

Jantar Mantar Reconstruction

Project report
DES 499 Project Course
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1.0 Introduction

As a part of this project course, we were expected to create a physically precise interactive model of the various yantras at [Jantar Mantar](#) in Unity. We created an interactive environment of the various yantras at Jantar Mantar for the user to navigate through it. The user can experience the environment at various times of the day, along with different weather conditions. We plan to include the main spots of Jantar Mantar while making the environment which consists of 13 architectural astronomy instruments. All the relevant links to the project can be found [here](#).

2.0 Rough Project Timeline

- As precision was the key while setting up this project, initially, we went through several Research Papers in the relevant field regarding Samrat Yantra, its dimensions, working, and history to get an in-depth insight into what we were working upon.
- Unfortunately, we could not find proper documentation/sketches depicting the exact dimensions of the Jantar Mantar. So, we made a rough model of Samrat yantra using blender 2.9 to proceed further.
- We faced issues due to an imprecise model and didn't have any reference to fix it. This issue was tackled by making a paper prototype for precision and symmetry.
- Parallely, we developed Day and Night changes cycle system in unity using a procedural sky shader constrained to follow the directional light.
- To get a knack for precision modeling, we took a model from our Engineering drawing course with proper dimensions and tried to recreate a CAD model in Blender until we got approval from Sameer sir in regards to its precision levels.
- We iterated through the same procedure for the Samrat Yantra model by first labeling it from the [Reference PDF](#) given by sir.
- Failing to identify the parts of the Samrat Yantra, we first labeled the PDF to get clarity on the parts of the model. These labeled parts were then cut out to make precise models.

- Parallely, the sundials shadow casting mechanism was developed in Unity, and combined with the day and night cycle, we used a dummy cylinder to observe the behavior of shadows throughout the day.
- The paper prototype was recreated using Blender.
- We also developed a custom input system player controls in Unity to debug shadows' behavior at any time we input.
- We then worked on the UI by introducing buttons (start, slide, right, backward, etc.) designed using Figma and implementing the canvas inside Unity.
- We then worked on a website to make it accessible to everyone. We created a home page using Html and CSS. It was designed to allow users to explore any Yantra that they wanted to by making a selection in the menu by performing a one-time signup using a javascript event listener.
- The WebGL backend of the Unity project was developed to export it to the web without any hassle.
- We began improving the model's precision using the reference PDF. Unfortunately, with the limited resources at our disposal, it turned out to be quite a tedious task, and after several iterations of minor adjustments, we were able to make something worthy of showcasing.
- Finally, we texture-mapped the model with the various texture maps that we designed.
- The model was imported inside Unity, and the entire project will be hosted on the website soon.

3.0 My Contribution

3.1 Reference Materials

- I, along with the team, collected a lot of Reference Materials and listed them [here](#).
- Although we couldn't find any document depicting the exact dimensions of the Jantar, we found a [website](#) containing a paper model replica of the Jantar Mantar.

3.2 Day & Night Cycles

- My job was to script the day & night cycles in Unity (initially needed to be more physically precise).
- I used a Procedural Sky shader for skybox, as it comes with a sun that mimics the directional light by default.

- Then I bound the directional light's rotation and intensity, fog color, and a clock to the day & night cycle.
- [This](#) is what the result looked like.

3.3 Shadows in Unity

- Used a cylinder model to simulate shadows on a full day and night cycle.
- The shadows depicted linear movement (motion on a straight line), unlike the sundial, which roughly works like a clock, and the dial rotates in a clockwise fashion.
- [This](#) is what the shadows look like.

3.4 Implementing new design in Unity

- Implemented sun movement for a more physically precise model of the Sundial.
- [Old Design](#) vs. [New Design](#).

3.5 Day/Night Cycle & Camera Controls

- Unity's default input system was used to take the players' input.
- The horizontal axis was assigned to the camera's rotation, whereas the vertical axis was kept responsible for the day/night cycle.
- A dedicated prompt was shown on the screen to inform the users about the same.
- [This](#) is what the controls looked like.

3.6 Custom Time Input

- I used the Text Mesh Pro input box to take inputs from the user.
- I limited each text box to take 2-digit integer inputs (HH & MM format).
- This value was used to assign a custom time value that users could input to check the behavior of the sundial at that particular time.
- [This](#) is what the results looked like.

3.7 WebGL Backend - Exporting the Project to Web

- The Unity project was optimized and revamped to be exported to the Web as a WebGL experience.
- The project was hosted online using Github Pages and can be accessed [here](#).
- All compressions on the build were disabled, and they generally raise conflicts while getting decompressed on the Jekyll framework that GitHub Pages use.
- The code was optimized to give preference to speed over size in the final build.
- The homepage was renamed to index.html (naming convention for homepages on GitHub Pages).

- The yantras were linked to the [jantar-mantar-experience.html](#) in our build.
- We further plan to use Firebase Authentication to only provide private sessions to the users who Sign Up for the experience.
- [This](#) is what the results looked like.

3.8 Documentation

- Curated development blogs for the entire project logging every work done [here](#).

4.0 Future Work

- We plan to pivot to CAD modeling solutions like Autodesk Fusion 360 to create a more physically precise reconstruction of the buildings.
- To ensure that the precision levels are top-notch, we even wish to go on a field trip to the Jantar Mantar to photo-scan its model using the 3D scanner at our disposal.
- We plan to improve the UI & UX experience using various methodologies like Gestalt's principle.
- We also plan to make the WebGL experience more interactive and scalable to mobile devices with cross-platform support.
- We plan to expand the experience by developing various other yantras across all Jantar mantras.
- We plan to implement Firebase Authentication to provide users with sessions of the experience only when have signed up for it.
- We plan to gamify the experience by implementing various game modes like a first-person mode for an added immersive experience, a creative mode for having additional controls, etc.
- We plan to make the environment more immersive by adding HDRI sky, pivoting to URP render pipeline, and improving the lighting system, a canvas that scales across the entire screen with an option to go to fullscreen mode.
- We plan to develop a VR experience out of this as well to make it more immersive.
- We also wish to pitch this project when it will be ready to [SERB – INAE Online and Digital Gaming Research Initiative](#) to set up a gaming lab at our college and even at LD Museum, Ahmedabad.

5.0 Acknowledgements

- “Paper Model 4_2016-01-04.” n.d. Jantar Mantar. Accessed November 25, 2022.
<https://www.jantarmentar.org/resources/Projects/SY-Model/Samrat-Yantra-Model-Template.pdf>.
- “Home.” n.d. YouTube. Accessed November 25, 2022.
<https://3dwarehouse.sketchup.com/model/659a270d-0612-4a1d-a4bc-8dcfc23dbbcc/astronomical-observatory-new-Delhi-jantar-mantar?hl=en&login=true>.
- “UNESCO Astronomy and World Heritage Webportal - Show entity | World heritage, Unesco world heritage site, World heritage sites.” n.d. Pinterest. Accessed November 25, 2022. <https://www.pinterest.co.uk/pin/16044142396404484/>.
- “Layout plan. (1) Jaiprakash Yantra; (2) Dakshinabhitti Yantra; (3) Ram Yantra; (4) Digamamsa Yantra, (5) Samrat Yantra; (6) Raj Yantra; (7) Unnatansha Yantra; (8) Rashivalayas Yantraa.” n.d. Architexturez. Accessed November 25, 2022.
<https://architexturez.net/file/jantar-mantar-jaipur-0066-png>.
- Schwartzberg, Joseph E. 2020. “Cosmo Graphical Mapping | Celestial Mappings – Mathomathis.” Mathomathis.
<https://mathomathis.com/cosmo-graphical-mapping-celestial-mappings/>.
- n.d. Jantar Mantar: Home. Accessed November 25, 2022.
<https://www.jantarmentar.org/>.

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