CS3570 Introduction to Multimedia Technology

Homework #4

Due: 11:59pm, 2025/05/16

1. Bézier curve (30%)

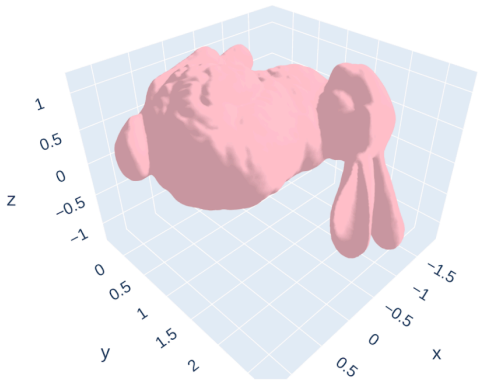
You are given 1 raster image (bg.png) and 1 path object (Bézier curve, extracted as **N points**); your objective is to draw the points and the Bézier curves.

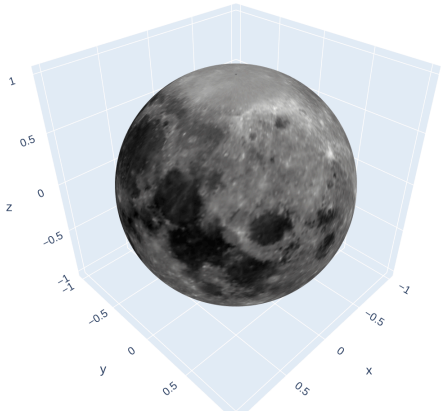
a. (20%) Plot two sets of cubic Bézier curves with different detail levels, along with their N control points, onto the provided background image bg.png. Each set contains (N−1)/3 cubic Bézier curves connected end-to-end, outlining the subject in the image. Color the low-detail curve in color cyan and the high-detail curve in color magenta. Save the resulting image as **1a.png**.
   I. for low detail curve: t = {0, 0.25, 0.5, 0.75, 1.0}; for high detail curve: t = {0, 0.001, 0.002, …, 1.0}**.**
   II. Discuss how you implement the Bézier curve and the differences between high and low-detail curves.

b. (10%) Scale up the image and the curves by 4, then plot and save it as **1b.png**.
   I. bg.png is scaled using Nearest-neighbor interpolation.
   II. First, scale the N points, then draw the curve (using the settings of the high-detail curve)

2. 3D Models (50%)

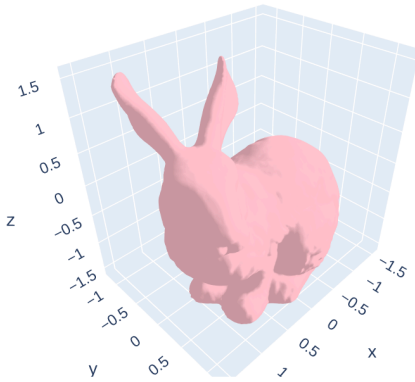
In this section, you will implement the translation and rotation of the 3D model bunny.obj and experiment with different illumination settings on a textured 3D surface. Here, we use Plotly, a Python graphing library, to render 3D graphics.





a. (15%) Shift the center of the bunny to (0, 0, 0) and save the figure as **2a.png**. Center is defined as `[(max(x) + min(x)) / 2, (max(y) + min(y)) / 2, (max(z) + min(z)) / 2]` where x, y, z are the vertices of the object.

b. (20%) Based on (a), implement the rotation matrix to rotate the bunny to face the screen(like the following example). Discuss how you implement the rotation and save the 3D figure as **2b.png**.



c. (15%) You are given a spherical surface with a moon texture. Render the surface under different illumination settings by varying the ambient strength k_a, diffuse strength k_d, and specular strength k_s in the following settings. (Please do not modify the given lighting position in the code):

I. (k_a , k_d , k_s) = (0.3, 0.3, 0.05) and (k_a , k_d , k_s) = (0.8, 0.3, 0.05)
II. (k_a , k_d , k_s) = (0.3, 0.4, 0.05) and (k_a , k_d , k_s) = (0.3, 0.95, 0.05)
III. (k_a , k_d , k_s) = (0.3, 0.8, 0.3) and (k_a , k_d , k_s) = (0.3, 0.8, 0.5)

Plot the result for each condition with **2 subplots** and discuss the difference between each pair of settings. Results are saved as **2c_1.png, 2c_2.png, 2c_3.png,** respectively. You can refer to the following link for more information.
plotly lighting reference: https://plotly.com/python/v3/3d-surface-lighting/

3. Report (20%)

1. Bézier Curve
   - Describe how you implement the Bézier curve.
   - Discuss the differences between high and low-detail curves.
2. 3D Models
   - Describe how you implement the rotation in 2(b).
   - Discuss the difference in each pair of lighting settings.

Reminder

- You are not allowed to import any library in your Jupyter Notebook file except for those we provide.
- Your code must display and output your results to enable us to verify its correctness.
- Please follow the instructions in the Jupyter Notebook and complete the parts marked as “TODO”.
- Please include your report in the Jupyter Notebook using markdown.
- Please compress your code, input images, and result images in a zip file named HW4_{StudentID}.zip and upload it to eeclass.
- Homework should be submitted before the announced due time. Scores of late submissions will be reduced by 20% per day.
- If you encounter any problems or have questions, please post them on eeclass.
- Please follow the file structure below: