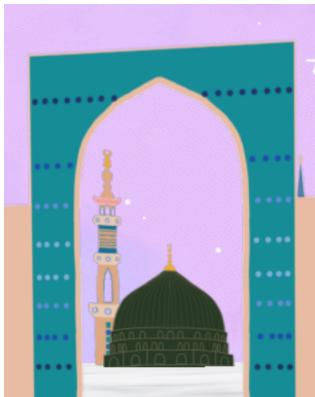


Figure 4: A transparent doorway from Bukhara leads to a mosque in Medina.

To make this scene educational, I also researched basic facts about each of the mosque illustrations and assembled them as info-panels. These info-panels pop up near an illustration when a user shifts and clicks on it, enabling interaction. Figure 5 is an example of the info panel that appears for the illustration of the Islamic Society of Boston Cultural Center (ISBCC). They include the name, location, and date of establishment of the respective mosque, including the both the Gregorian year (A.D. / C.E.) and the Islamic year (A.H. or "After Hijra").



Figure 5: An info panel that appears when the illustration for a Boston mosque is clicked

3.1 Implementation

The implementation of this scene could be split up into two parts. The first part involves loading the illustrations onto the scene, and the second part involves linking each illustration such that its respective info panel appears when it is clicked.

To load the illustrations on the scene, I used them as textures mapped as meshes upon a simple 2D plane. I set the 2D planes to have dimensions with the same ratios as the dimensions of the original image. I also set them to be transparent, so that the user can "see" through the windows or doorways of the illustrations. Once the plane is set up, I position it however I want in the scene and rotate it so the user can view it well. The below code snippet is an example of how one illustration, the green dome, is loaded onto a plane which is then positioned on the scene.

```
var objectTexture = new THREE.TextureLoader().load(
  'illustrations/greendomeT.png');
var objectGeometry =
  new THREE.PlaneBufferGeometry(1200, 1200);
var objectMaterial = new THREE.MeshBasicMaterial({
  map: objectTexture,
  side: THREE.DoubleSide,
  transparent: true
});
greendome =
  new THREE.Mesh(objectGeometry, objectMaterial);
greendome.position.x = -1700;
greendome.position.z = -1000;
greendome.position.y = 500;
greendome.rotateY(22.5);
scene.add(greendome);
```

The second part of the code implementation exists in the "on click" function, which is activated when a user pushes the "shift" key and clicks simultaneously. For this, I first calculate the location where the user clicks, and whether it intersects a specific illustration. In the code snippet below, I check if the click intersects either the green dome or the Nabawi minaret, both of which are planes that make up the Prophet's Mosque illustration. If it does intersect either of those planes, load an info panel onto a plane (in the same way I loaded the illustrations onto the planes) and position it near the respective illustration. I also use a boolean, "infoappears", to keep track of whether there is another info panel currently in display. If there is, I remove it before placing a new one onto the scene. This ensures that only one info panel appears at a time.

```
window.onclick = function (e) {
  [...]
  intersects = raycaster.intersectObject(greendome);
  intersects2 = raycaster.intersectObject(nabMinaret);

  if (intersects.length > 0 || intersects2.length > 0) {
    if (infoappears) {
      // if there's another info box, remove it
      scene.remove(object);
    }
    infoappears = true;
    // otherwise, set infoappears to true
    objectTexture = new THREE.TextureLoader().load(
```

```

    'illustrations/nabawiInfo.png');
objectGeometry =
  new THREE.PlaneBufferGeometry(600, 400);
objectMaterial = new THREE.MeshBasicMaterial({
  map: objectTexture,
  // side: THREE.DoubleSide,
  transparent: true
});
object =
  new THREE.Mesh(objectGeometry, objectMaterial);
object.position.x = greendome.position.x + 333;
object.position.y = greendome.position.y + 333;
object.position.z = greendome.position.z + 333;

scene.add(object);
}
[...]
}

```

3.2 Milestones

3.2.1 *Milestone 1.* I researched different mosques from around the world and throughout history. I selected eight of them to illustrate and designed information panels for each of them.

3.2.2 *Milestone 2.* I set up a scene using ThreeJS and loaded the illustrations as meshes upon 2D planes positioned in different locations.

3.2.3 *Milestone 3.* I designed user interactivity by enabling the information panels to pop up when a user clicks on an illustration.

3.3 Challenges

- Challenge 1: Although the planes used to display the illustrations were set to be transparent, when two planes were too close to each other, one was often blocked by another. This required a manual change in position so that the two planes were far away enough so as not to obstruct each other.
- Challenge 2: While the above challenge seemed to be a glitch in ThreeJS, another challenge I faced was strictly due to z-fighting. This occurred when two planes overlapped each other, causing the affected parts of the planes to appear pixelated, with the planes interchangeably flickering above each other. This also required a manual change of position, either by translating the plane's coordinates or by rotating them.

4 RESULTS

The final result is an interactive 2.5D scene displaying simple illustrations of various historical landmarks of Islamic architecture. One perspective from the scene, which displays one of the info panels, is shown in Figure 6.

5 CONCLUSIONS

2.5D is a unique format for representing art as it allows for any digital artists to display their work in an interactive environment. Moving forward, this project may benefit from collaborations with



Figure 6: The final result

other digital artists specialized in detailing the architecture from the diverse contexts of the Muslim world.

This was a fun project to pursue because it allowed me to be creative artistically and algorithmically. Moreover, I hope that it is the start of a broader exploration into visualizing, interpreting, and recognizing significant historical and cultural landmarks. This platform has the potential to expand into a collaborative project upon which digital artists may display their 2D artwork of Islamic architecture to educate a broad audience. By harnessing interdisciplinary skills, this project can grow from the small 2.5D scene that it is now to encompassing a wide variety of architecture from around the world to promote the education and appreciation for cultural and religious landmarks.

My project does not attempt to serve as an information database. Instead, the goal is to showcase art representations of real historical monuments that still exist today and are significant from an Islamic perspective. Hence, by showcasing these illustrations, I use an artistic license that allows for creativity in the representation of specific details of a building's design or architecture, including minor changes or omissions of details such as geometric paintings or exact scaling. However, the illustrations still display the key attributes of the monuments.

The goal, then, is to provide a connection between the recognizable mosque structures and the specific contextual information for each of them. Visualization improves the study of history and culture by presenting it to a broader audience and by promoting a diversity in interpretation, storytelling, and identity building. Using the modern tools of computer graphics, this project carries on the tradition of preserving, retelling, and reshaping our stories and manifestations to educate ourselves and others about the richness of our past.

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