CS 557 Computer Graphics Shaders

Project #3A

Displacement Mapping and Lighting

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Video Link: https://youtu.be/uaBdbrlxQRI

Description:

This project implements a shader that applies **displacement mapping** and **per-fragment lighting** to turn a flat quad into a curtain with pleats. It runs with "pleats.glib" using glman.

The displacement that creates pleats occurs in the vertex shader, which utilizes the sine wave function to modify the z-position of vertices on an XY quad. The amplitude (**uA**) and period (**uP**) of the sine wave are adjustable parameters in the glman user interface. The sine wave function is modified by multiplying its amplitude with the vertex's relative position to the top of the quad. This adjustment increases the sine wave amplitude from 0 as it moves downward from the top of the quad, thus creating the curtain effect. Based on the displaced vertex, its associated normal vector is recalculated using the tangent slopes in the x- and y-directions. These slopes are obtained from the derivatives of the sine wave function, and their cross-product is the final normal vector.

Per-fragment lighting is implemented in the fragment shader, as in previous projects, with adjustable parameters (**uKa, uKd, uKs, uShininess, uLightX, uLightY, uLightZ**) that can be modified through the glman user interface. The only change is that diffusion is applied to both sides of the quad, ensuring consistent lighting on both the front and back when the object is rotated. Besides, the parameter **uColor** allows users to change the curtain color using glman's color palette.

[Screenshots are on the next pages]

Screenshots:

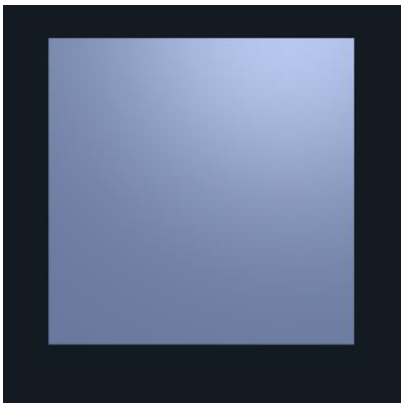

Fig 1. Original XY quad **without displacement mapping**

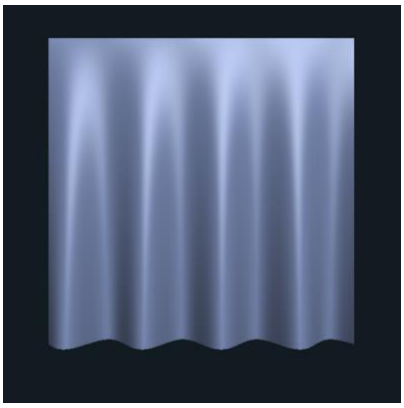

Fig 2. XY quad transformed into a curtain with pleats **using displacement mapping** as uA and uP increase.

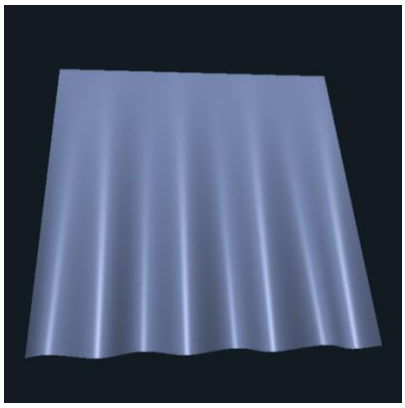

Fig 3. Per-fragment lighting is effective due to the displaced normal vector, which **adjusts as the curtain in Fig 2 is rotated**

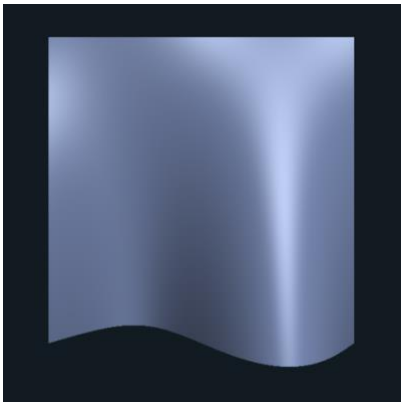

Fig 4. The curtain with **high uA and high uP**.

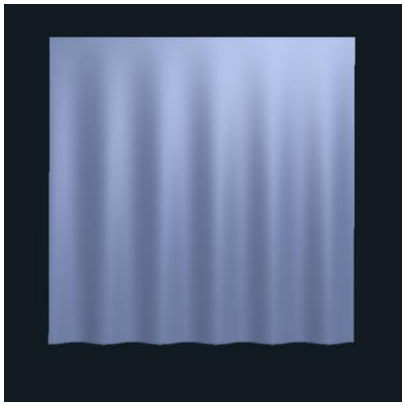

Fig 5. The curtain with **low uA and low uP**.

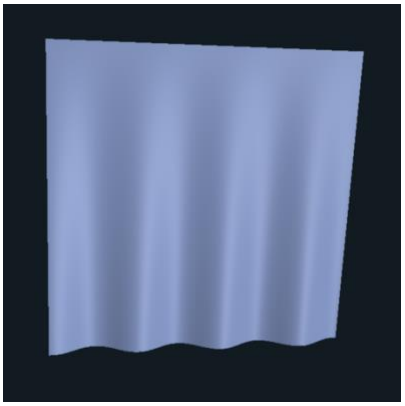

Fig 6. The curtain has a fabric texture with **low uKs**.

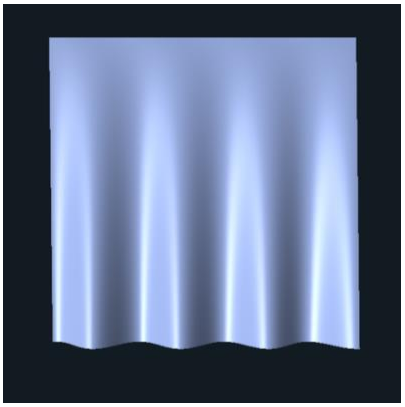

Fig 7. The curtain has a silk fabric texture with **increased Ka and an adjusted light position**.

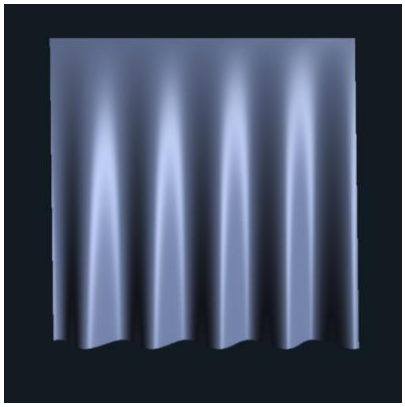

Fig 8. The lighting on the curtain when **the light moves to the far right**.

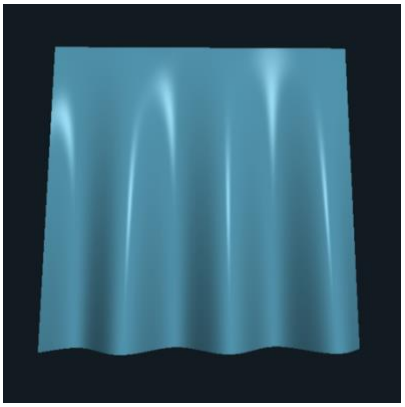

Fig 9. The curtain has a reflective fabric texture with **high uShininess**.

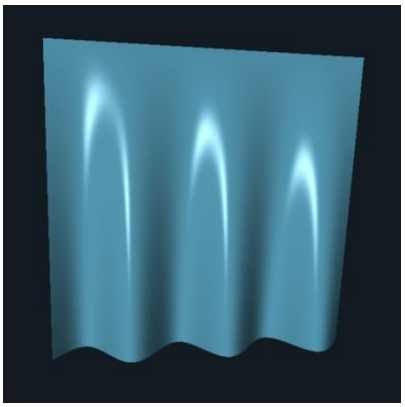

Fig 10. The lighting on the curtain in Fig. 9 changes **as the curtain is rotated in view**.

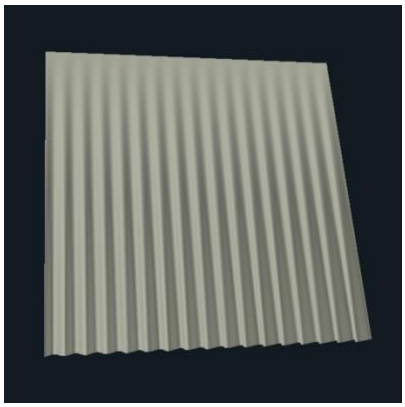

Fig 11. The curtain displays a single face corrugated cardboard texture with **low uKs, low uA, and low uP**.

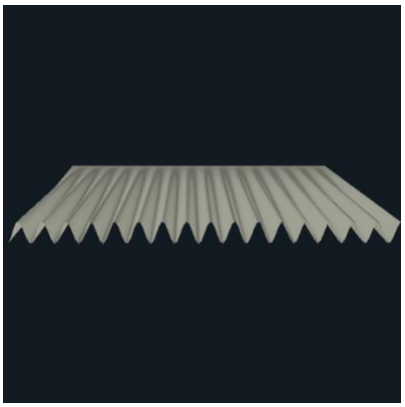

Fig 12. Evidence of displacement mapping.