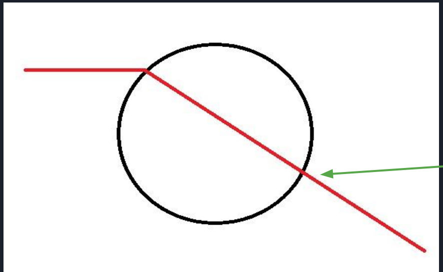
CG 2021 HW3

Advanced texture mapping

- In this assignment, you are going to write a program based on the provided template that implements several shader effect on texture mapping with GLSL

Spec

- Implementation (80%)
  - [Part 1] Skybox (10%)
  - [Part 1] Environmental Mapping (35%)
    - Apply Fresnel effect
    - reflection + refraction + chromatic dispersion
    - The refraction can compute single side only.
    - No need to consider the wood plane in this part.



You can ignore this refraction

Spec

- Implementation (80%)
    - [Part 2] Normal mapping (35%)
        - Generate the normal map as a sine wave (20%)
        - Correct tangent space transform matrix (10%)
        - Apply Blinn-Phong shading (5%)
            - Directional light
            - Look what you did in HW2
            - The light direction is correct now (source → target)
            - Ks = 0.75, Kd = 0.75, Shininess = 8, attenuation = 1

Spec

- Report(20%)
  - Implementation(HOW & WHY)
  - Problems you encountered
  - Don’t paste code without any explaination
  - File name: report_<your student ID> .pdf
- Bonus(10%)
  - Ex: displacement mapping and/or parallax mapping on the fake wave
  - Ex: Show the height map correctly
  - Other creativity

Hint

- Read the TODOs in the template
- Read comments to get more hints & ideas
- Before you ask question on E3, make sure you have Googled it
- If you have questions when you reading other part of the template code, you can ask it in forum too.
- Feel free to report bugs if you find one. :)

Notes

- Deadline: 12/06 23:59
  - You need to upload hw3_<your student ID>.zip and report_<your student ID> .pdf respectively
  - hw3_<your student ID>.zip (root)
    - assets
    - include
    - src
  - You can use script/pack.ps1 (PowerShell) or script/pack.sh (Bash)
  - Incorrect submission will -5 points
- No plagiarism, -10 points per day after deadline
- No demo required this time

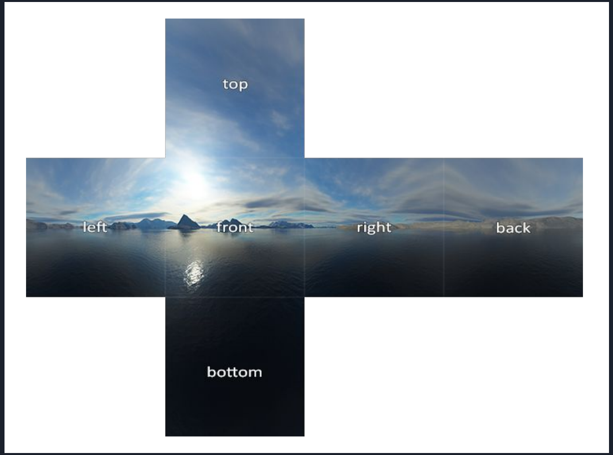
Notes

- Final’s group list
- Final proposal presentation starts from 11/23 NEXT WEEK 12:30
    - Remote presentation
    - Submit your proposal to E3 before 11/23 23:59
- The form for paper presentation will be anounced recently
    - MUST discuss the paper’s topic with teacher in advance

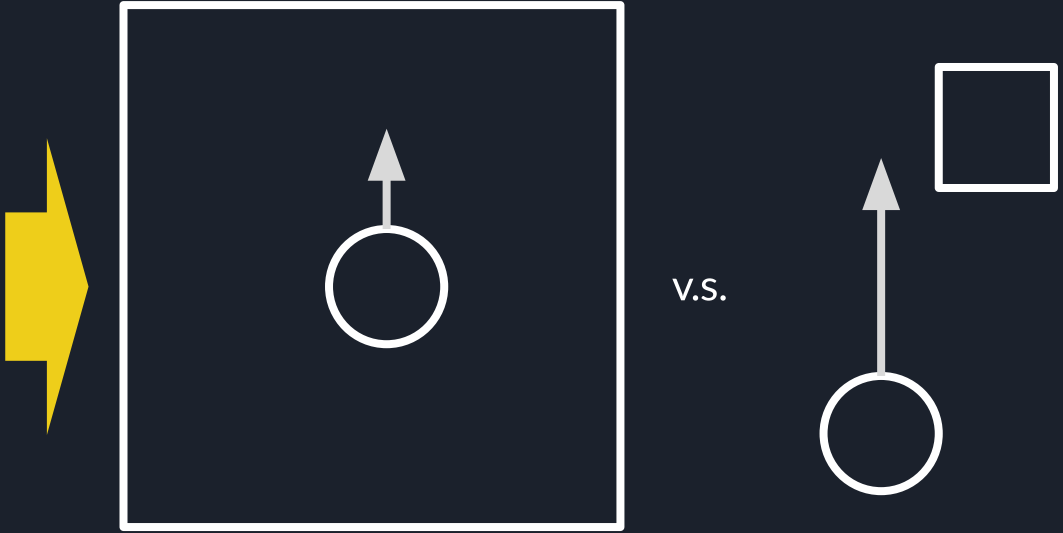
HW 1 Scoring

- Receive feedbacks until 11/26 23:59
- Viewing transformation
- Report

Appendix: Skybox



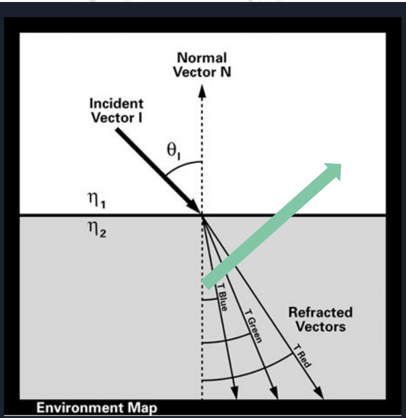
Cubemap.cpp



Appendix: Fresnel Effect

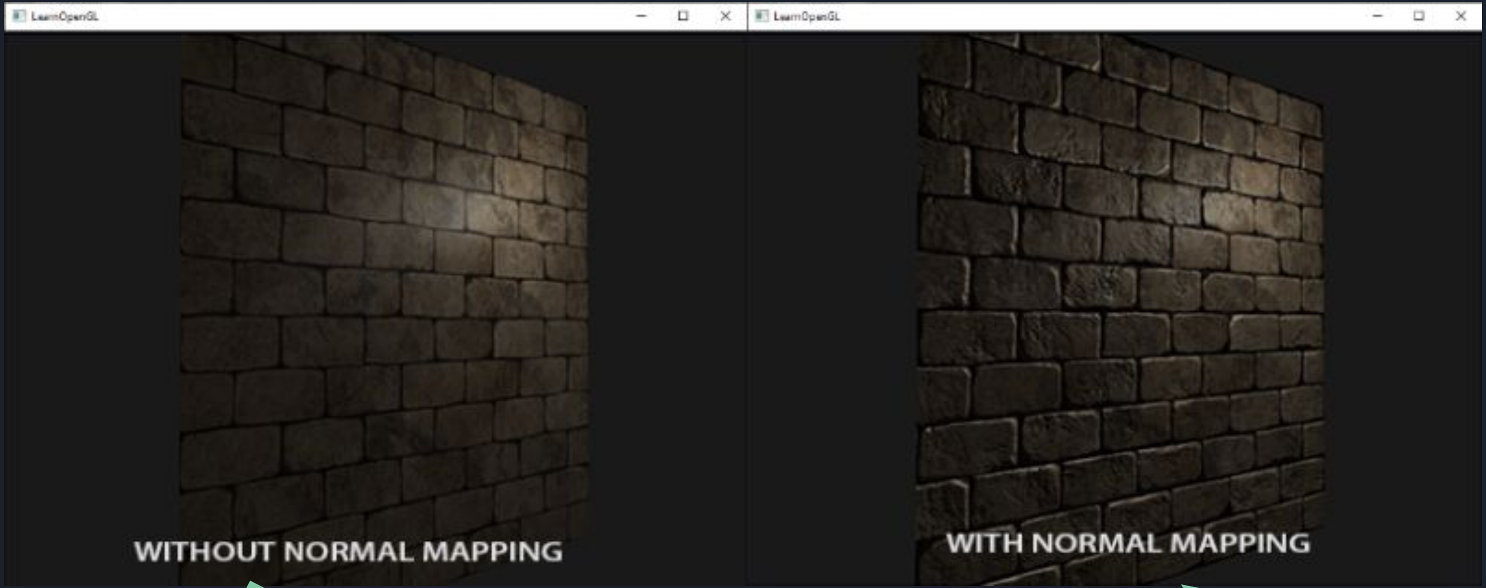
- Fresnel equation we use: it’s an approximation
    - The coefficient presents how strong the reflection is

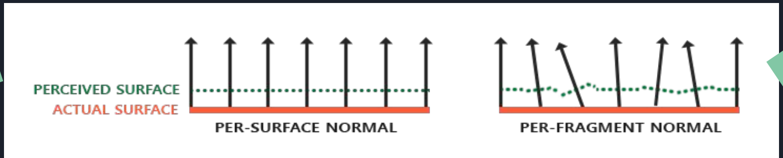
$$reflectionCoefficient = \max(0, \min(1, bias + scale \times (1 + I \bullet N)^{power}))$$



https://developer.download.nvidia.com/CgTutorial/cg_tutorial_chapter07.html

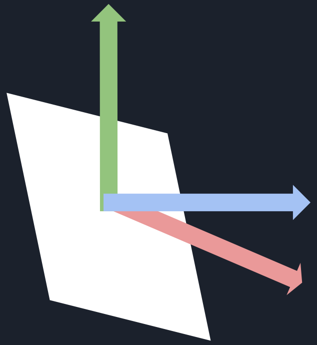
Appendix: Normal Mapping



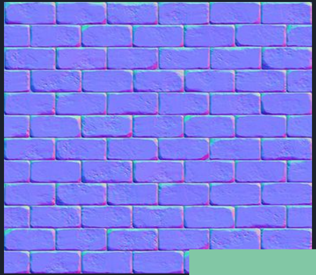


Appendix: Normal Mapping

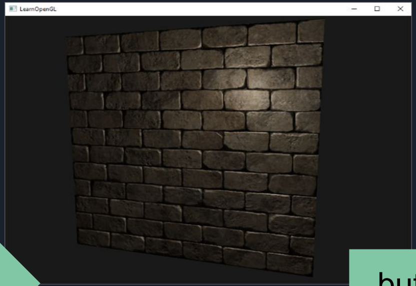
- Note the difference with bumping mapping
- Though range is [-1, 1], but store as RGB
  → you have to transform it before using it
- Incorrect after rotation
  → Tangent space



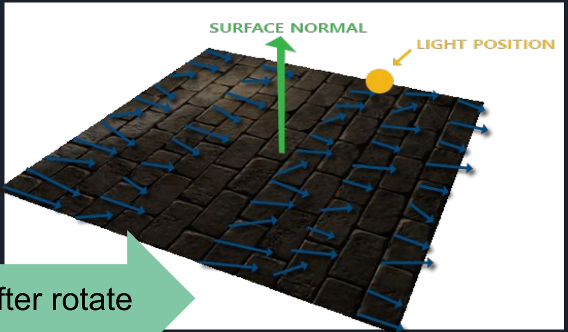
a vtx's normal vector



apply

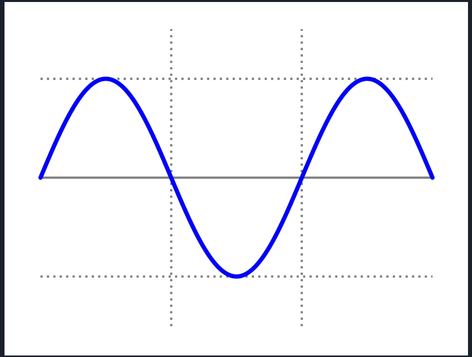


but after rotate

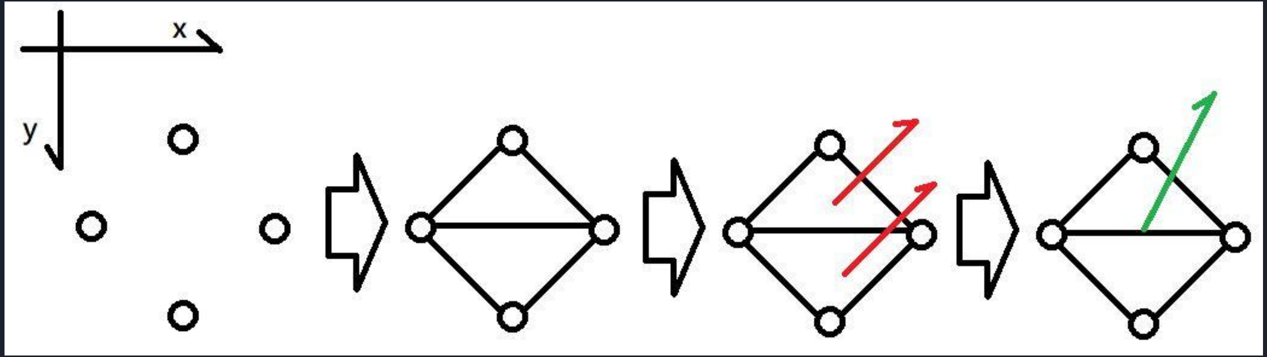


Appendix: Normal Mapping

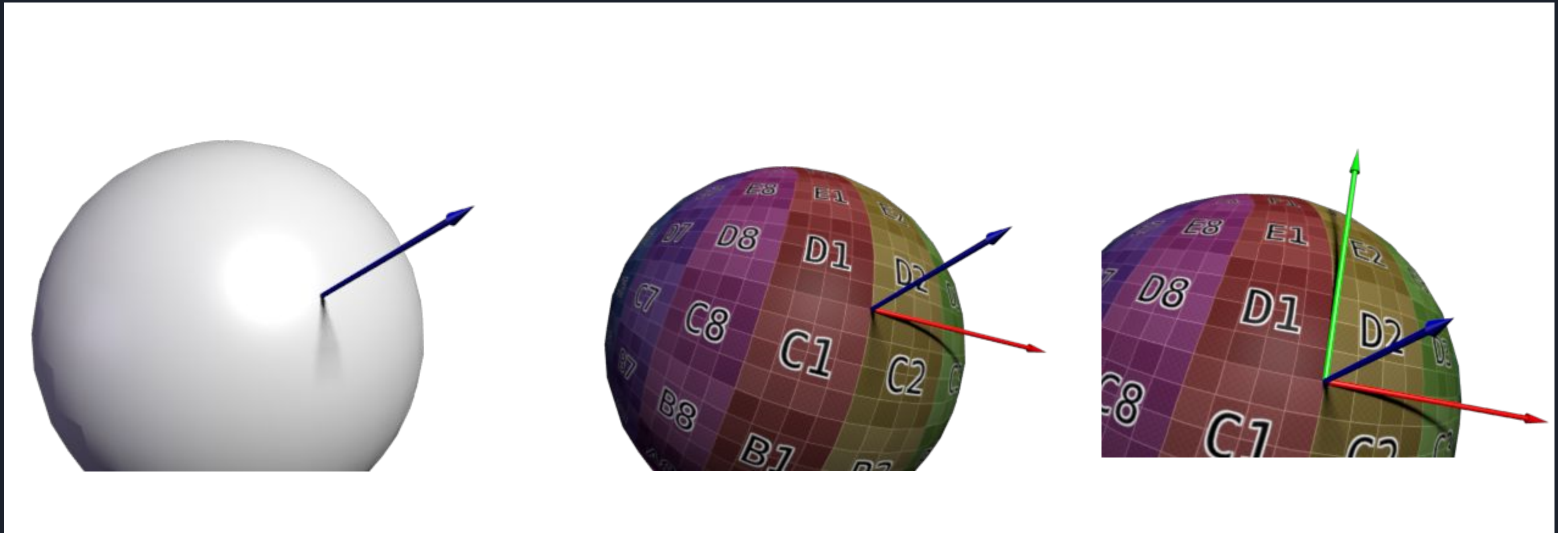
- How to generate the normal vector in HW3(sine wave)?
  - calculating with fragment's position
  - Order? Space?
  - Online creator



https://zh.wikipedia.org/wiki/File:Simple_sine_wave.svg

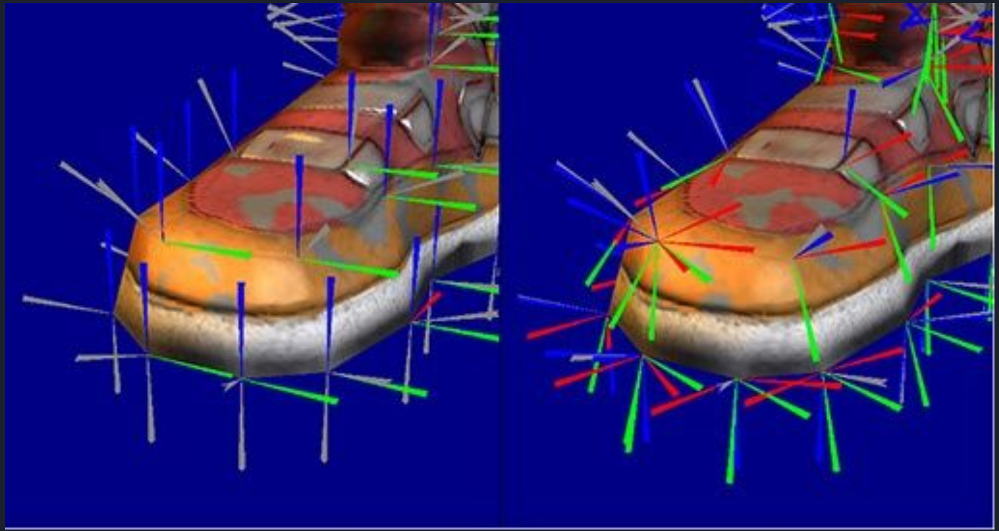


Appendix: Tangent Space



http://www.opengl-tutorial.org/intermediate-tutorials/tutorial-13-normal-mapping/

Appendix: Tangent Space



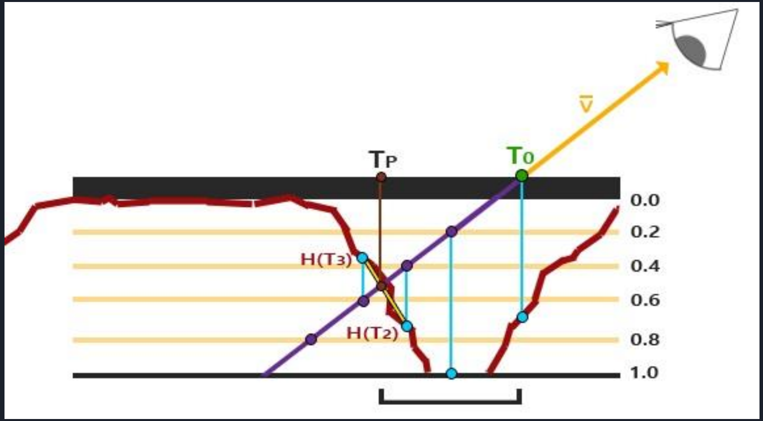
https://docs.cryengine.com/plugins/viewsource/viewpagesrc.action?pageId=1605679

Appendix: Displacement mapping

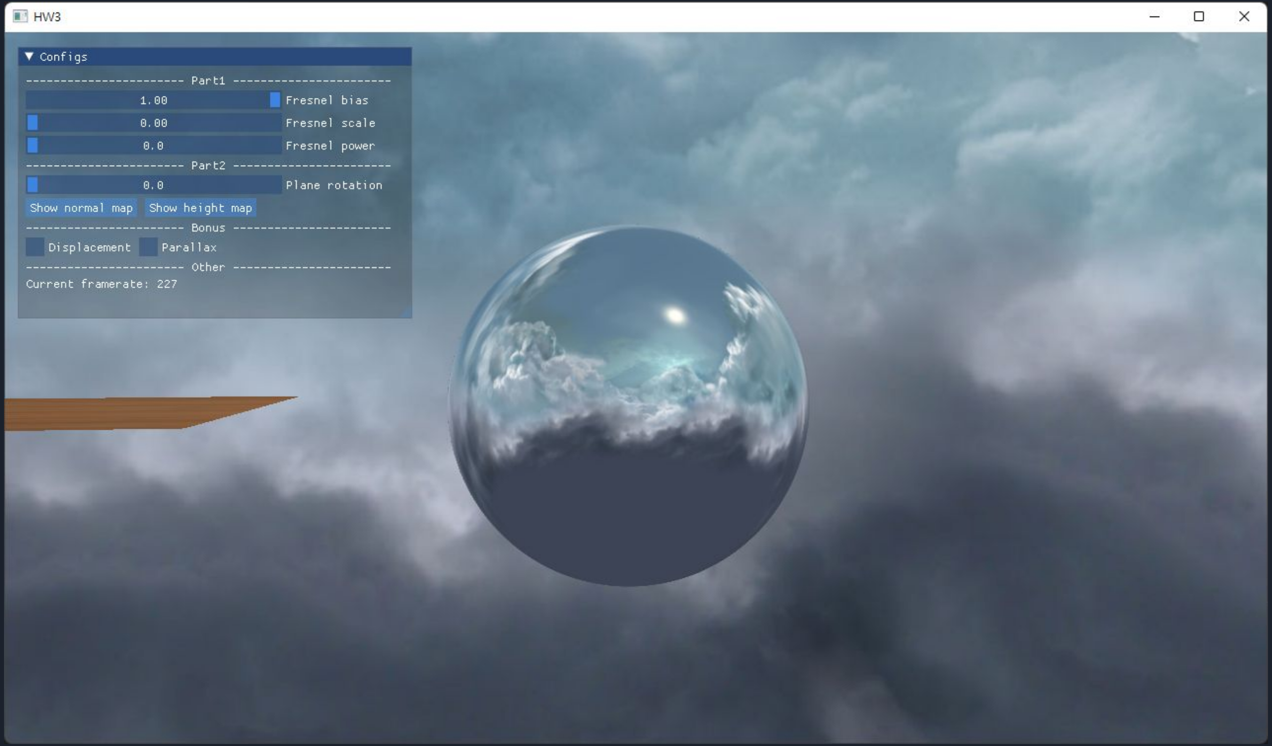
- cons:
    - Need a lot of vertice to have good result
    - A plane needs ~10000 vertices, which is not efficient.
- pros:
    - Very easy to implement (move position along normal in vertex shader)

Appendix: Parallax occlusion mapping

- cons:
  - More difficult to implement.
- pros:
  - You can achieve similar effect of displacement mapping using only 4 vertices.

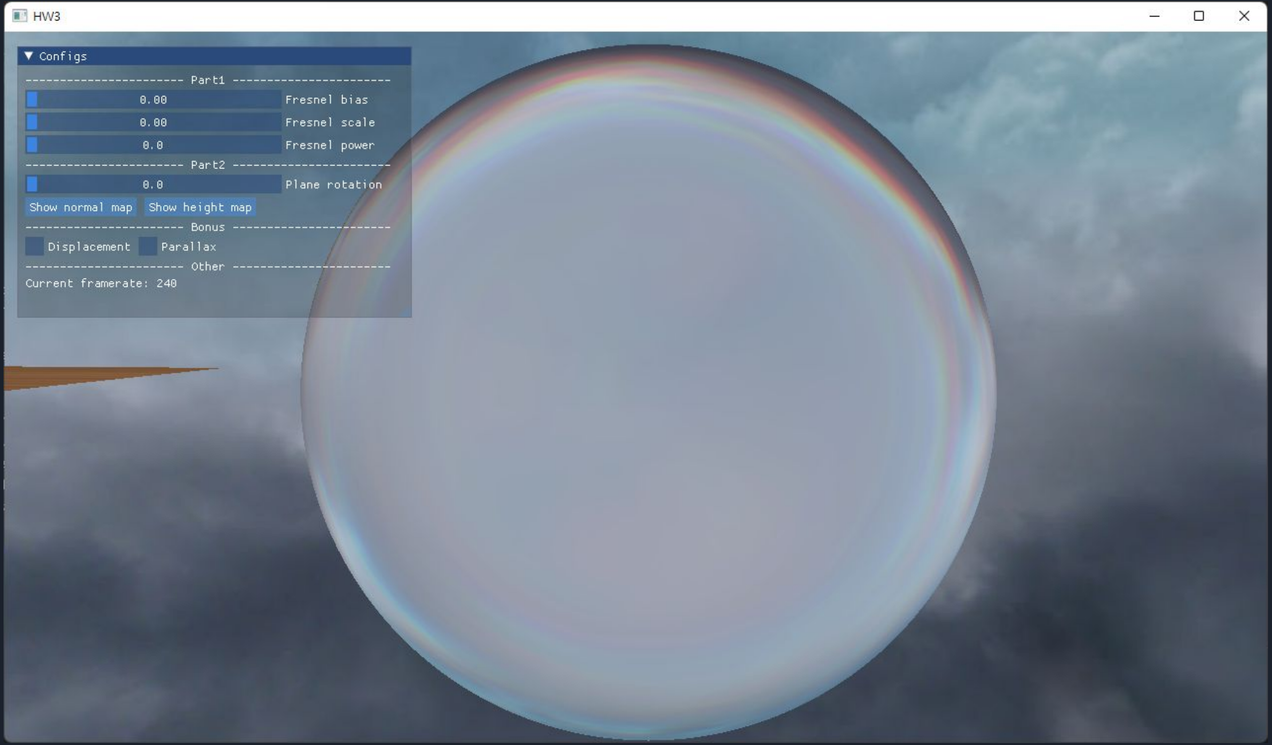


Appendix: 100% reflection


HW3

```
▼ Configs
---------------------- Part1 ----------------------
          1.00                  Fresnel bias
          0.00                  Fresnel scale
          0.0                   Fresnel power
---------------------- Part2 ----------------------
          0.0                   Plane rotation
Show normal map  Show height map
---------------------- Bonus ----------------------
□ Displacement  □ Parallax
---------------------- Other ----------------------
Current framerate: 227
```

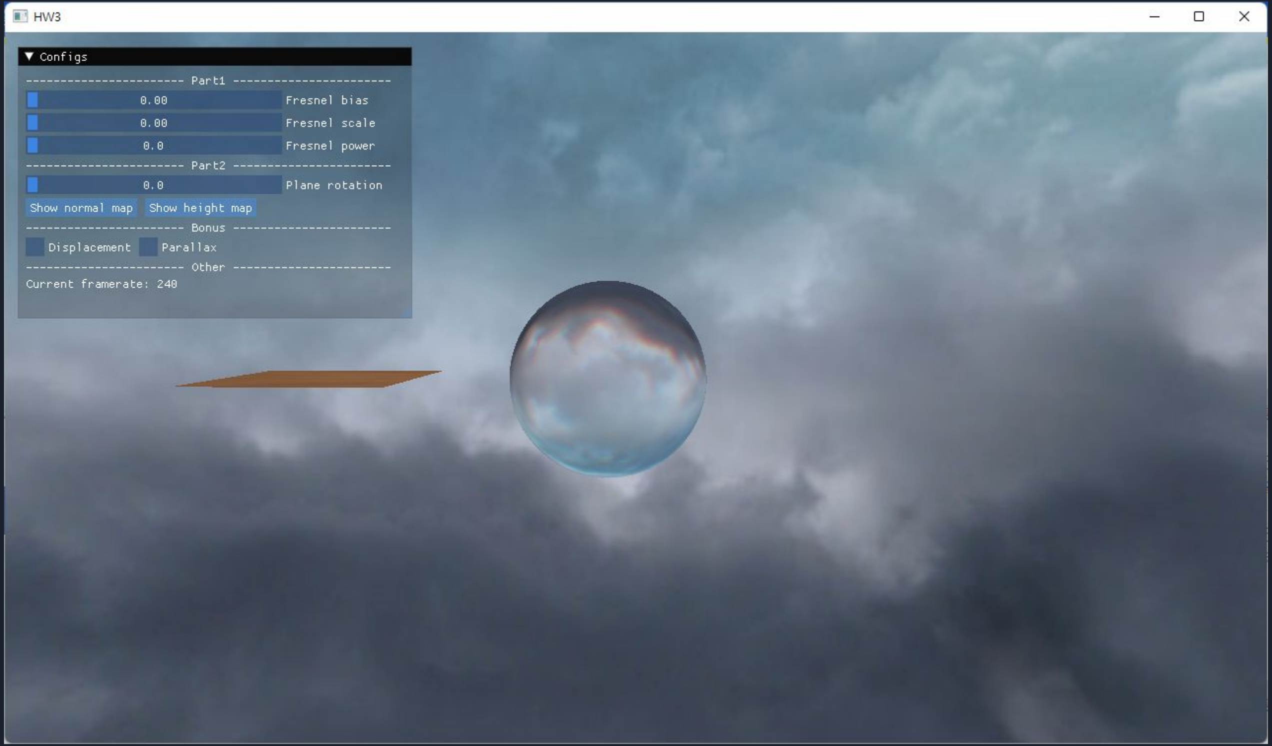
Appendix: 100% refraction, close



```
---------------------- Part1 ----------------------
0.00  Fresnel bias
0.00  Fresnel scale
0.0   Fresnel power
---------------------- Part2 ----------------------
0.0   Plane rotation
```

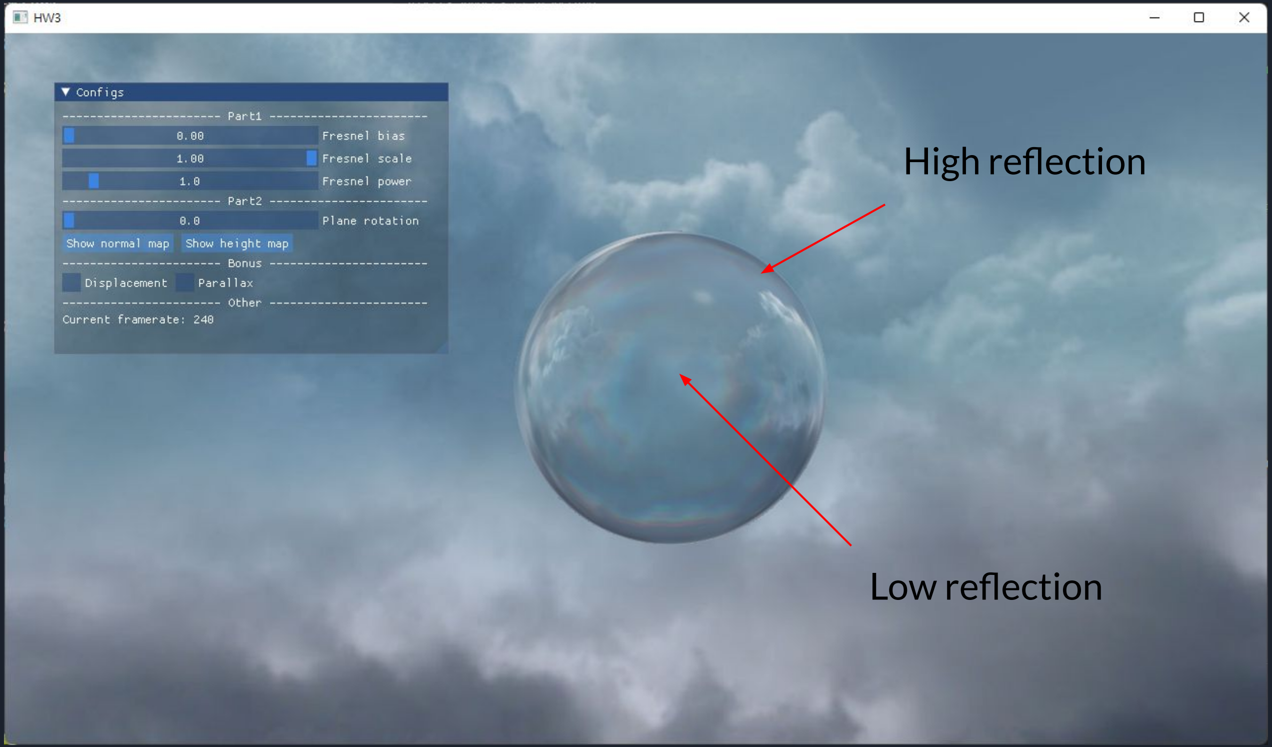
```
---------------------- Bonus ----------------------
□ Displacement □ Parallax
---------------------- Other ----------------------
Current framerate: 240
```

Appendix: 100% refraction, far



```
---------------------- Part1 ----------------------
0.00 Fresnel bias
0.00 Fresnel scale
0.0 Fresnel power
---------------------- Part2 ----------------------
0.0 Plane rotation
---------------------- Bonus ----------------------
□ Displacement □ Parallax
---------------------- Other ----------------------
Current framerate: 240
```

Appendix: Reflection + Refraction

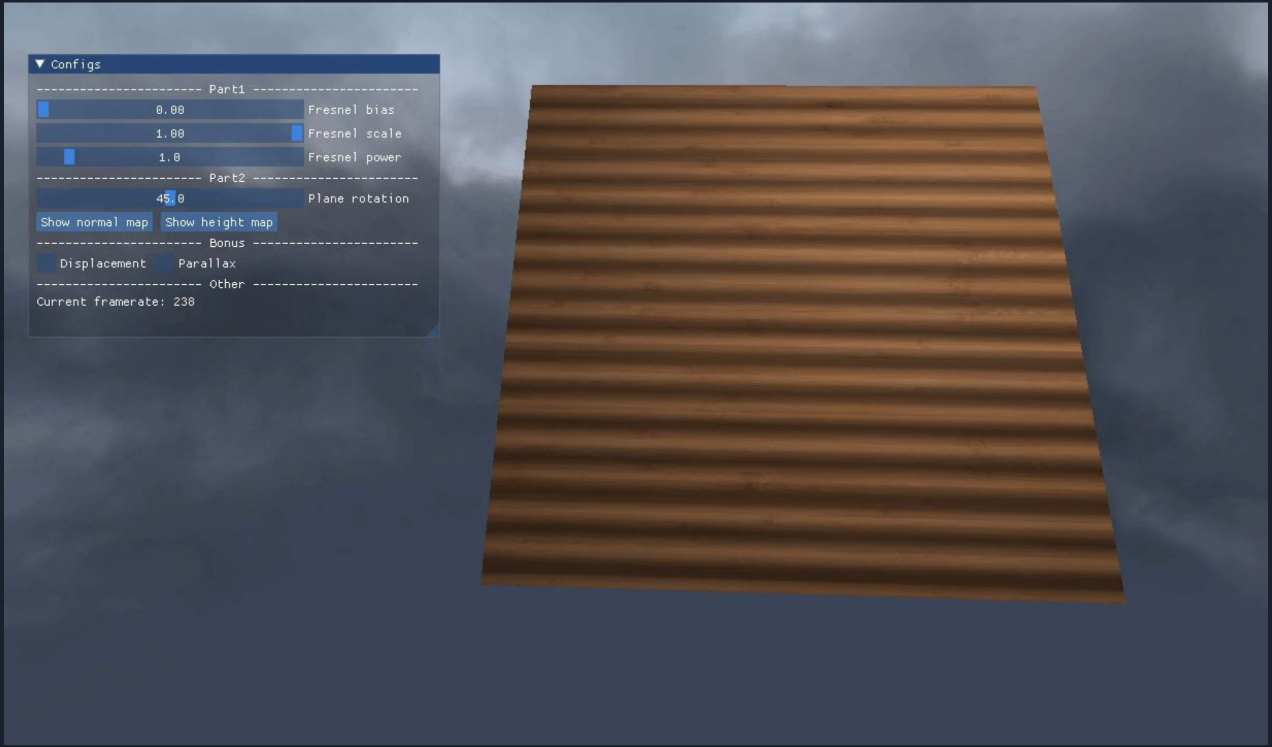


```
----------------------- Part1 -----------------------
0.00    Fresnel bias
1.00    Fresnel scale
1.0     Fresnel power
----------------------- Part2 -----------------------
0.0     Plane rotation
Show normal map   Show height map
----------------------- Bonus -----------------------
□ Displacement  □ Parallax
----------------------- Other -----------------------
Current framerate: 240
```

High reflection

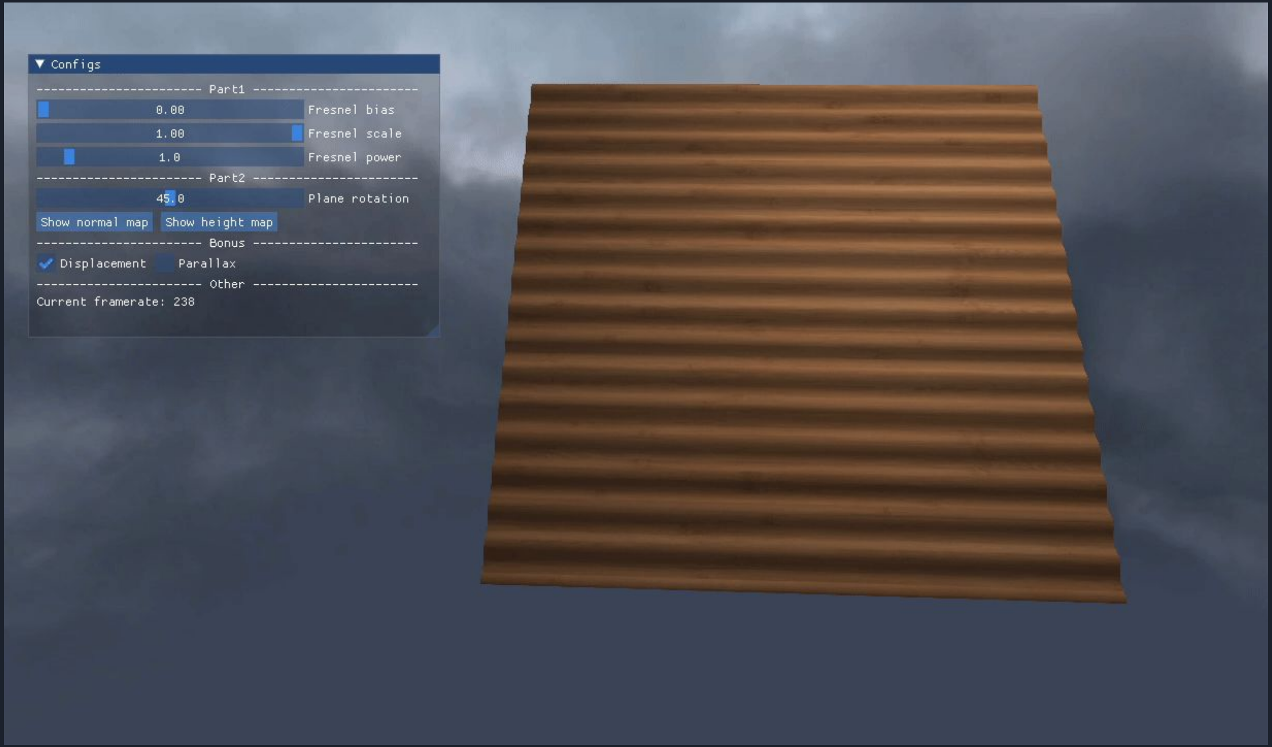
Low reflection

Appendix: Normal mapping



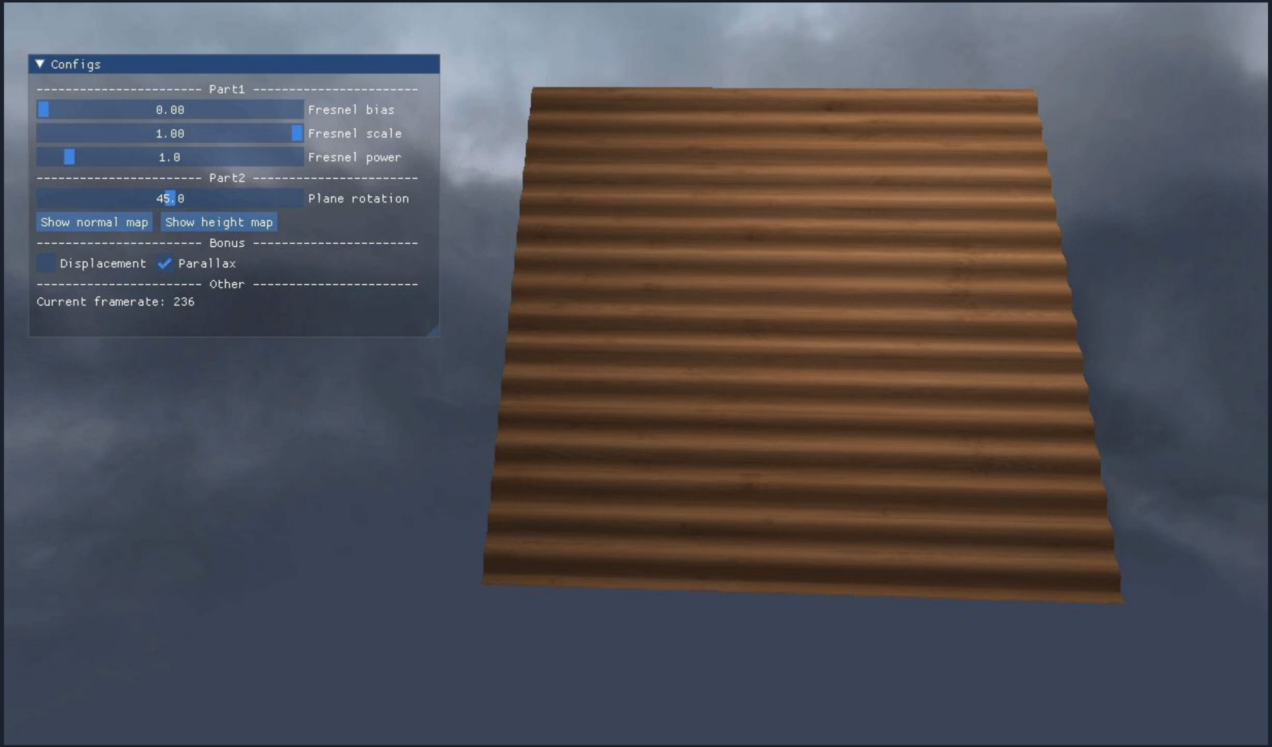
```
▼ Configs
---------------------- Part1 ----------------------
0.00        Fresnel bias
1.00        Fresnel scale
1.0         Fresnel power
---------------------- Part2 ----------------------
45.0        Plane rotation
---------------------- Bonus ----------------------
□ Displacement  □ Parallax
---------------------- Other ----------------------
Current framerate: 238
```

Appendix: Normal + Displacement (10000 vertices)



```
---------------------- Part1 ----------------------
0.00    Fresnel bias
1.00    Fresnel scale
1.0     Fresnel power
---------------------- Part2 ----------------------
45.0    Plane rotation
---------------------- Bonus ----------------------
☑ Displacement   ☐ Parallax
---------------------- Other ----------------------
Current framerate: 238
```

Appendix: Normal + Parallax mapping



▼ Configs

---------------------- Part1 ----------------------

0.00 Fresnel bias

1.00 Fresnel scale

1.0 Fresnel power

---------------------- Part2 ----------------------

45.0 Plane rotation

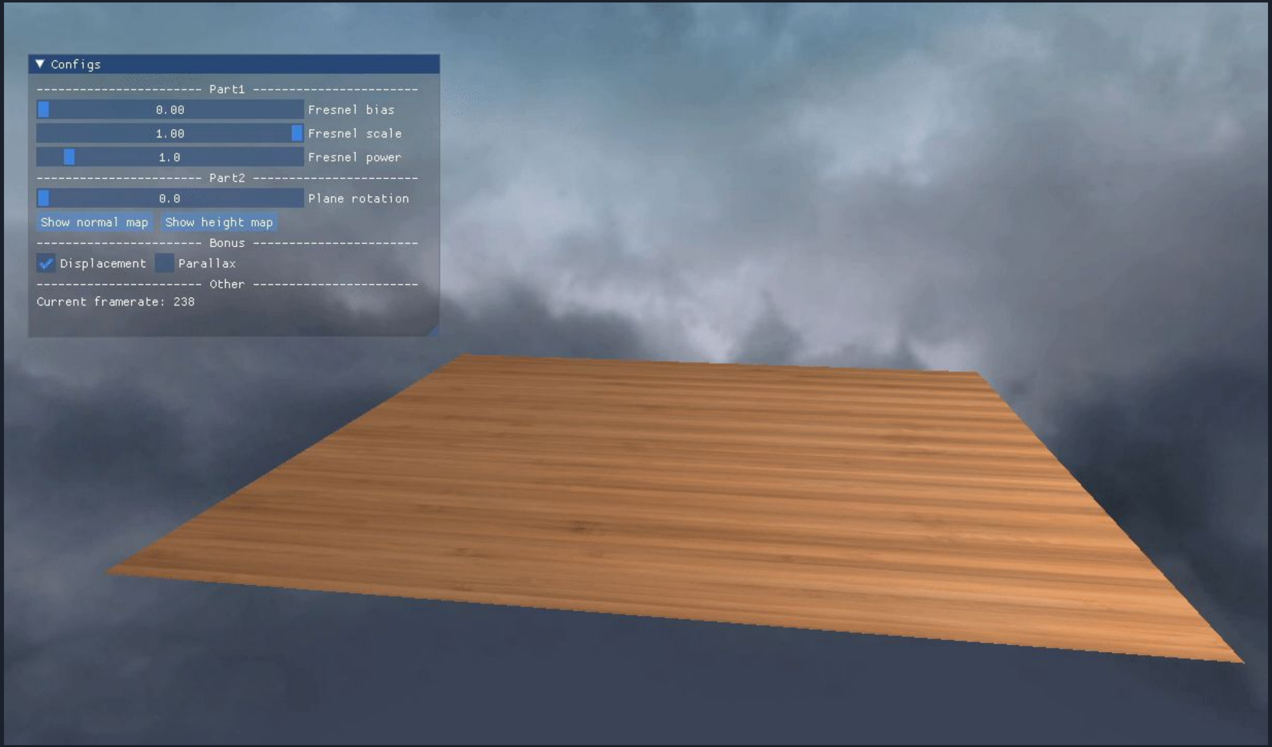
---------------------- Bonus ----------------------

□ Displacement ☑ Parallax

---------------------- Other ----------------------

Current framerate: 236

Appendix: Displacement map with 4 vertices



```
▼ Configs
---------------------- Part1 ----------------------
0.00        Fresnel bias
1.00        Fresnel scale
1.0         Fresnel power
---------------------- Part2 ----------------------
0.0         Plane rotation
Show normal map   Show height map
---------------------- Bonus ----------------------
☑ Displacement   □ Parallax
---------------------- Other ----------------------
Current framerate: 238
```

Appendix: Useful tools

- GLSL language integration (Visual Studio extension)
- GLSL validator (glslang)

Reference

- E3
  - textureMapping.ppt and textureMapping2.ppt
- https://learnopengl.com/Advanced-Lighting/Normal-Mapping
- https://developer.download.nvidia.com/CgTutorial/cg_tutorial_chapter07.html