TNM061 3D Computer Graphics
Materials
Lab instructions 2023

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Contents

1 Introduction

After having created some models in the last lab, it is now time to bring in some colors. Materials, sometimes also called shaders, define the look of an object and can be assigned to the entire object or just parts of it. They give a scene additional depth and details. There is a wide variety of different materials available including standard illumination models like Lambert and Phong as well as more elaborate models for dielectric materials like glass and much more.

Topics covered in this lab:

- Material editor
- Basic materials
- Composite or layered materials
- Procedural materials

Note

Depending on the materials you choose, you might need to add at least one compatible light source to your scene. Otherwise the rendered image might just be black. In particular when using the Arnold renderer (enabled by default in 3ds Max and Maya), the default lighting will not work for any Arnold-specific materials. The alternative is to use standard materials and use the default software renderer.

2 Theory

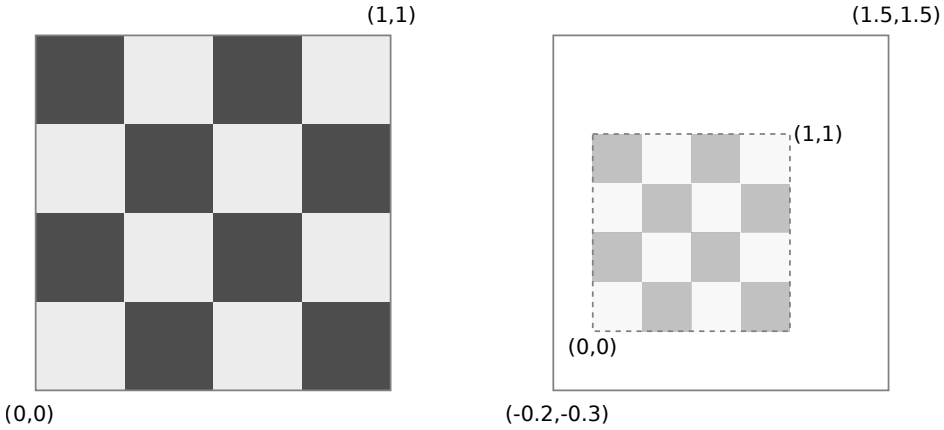
1. Someone modeled a simple lamp shade using a revolution surface for the base and a loft surface for the lamp shade. You can assume that the surfaces created by the loft and revolve operations are a parametric surfaces.

   What steps are necessary to use this surface in a game you develop on your own and render it with OpenGL?

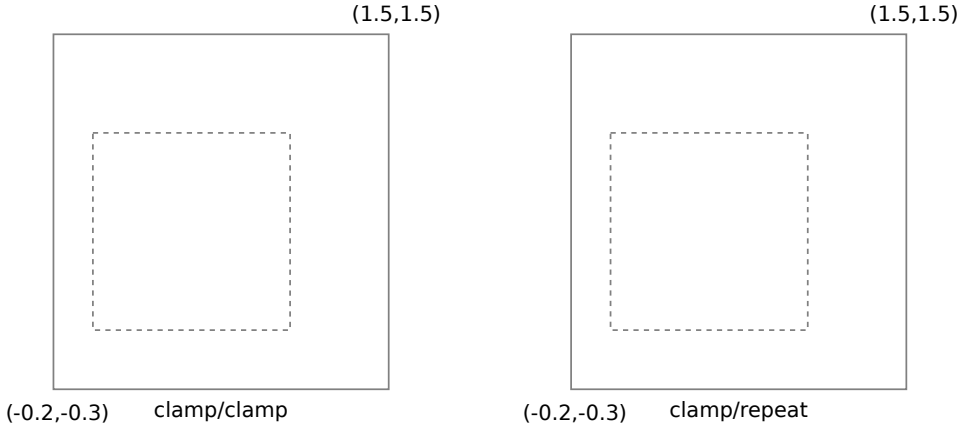
2. Is there a difference between normal mapping and bump mapping? Why would you use one or the other? Briefly explain your reasoning.

3. Your task is to model and animate the creation of a marble statue which is chiseled out step-by-step of a solid marble block. What kind of texture would you use here to avoid unnecessary re-texturing when arbitrary parts are cut away?

4. Consider the checkerboard texture defined in texture coordinates $(0, 0)$-$(1, 1)$. This texture is applied to a larger quad. The texture wrapping mode determines how the texture continues outside the range $[0, 1]$.



Fill in the textures below. On the left using a clamp wrapping mode for both directions. On the right, use clamp horizontally and repeat in the vertical direction.



3 Assignments

In the following you will be using the material editor to create and design new materials for different purposes. Depending on the tool you use, these editors are known as:

3ds Max Material Editor (*Compact Material Editor* and *Slate Material Editor*)

Maya Hypershade

Blender Shader Editor

Note: Make sure to save your scene and create rendered images of the final material applied to the objects as defined in the tasks. Present the images to the lab assistant for assessment and feedback during the lab session.

Note: All materials are not equal even in the same modeling software. Depending on which renderer you are going to use to create the final image, some materials might not show up as expected (or not at all). This is particularly the case when using the *Arnold* Renderer in 3ds Max or Maya. Here, you may need to use different materials like the *Physical Material* entirely or enable. (See the last page for some settings in 3ds Max.)

3.1 Tasks

1. Download the supplemental material for this lab from Lisam.
2. Familiarize yourself with the material editor in the modeling software you use. In Lisam, you can find a brief overview on the Material Editor in 3ds Max and some details on the *Standard Material* (see 3dsmax-materialeditor.pdf under labs).
3. **Simple material:** Follow the instructions given in Section 3.2. Render an image of the teapot with the material applied.
4. **Layered material:** Create a material by combining several textures into a single material as described in Section 3.3. Apply the material to a plane and a box and render the result.
5. **Procedural material:** Create a procedural material according to Section 3.4 without using any textures. Render an image of the material applied to some objects.
6. Pick at least **three** of the following objects and design a material to create an impression of the real thing. Render the result and save the image.
   - An orange or round avocado (sphere). Mimic both glossiness and bumps.
   - Meatball (sphere), fresh from the frying pan and slightly charred and greasy.
   - Hamburger patty (cylinder), charcoal-grilled with black stripes from the grid.
   - Sugar-sprinkled donuts (torus).
   - Cobblestone made of granite (box).
   - Worn wooden floor plank (box), *Wood* map as foundation with a *Bump Map*.
   - Heavily-used croquet ball (sphere) with impact marks and flaked paint.
7. **Optional:** Create a suitable material for the custom object you modeled in lab 3 and apply it.
8. **Optional:** Try to apply different materials to different sides of a *Box*. In 3ds Max you can use the *Multi/Sub-object* material.
9. **Optional:** Apply a two-sided material (*2-sided Material* in Blender) to some object like the teapot or the monkey (Blender). Make the outside appear as orange metal while the inside should be a silvery metal. You may want to remove part of the object's surface to be able to look inside.
10. **Optional:** Make thin smoke above the coffee mug from the first lab session, by using a nearly transparent material applied to a plane. Use *Noise*, preferably combined with a *Gradient*.

3.2 Simple material

1. Import the model of the Utah Teapot (`teapot.obj`) from the lab material or, in case you are using 3ds Max, you can create a *Teapot* directly from the primitives list. The teapot is quite useful since its curved surfaces can demonstrate the reflection properties of shiny materials. However the default material looks quite boring. Usually it is a gray Lambertian material, that is a purely diffuse material.

2. Create a new material in the material editor and apply it to the teapot. Preferably a basic material like *Phong* or *Blinn-Phong*. Adjust the diffuse color to a red shade. Notice how the specular color only affects the highlight. Set the glossiness and specular exponent so that the material appears to be made of plastic.

   You can find a description of some of the material settings here for 3ds Max, Maya, and Blender.

3. Replacing the colors with a texture or map can add more variation and details to the object's surface. This can either be a texture from a photograph or a procedural texture. Apply a noise texture/map instead of the red diffuse color. Play with the different settings of the noise texture and observer their effect. It might be necessary to adjust the scaling of the texture.

4. Render the teapot with the noise material you created.

3.3 Mix material

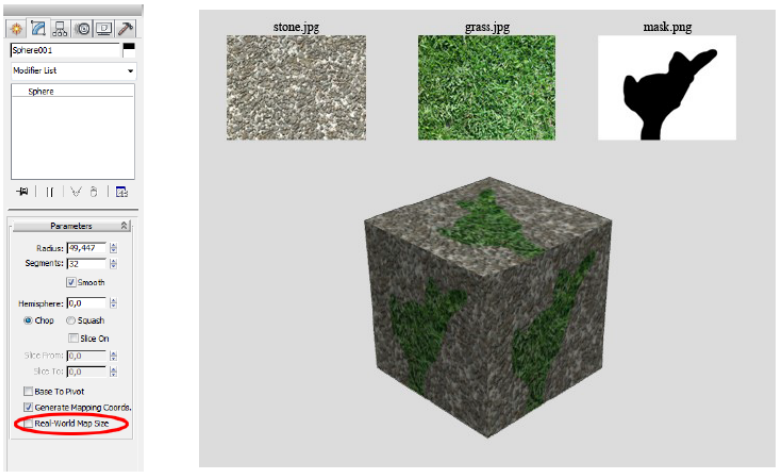


Figure 1: A material using a *Mix* material combining multiple textures into a more complex surface appearance.

Have a look at the three textures from the lab material (`stone.jpg`, `grass.jpg`, and `mask.png`). You will now use these textures to create a more complex material. The idea is to use a gray-scale mask that defines where the stones are visible and where the grass.

1. You can mix different textures or maps with special material nodes. These are *Mix Map* (3ds Max), *Layered Shader* (Maya), *Mix Shader* (Blender).

   Create a new material that mixes the textures similar to Figure 3.3.

   As usual, there is more than one way to achieve the goal. There are for example *Blend Materials*, *Composite Maps*, and *Layered Shaders* which have different purposes but could be used here as well.

2. Apply the material to a plane and a box and render the result.

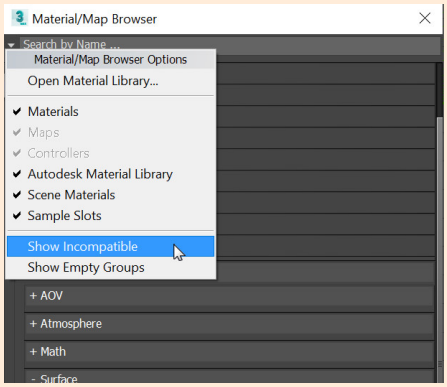
3.4 Procedural material

Procedural materials can be used to create complex materials without using any images or photographs. It might be hard to get the same level of realism and level of detail as you get from a photo, but the advantage is that every detail such as color, contrast, size, and type of pattern are editable with a few simple changes of parameters, instead of using a separate image editing program and spending considerable effort.

1. Make a checkered tile floor with a *Checker* map.
2. Continue by replacing the colors of the checker board with two *Noise* maps and try to make it look like marble.
3. Noise textures are very important in the context of procedural materials. Create a new material that mimics the look of Task 3.3. Use several noise maps/textures for the different parts of the material. Experiment with different types of noise (*Noise*, *Cellular*, *Voronoi*, ...).

   Hint: start with a coarse noise and apply a threshold. This should give you a decent mask for blending between the stones and the grass.
4. Apply the material to some objects and render the result.

Note for 3ds Max 2021/2022



In case some of the described materials and maps are missing in the material editor or during rendering, you may need to enable the support for legacy materials when using the latest versions of **3ds Max**. This is necessary since both the default material and the default renderer have been changed to *Physical Material* and *Arnold*. To do so, open the material editor and then the Material/Map Browser. Click on the dropdown next to "Search by Name..." and select "Show Incompatible" as shown in the image.

To make the noise work in 3ds Max you also need to make sure that the render setup settings are correct. You do this in the Render Setup tab. Make sure "Renderer" is set to "Arnold" and that the "Legacy 3ds Max Map support" box is checked under the System tab.

See also Autodesk Knowledge base.