RENDERING PARTTWO

WHAT WE HAVE SO FAR:

GEOMETRY AFTER TRANSFORMATION AND SOME BASIC CLIPPING / CULLING



TEXTURES AND MAPPING

MATERIAL

VISUALLY DISTINGUISHES 2 OBJECTS WITH IDENTICAL GEOMETRY

FOR NOW, WE FOCUS ON OBJECT'S COLOR

OTHER MATERIAL PROPERTIES WILL BE DISCUSSED LATER



OBJECT COLOR

TRIVIAL CASE constant color

USUAL CASE color changes over object

WE NEED TO STORE THE INFORMATION ABOUT THE COLOR



TEXTURE

USED TO DEFINE OBJECT COLOR

IMAGE TEXTURE

PROCEDURAL TEXTURE i.e. formula, algorithm



TEXTURE MAPPING

OBJECT SPACE \leftrightarrow 2D TEXTURE SPACE



NEW COORDINATE SYSTEM: TEXTURE COORDINATES

UV MAPPING



DIFFERENT UV MAPPINGS



VARIOUS UV MAPPINGS

PLANAR, FACE, BOX CYLINDRICAL, SPHERICAL, SHRINK WRAP OR... UNWRAP





http://www.ru.is/kennarar/hannes/useful/BlenderManual/htmll/

LIGHTS AND SHADOWS

GENERAL PROBLEM

FOR A POINT ON AN OBJECT, BRIGHTEN/DARKEN THE ORIGINALOBJECT COLOR TO REPRESENT LIGHT CONDITIONS.



FLAT SHADING

ONE NORMAL PER FACE

ENTIRE FACE = ONE COLOR



PER-VERTEX LIGHTING

ILLUMINATION IS CALCULATED ONLY IN VERTICES

AREAS BETWEEN THEM ARE INTERPOLATED



PER-PIXEL LIGHTING

ILLUMINATION IS CALCULATED FOR EVERY PIXEL

MUCH MORE CALCULATIONS BUT CURRENT GPUS DON'T CARE ANYMORE



PER-VERTEX

VS. PER-PIXEL

EDGES ARE WEIRD SPECULAR IS NOT ROUND





SURFACE NORMAL VECTOR

ORTHOGONAL TO THE SURFACE E.G. VECTOR PRODUCT OF EDGE VECTORS



SURFACE NORMAL AND ANGLES

REFLECTION AND REFRACTION by surface normal DIFFUSE (MATTE) ILLUMINATION by surface normal



LIGHT REFLECTION DISTRIBUTION





DIFFUSE LIGHT



AMBIENT LIGHT



DIFFUSE + AMBIENT



DIFFUSE + AMBIENT + SPECULAR



LOCAL ILLUMINATION MODELS

FAST BUT INACCURATE

EMPIRICAL (NO PHYSICAL BACKGROUND)

MANY PHYSICAL EFFECTS ARE IMPOSSIBLE TO ACHIEVE

COMPUTER GAMES REAL-TIME RENDERING

GLOBAL ILLUMINATION

PHOTOREALISM

LIGHT REFRACTION MUTUAL OBJECT REFLECTION CAUSTICS CHROMATIC ABERRATION COLOR BLEEDING (SOFT) SHADOWS





REFRACTION, CAUSTICS



REFLECTIONS



CHROMATIC ABERRATION



COLOR BLEEDING

raytracing + AAO

raytracing + AAO + indirect

http://feeblemind.org/blog/

COLOR BLEEDING



HARD SHADOWS VS. SOFT SHADOWS

THE SOFTNESS OF THE SHADOW DEPENDS ON THE TYPE AND DISTANCE OF LIGHT SOURCE



REALISTIC VS. NON-REALISTIC SCENE



GLOBAL ILLUMINATION

SPECIAL LIGHTING MODELS

SLOW BUT MORE PHYSICALLY CORRECT Often a combination of different methods

MOVIES, ARCHITECTURE, OFF-LINE RENDERING Where quality is most important

RAYTRACING – REFLECTIONS/REFRACTIONS



RAYTRACING

TRACING A BEAM FROM VIEWER'S EYE THROUGH EACH SCREEN PIXEL.

FIND FIRST BEAM INTERSECTION WITH OBJECTS, COMPUTE LOCAL LIGHTING

TRACE REFLECTED AND REFRACTED BEAMS COMBINE THE RESULTS WITH LOCAL RESULT

REPEAT RECURSIVELY

RAYTRACING EXAMPLE



3 COMPONENTS



Reflected light

Refracted light

Own color

RADIOSITY – INDIRECT ILLUMINATION

OBJECT HIT BY LIGHT IS A NEW LIGHT SOURCE

LIGHT EXCHANGE BETWEEN OBJECTS

http://www.bxhdesigns.com/



REAL WORLD RADIOSITY

LIGHT REFLECTORS IN PHOTOGRAPHY

http://www.hootphotography.com





RADIOSITY EXAMPLE

DIRECT ILLUMINATION

INDIRECT ILLUMINATION

BASIC SITUATION



EXAMPLE

INDIRECT LIGHT COLOR BLEEDING SOFT SHADOWS AREA LIGHT



LIGHT SOURCE TYPES

OMNIDIRECTIONAL, SPOTLIGHT, AREA, DIRECTIONAL, OBJECT LIGHT. WHAT ARE THE DIFFERENCES?





SHADOWS

WHY SHADOWS?



SHARP VS. SOFT SHADOWS

SHARP - RAYTRACING, SHADOW VOLUME SOFT - RADIOSITY, SHADOW MAPS



SHADOWS IN GLOBAL METHODS

RAYTRACING





RADIOSITY

http://www.soe.ucsc.edu/classes/cmps161/Winter04/projects/aames/index.htm

RAYTRACED SHADOWS

CAMERA→RAY→INTERSECTION←OBJECT INTERSECTION→SHADOW RAY← LIGHT(S)

TEST SHADOW RAY FOR OBJECT

Shadow if trueLight if false

SHADOWS IN LOCAL METHODS (REALTIME)

SHADOW VOLUMES GEOMETRY SPACE EXTINCT 🛞

SHADOW MAPS SCREEN SPACE GOOD HW SUPPORT POPULAR



SHADOW MAPS

LOOK FROM THE LIGHT

STORE DEPTH INFORMATION IN A SHADOW MAP 2D raster data



smallest distance between light and objects

SHADOW MAP STORES THE DISTANCE FROM THE LIGHT TO THE NEAREST OBJECT

SHADOW MAPS

WHEN RENDERING A POINT ON AN OBJECT

FIND ITS POSITION IN THE SHADOW MAP



SEE IF THE POINT IS FARTHER THAN WHAT'S STORED IN THE SHADOW MAP

SHADOW MAPPING EXAMPLE



http://www.devmaster.net/articles/shadow_techniques/

SHADOW MAP RESOLUTION

HOW MANY POINTS ARE STORED IN THE 2D SHADOW MAP

LOW COUNTS = SHADOW ARTIFACTS



Stamminger, Drettakis: Perspective Shadow Maps

FILTERING AND SOFT SHADOWS

REMOVES ARTIFACTS (JAGGED EDGES) SIMULATES SOFT SHADOWS



Soft-Edged Shadows, http://www.gamedev.net