Lesson 13
Parallax Occlusion Mapping
PV227 – GPU Rendering

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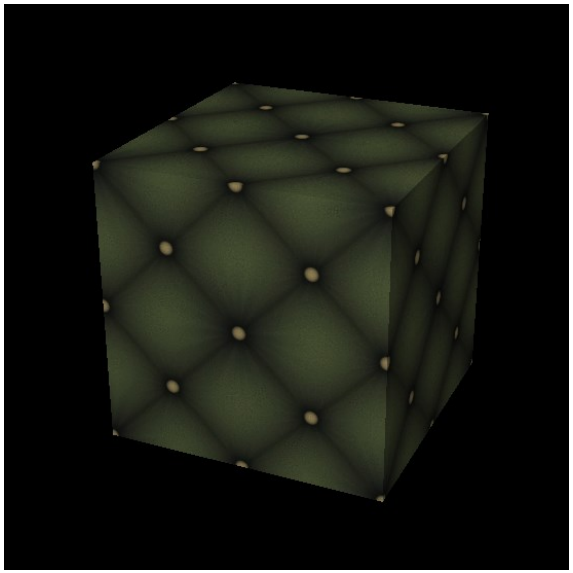
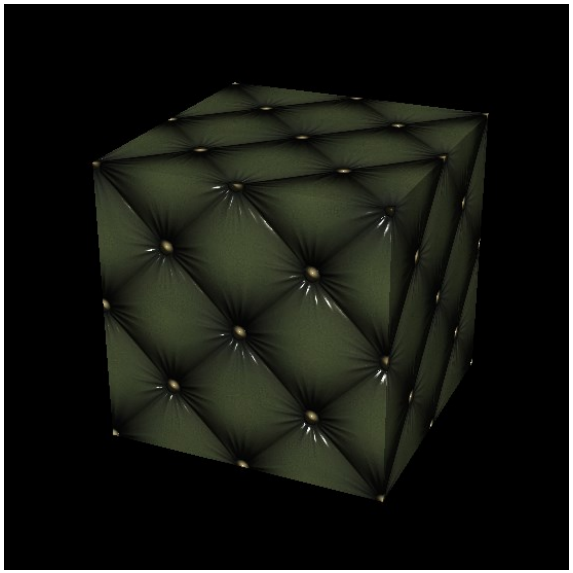
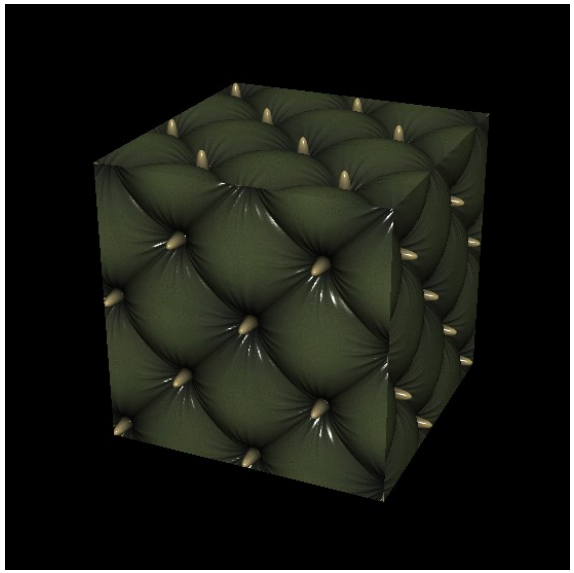
Parallax Occlusion Mapping



Nothing

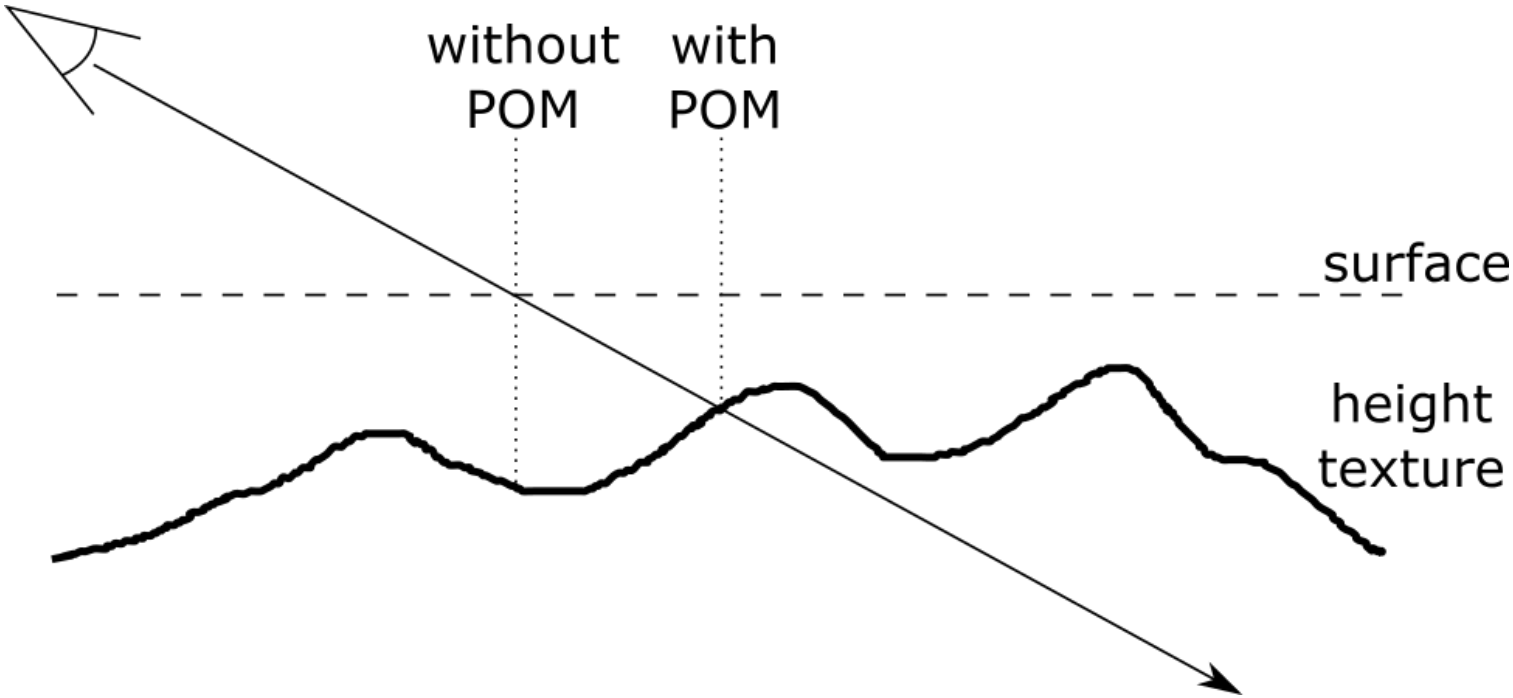


Normal mapping



Parallax Occlusion Mapping

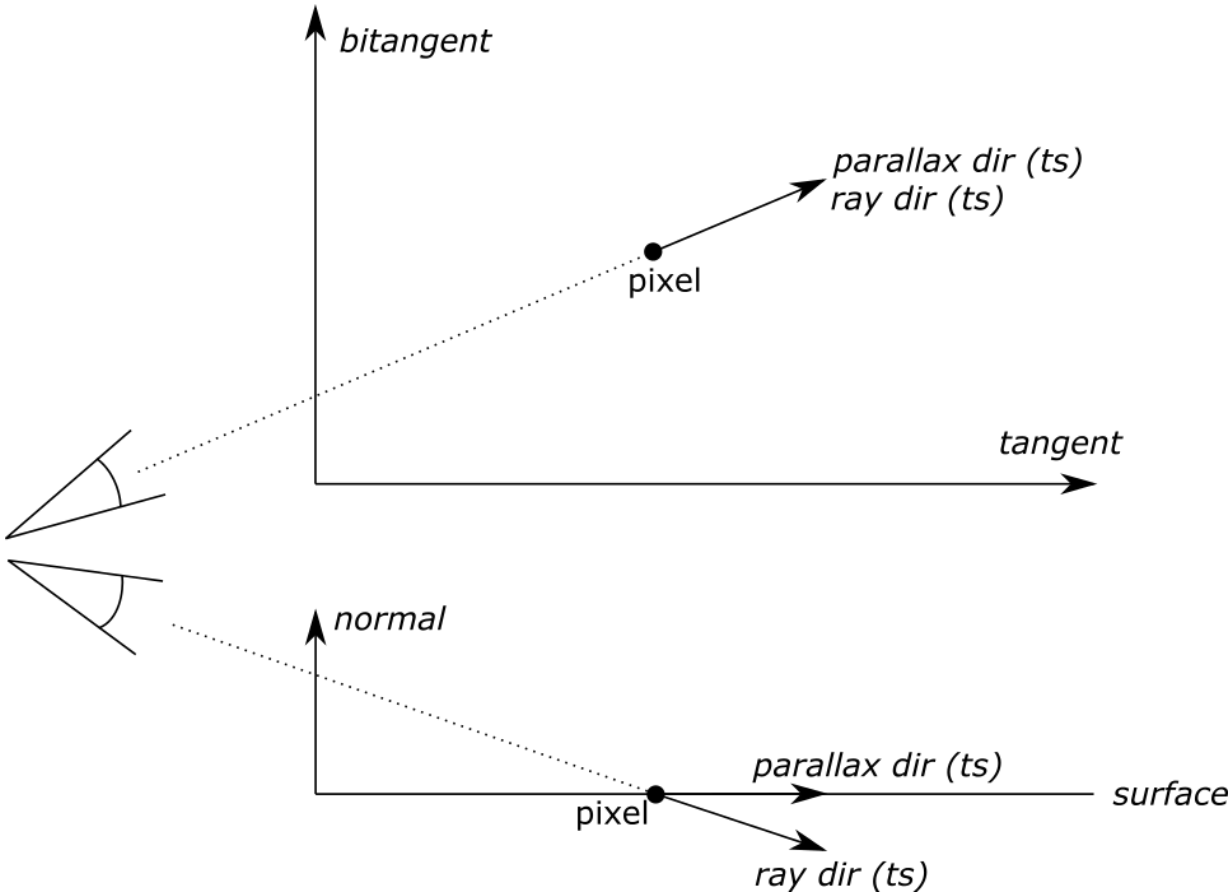
Basic principle



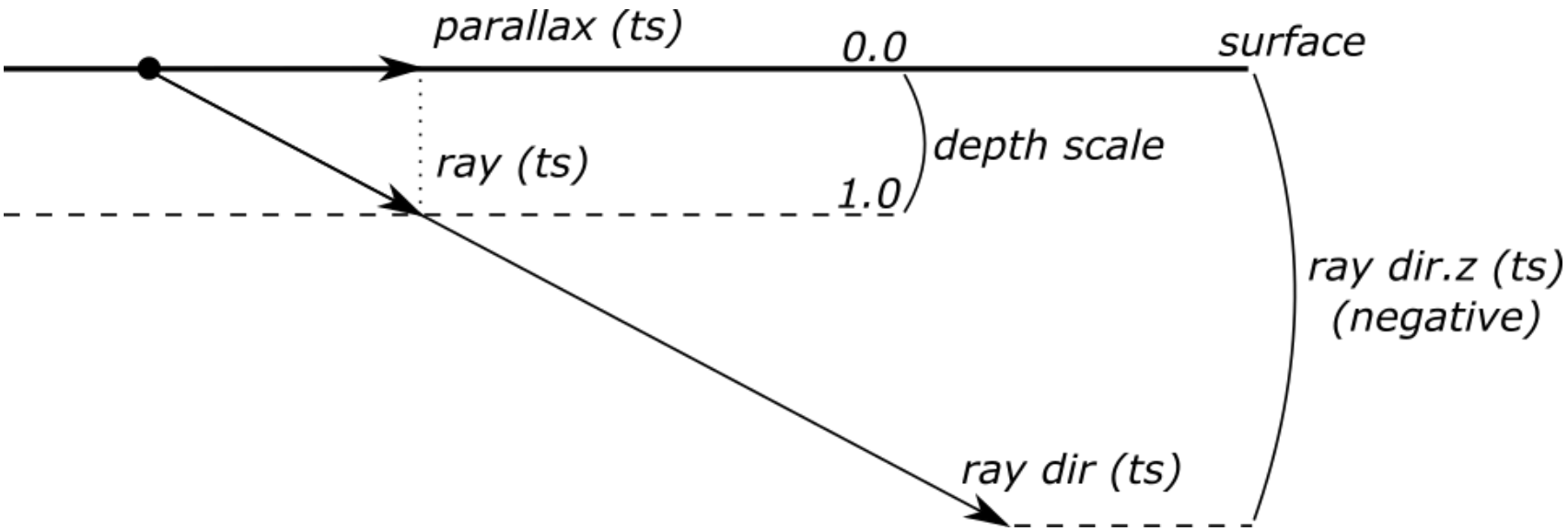
Basic principle

Parallax direction

- We work in the tangent space (ts) (on the surface of the object)
- *parallax dir* (*ts*) = *ray dir*.*xy* (*ts*)



Maximal parallax



$$\frac{ray\,(ts)}{depth\,scale} = \frac{ray\,dir\,(ts)}{-ray\,dir.z\,(ts)}$$

$$\frac{ray\,(ws)}{depth\,scale} = \frac{ray\,dir\,(ws)}{-ray\,dir.z\,(ts)}$$

$$parallax\,(ts) = ray.xy\,(ts)$$

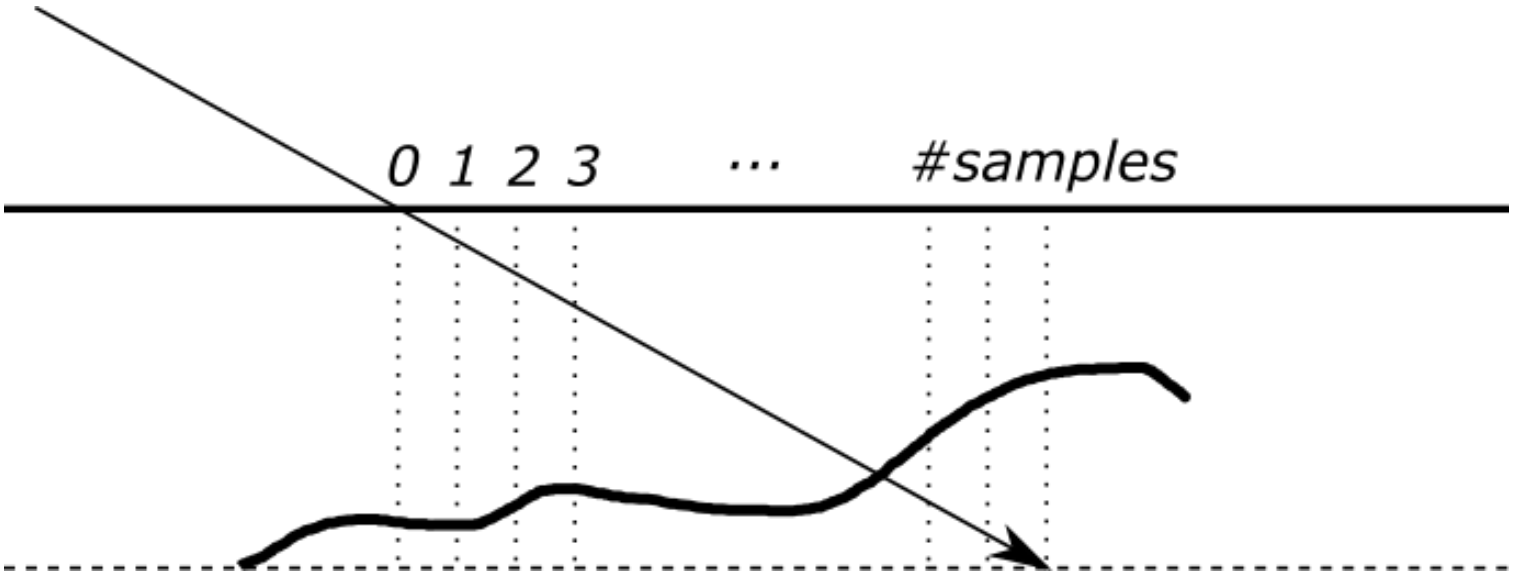
Texture space

- Our space with texture coordinates is a little different from the tangent space
- Directions of tangents and bitangents are the same as directions of s and t coordinates
- The sizes are different

$$parallax\,(texs) = ts\_to\_texs \cdot parallax\,(ts)$$

Sampling

- Sample the height texture to find the first intersectoion



Algorithm

for sample i **do**
  $percentage \leftarrow i/\#samples$
  $sample\_tex\_coord \leftarrow tex\_coord_0 + parallax\_texs \cdot percentage$
  $tex\_depth \leftarrow$
    $one\_minus\_sample(height\_tex, sample\_tex\_coord)$
  $ray\_depth \leftarrow percentage$
  if $ray\_depth > tex\_depth$ **then**
    break
  end
end

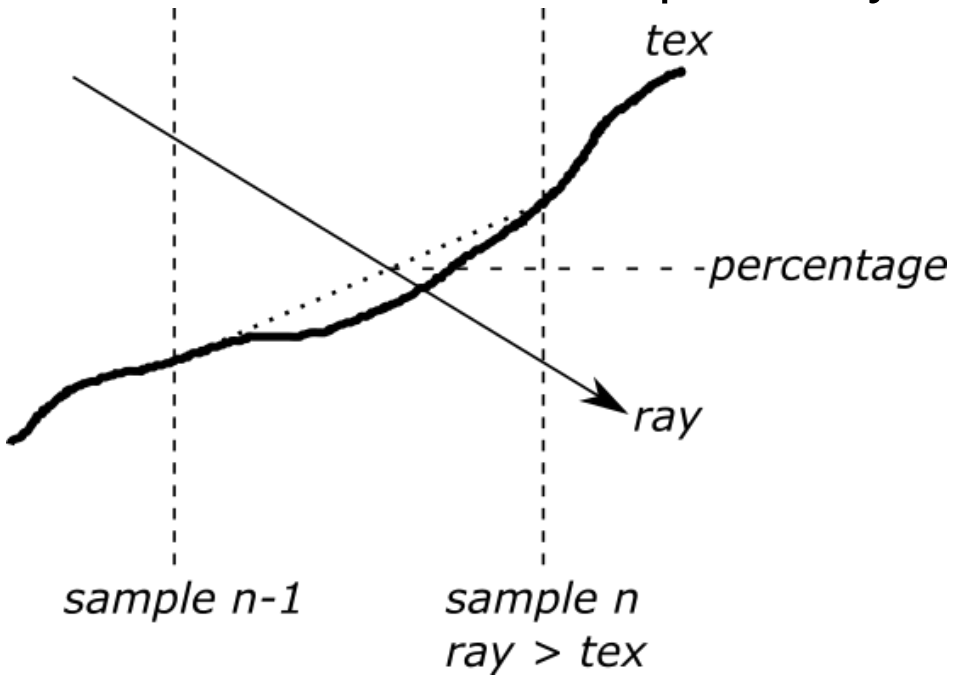
Use last *percentage* to compute the final texture coordinate and position.

Task: Implement POM

- **Task 1:** Implement this algorithm

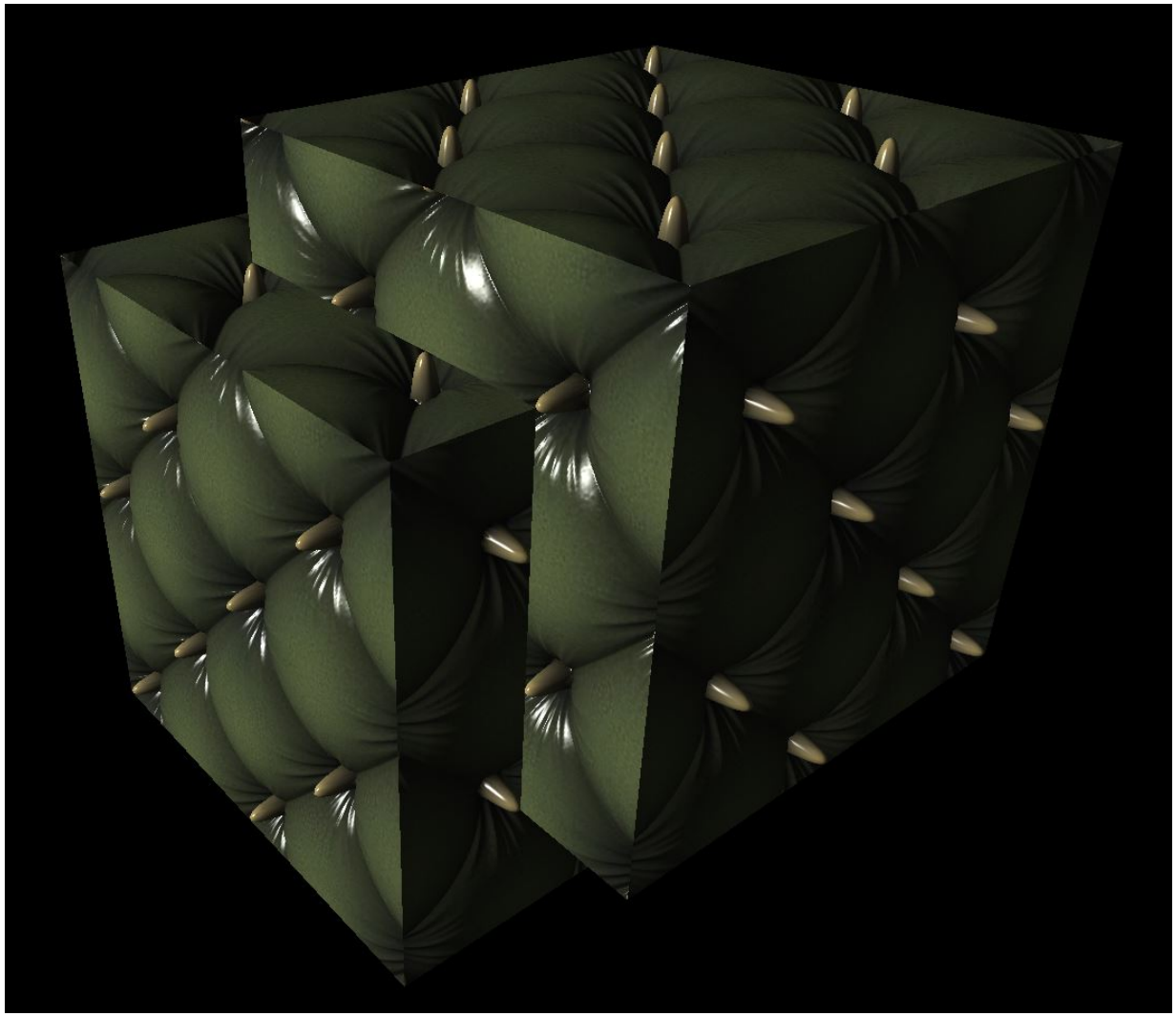
Task: Improve POM

- **Task 2:** Compute the intersection more precisely



- Result: Better result with less samples

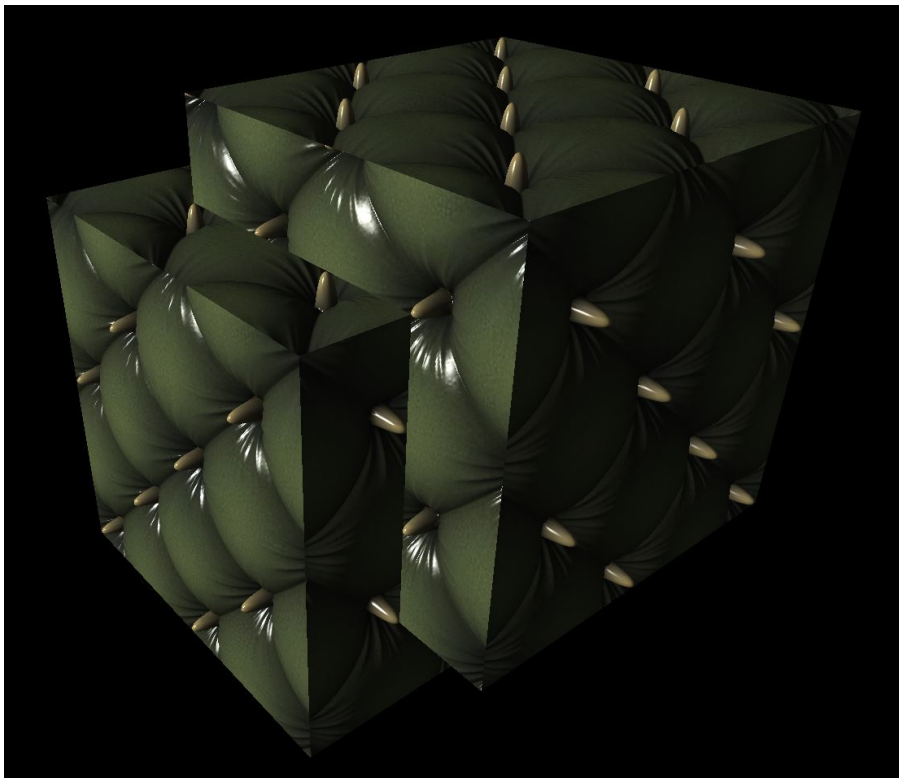
Interaction with other objects



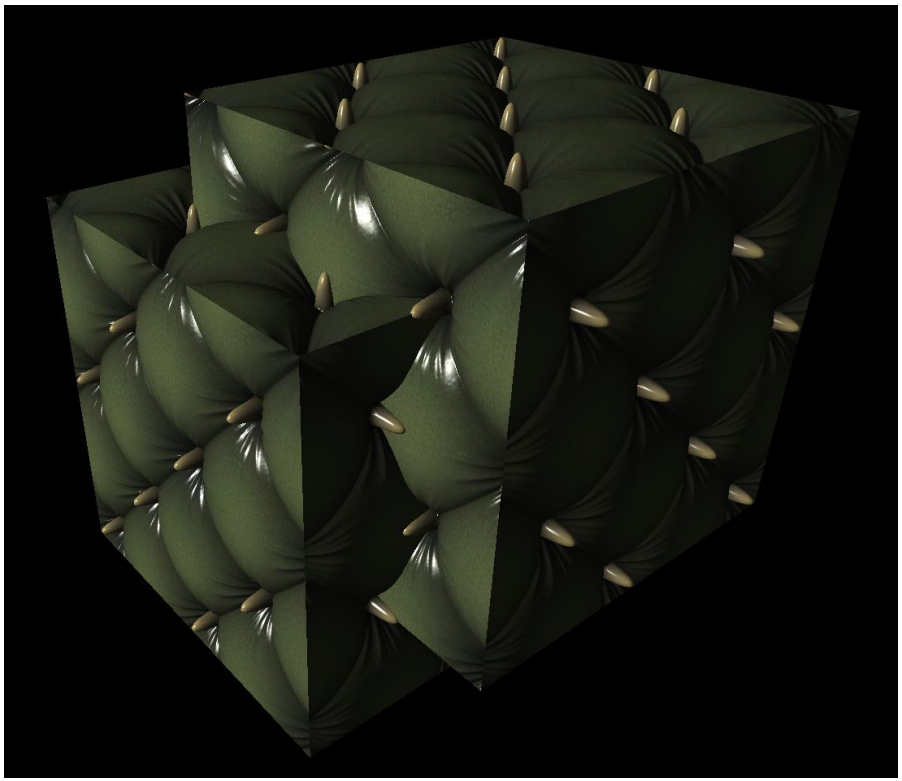
Task: Improve interaction with other objects

- **Task 3:** Adjust fragment's depth
  - Transform offseted position into clip space (transform in with *view* and *projection* matrices)
  - Transform it into normalized device coordinates (divide it with its *w*)
  - Transform it from $[-1, 1]$ to $[0, 1]$
  - Store its *z* into *gl_FragDepth*

Task: Improve interaction with other objects



Without depth adjustment

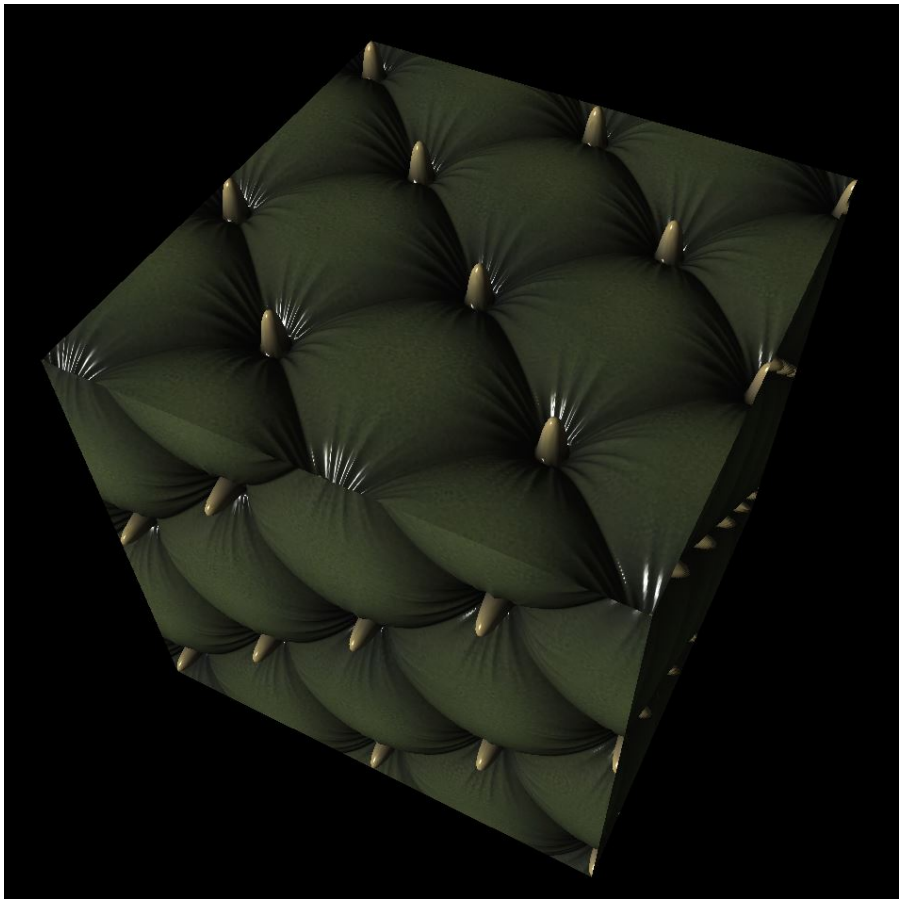


With depth adjustment

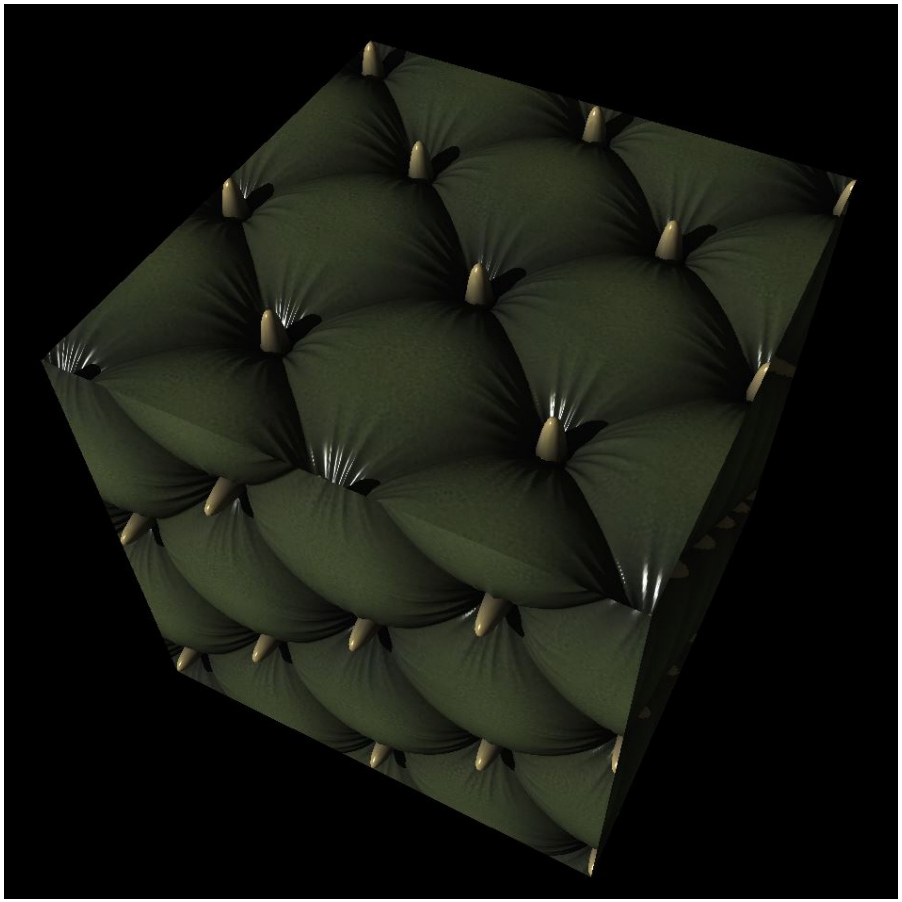
Task: Self-shadowing

- **Task 4:** Implement self-shadowing
  - Cast another ray from the offseted position to the light
  - Check whether there is an obstacle in the height map

Task: Self-shadowing



Without self-shadows



With self-shadows