LIGHTING A 3D MODEL

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Abstract: This paper describes detailed lighting procedure of 3D scene using blender software package. The aim is to define and describe all procedure, step by step, that provide the final result. Two different scenes have been lit in this paper: one with proper instructions and other for showing the extent of technique. Since it is possible to make a theoretically unlimited number of light sources in virtual 3D studio, the theoretical part of the paper outlines the basic guidelines for understanding the nature of the light in computer-generated environment and for its more quality and more realistic implementation.

Key words: blender, lights, 3-point lighting, eevee render engine

1. INTRODUCTION

The beginnings of computer graphics date back to the early sixties of the last century. First results and graphical representations were confined to the line and curve and objects were represented with their silhouettes. Rotating in space, a new silhouette would take place of the old one, thus creating the illusion of three-dimensional object. This type of graphics was called "vector graphics" and can be considered as the forerunner of today's 3d computer graphics. Later, in 70`s and 80`s, algorithms for mathematical representation of surfaces have enabled internal shading of objects and made them respond to light placed inside a virtual 3D space. Nowadays, 3D computer graphics (3D modeling) have wide range of usage that extend through models that we can see in various PC games, animated and special effects films, medical software, various web presentations as well as a presentation technique in architecture and urbanism. The aim of all forms of presentation is to provide as much information about the project. This information should be readable not only for expert architects, but for wider public, which are not from this profession. The most common way to represent models in architecture and urbanism is done through digital technology. There is a wide range of software for 3D modeling: Autodesk 3ds Max, AutoCAD, ArchiCAD, Solid Works, Sketchup, Autodesk Maya, Blender, LightWave 3D, Autodesk Softimage, CATIA, etc. Utilization of these software provides to creators to have simpler modeling possibilities and also understandable, detailed, conceivable and photorealistic project representation. One of the most popular software is Blender. It is open-source software and now it is also cooping with industry of 3D and 2D world visualisation.

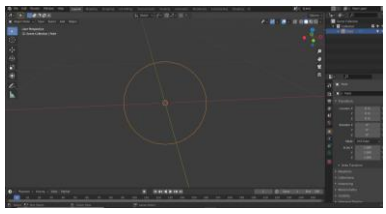
1. Lights

Light or visible light is an electromagnetic radiation. When light falls on an object that object reflects the light and when that light enters our eye, we “humans” are able to see that objects. The more object reflects the light the more clearly, we are able to see the object. That’s why we are able to see our hands and we can see through glass as hands reflects more amount of light than glass (glass refracts the light).
Computer graphics cannot faithfully simulate the complex nature of light, we are forced to use various additional lights to enrich computer graphics and skillfully, artistically simulate real-world phenomena. To make objects clearly visible and create good looking and realistic renders it is necessary to set proper positions of different light types, giving proper direction to light and adjusting intensity of light. The greater number of lights in the scene increases the brightness in the scene.

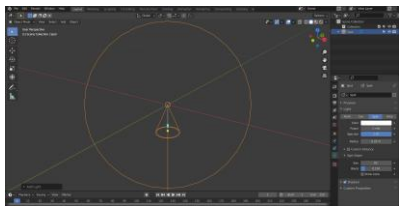
1.1. Types of lights

Before setting the light, it is important to know different types of lights and which light will dominant in the scene.
There are several types of computer-generated light: point light, spot light, directional light, area light, ambient light, HDRI.

- **Point light** simulated rays shining out from one infinitely small point in the space and emits light uniformly in all directions. (example: glowing star in space)

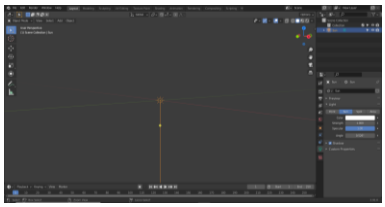


- **Spotlight** simulates light radiating from a point, much like a point light. A spotlight, however, limits the illumination to light within a specified cone or beam of light only. The rotation of a spotlight can determine where the beam is aimed (example: flashlight)

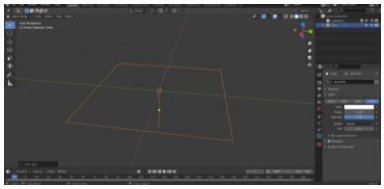


- **Directional light** sets a single vector for all is illumination and hits every object from the same angle, no

matter where the object is located. All the shadows cast by a directional light are cast in the same direction and are orthogonal projections of each object shape (example: sunlight).



- **Area light** is an imitation of light source coming from large area. This light is available in different physical forms: Square, Rectangle, Circle/Disk, Ellipse.



- **Ambient light** represents a constant and simulate global, or indirect lighting. Ambient light of all objects in the scene is the same, illuminating them without adding shadows.
- **HDRI** (High Dynamic Range Image) is a technique to light a scene using a special texture. It is easiest way to light any scene in computer graphics.

2. RENDER ENGINES

Render engines are the software items that perform the transformation of the prepared 3D scene into 2D image or animation. They can be based on different methods, such as ray-tracing, rasterization, path-tracing.

- Ray-tracing is a rendering technique for generating an image by tracing the path of light as pixels in an image plane and simulating the effects of its encounters with virtual objects. The technique is capable of producing a high degree of visual realism, more so than typical scanline rendering method, but at greater computational cost.

Rasterization is one of the typical techniques of rendering 3D models.

- Compared with other rendering techniques such as ray-tracing, rasterization is extremely fast and therefore used in most real-time 3D engines.
- Path-tracing is a computer graphics Monte Carlo method of rendering images of 3D scenes such that the global illumination is faithful to reality. Fundamentally, the algorithm is integrating over all the illuminance arriving to a single point on the surface of an object. This illuminance is then reduced by a surface reflectance function (BRDF) to determine how much of it will go towards the viewpoint camera. This integration procedure is repeated for every pixel in the output image. When combined with physically accurate models of surfaces, accurate models of real light sources (light bulbs), and optically correct cameras, path tracing can produce still images that are indistinguishable from photographs.

Using different render engine can change the workflow of lighting the scene. Since some engines provide indirect lighting and some don't, lights are placed according to render engines abilities. Path-tracing rendering engine is capable of calculating global illumination and illuminate the object accordingly so in that case we may or may-not need to add ambient lights. But in render engine which do not calculate global illumination (like eevee; real-time render engine by blender) there we have to use ambient light to produce more realistic results.

3. LIGHTING

In this chapter we will be dealing with basic lighting techniques to illuminate an object using previously acquired knowledge and further we will make our scene more natural as object really exist (photorealism).

There are different techniques to light a scene and which way to illuminate a scene depends upon what the artist is trying to convey through his scene. Same scene can be lit in different ways to convey different story or vibes like a monk in temple can be represented as neutral, evil, mysterious or supernatural character using different types of lights.

Generally, three-point lights are used in most of the scenes in which each light perform different roles and using only these three lights we can achieve the results we discussed before.

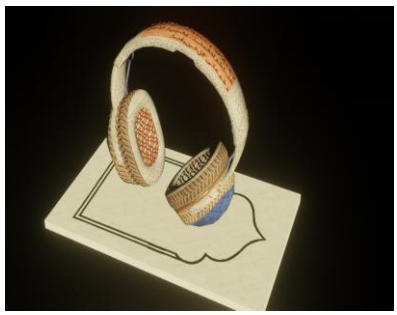
Before setting lights, it is necessary to decide the position of camera so that we can setup lights according to what we are seeing and we should not bother about what is not visible through camera. We have setup our camera and lighting will be done according to the perspective of the camera.

3.1. Key light

The key light is the first and usually most important light that a photographer, cinematographer, lighting cameraman, or other scene composer will use in lighting setup. The purpose of the key light is to highlight the form and dimension of the subject.

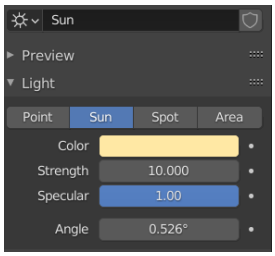
Key light can be any type of light and its light main purpose in this example project is to illuminate the object.

In this example project we have used directional light as key light to illuminate the object.



In this render, only key light is present and it serves its purpose of displaying the object's dimensions/shape.

Here are the settings of the key light we have used for this project.

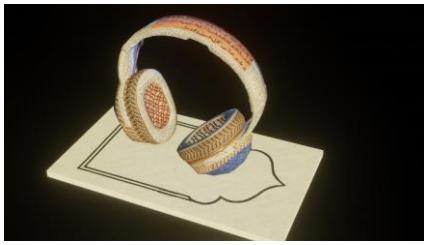


In blender directional light is known as sun-light, we have changed the colour of light from white to colour between off-white and yellow so scene look little warm. If we change its colour to closer to blue then scene will look cooler than this image.

3.2. Fill Light

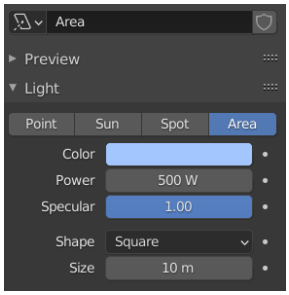
Fill light is used to reduce the contrast of a scene to match the dynamic range of the recording media and record the same amount of details typically seen by eye in average lighting and considered normal. In short fill light provides lift to the shadows and fill those areas of object which was left by key light.

The same scene we have seen before look much better after adding fill light in the scene.



In this render we have added fill light next to the object which covers all the dark shadows left by key light. Now we can see the whole object clearly without any shadow remaining.

We have used blue colour area light as fill light so that it looks like object is reflection light from sky.

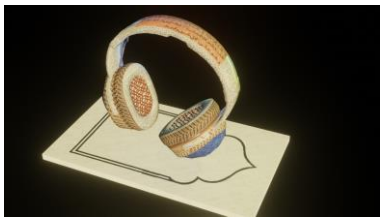


Since we are able to see the whole object with the lighting setup, we have done but its blending very little with the background; we can fix this issue with backlight.

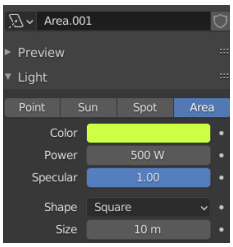
3.3. Backlight

Backlighting is the process of illuminating the subject from back. In other words, the lighting instrument and viewer face each other, with the subject in between. This creates a glowing effect on the edge of the subject, while other areas are darker therefore it is also called rim light. The backlight can be natural or artificial source of light.

We have added rim-light/backlight in the scene.

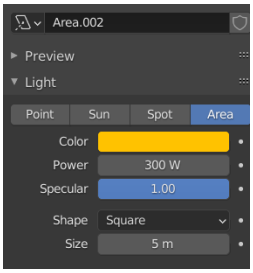


We have used green colour as rim light here to create a feeling of light reflecting from nature around it (trees, grasses, bushes) also green is close to complementary colour of blue colour this is also reason for using green colour as rim light.



Since one backlight was not looking enough so we decided to add another backlight behind left ear of the headphone.

We have used yellow colour to add complementary colour to blue fill light next to the second rim-light.



This is the settings of the second backlight we have used.

3.4. Lighting using HDRI

We can use HDRI to light our scene which we have downloaded from internet. HDRI can be used alone to light the scene and we can use 3-point lights with HDRI to improve the render result.

Since, HDRI provide real-world lighting conditions and lit or

scene from all directions, it is giving best result as alone if we add 3-point lighting with HDRI in this scene it will look over lighted and will not look good.
We also have an example where lighting done with HDRI alone was not looking good, but when we add other light sources it adds some life to the scene.

This scene is only lit with HDRI, which gives flat lighting and makes the image uninterested. When we use the above lighting techniques with HDRI, it improves the result so much.

This is the result after we add other light sources with HDRI. We use Big blue area light as key light (as it is night time so blue moonlight falling on grave) and couple of backlight/rim-lights at the back of grave with same light colour as of moonlight and two red backlights at the back of hand with very low intensity (so that we can separate them from grave-stone), we use fill light as light coming out of grave to create a sense of sooky and supernatural activities.
Using HDRI always boosts the lighting of the scene but it depends on project to project that whether you have to use HDRI alone or with other light sources. Most of the time it is always good idea to use 3-point lighting with HDRI, it always makes the scene interesting, but sometimes it doesn't work like in our first example project.

4. CONCLUSION

Lighting a scene is more than just illuminating the objects, there should always a purpose of light, and lighting should be done to show what type of mood the scene you want to show. There is no point in making high-quality models with high-quality textures when there is no proper lighting in the scene as no details can be seen if there is no light. Also, it is lighting which makes the boring even model and textures are of high-quality and also with proper lighting any scene can be made interesting. Therefore, lighting a scene is both an art and a technical skill.
Even a basic knowledge about lighting can contribute to improve the overall sense and mood of displayed scene. 3D modeling and animation goal is to describe a concept, to show function of space and possible interaction between users and designed space. Animation has potential, according to some architects, to become even a part of designing methods, to become a part of creative thinking process during development.

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