3D Wed Gallery for Game

Title: 3D Web Gallery for Game

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Chapter 7 LIGHT IN 3D

Learning Outcome

Objectives of this chapter are: -

- What is light
- Type of light
- Common Properties of light

LIGHTING

Lighting in a 3D world is just as essential as it is in real life.

Figure 1 Example of Light effect in 3D

Lighting, (in combination with textures, camera angle etc.) is where a scene has the potential to come alive. Used improperly, light can wash out a scene, make objects appear hard or flat, and destroy all the hard work. But skilfully applied, lighting can make a scene convincing, or if realism is the aim, create (in combination with materials and geometry), a scene that is virtually indistinguishable from real life.

In 3D, lights don’t exist as they do in the real world. Lights in 3D are objects that are designed to simulate how lighting works in real life, but to obtain the results you’re after, you have to apply a number of settings, not only to the lights, but to the materials.

What is light?

Light is electromagnetic radiation within a certain portion of the electromagnetic spectrum. The word usually refers to visible light, which is visible to the human eye and is responsible for the sense of sight. Visible light is usually defined as having wavelengths in the range of 400–700 nanometres. (Wikipedia, 2016)

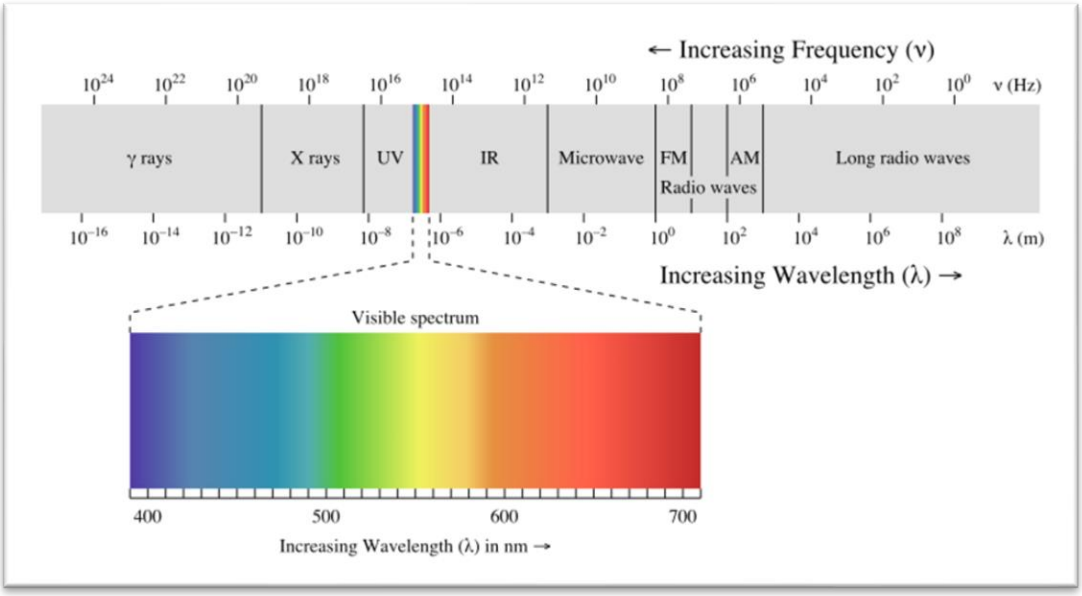

Figure 2, Electromagnetic spectrum with light highlighted

The main source of light on Earth is the Sun. Historically, another important source of light for humans has been fire, from ancient campfires to modern kerosene lamps. With the development of electric lights and power systems, electric lighting has effectively replaced firelight.

The primary properties of visible light are intensity, propagation direction, frequency or wavelength spectrum, and polarization, while its speed in a vacuum, 299,792,458 meters per second, is one of the fundamental constants of nature. Visible light, as with all types of electromagnetic radiation (EMR), is experimentally found to always move at this speed in a Vacuum.

Natural Lights

The natural light is the light from the sun (sunlight). Sunlight is a portion of the electromagnetic radiation given off by the Sun, in particular infrared, visible, and ultraviolet light. On Earth, sunlight is scattered and filtered through Earth's atmosphere, and is obvious as daylight when the Sun is above the horizon. When direct solar radiation is not blocked by clouds, it is experienced as sunshine, a combination of bright light and radiant heat.

Figure 3, Sunlight shining through clouds

Figure 4, Incandescent (left) and fluorescent (right) light bulbs turned on

Computer graphics lighting

Computer graphics lighting refers to the simulation of light in computer graphics. This simulation can either be extremely accurate, as is the case in an application like Radiance which attempts to track the energy flow of light interacting with materials using radiosity computational techniques. Alternatively, the simulation can simply be inspired by light physics, as is the case with non-photorealistic rendering. In both cases, a shading model is used to describe how surfaces respond to light. Between these two extremes, there are many different rendering approaches which can be employed to achieve almost any desired visual result.

Figure 5 Computer Graphic lights example

Computer graphics lighting can also refer to the job of lighting in computer animation. A computer graphics lighter will employ many of the same methods a live-action lighting designer or gaffer might employ. However, the computer graphics lighter will work within a computer graphics application.

Lighting in 3D

Lighting in 3d simulates natural lighting. Lights are objects that simulate real lights such as household or office lamps, the light instruments used in stage and film work, and the sun itself. Different kinds of light objects cast light in different ways, emulating different kinds of real-world light sources.

Lighting is the one of the most important aspects of creating great looking 3D art, but also one of the most complex and challenging to master. When done correctly it can help build masterpieces, when done incorrectly it can literally destroy even the best of works (Gulati, 2012).

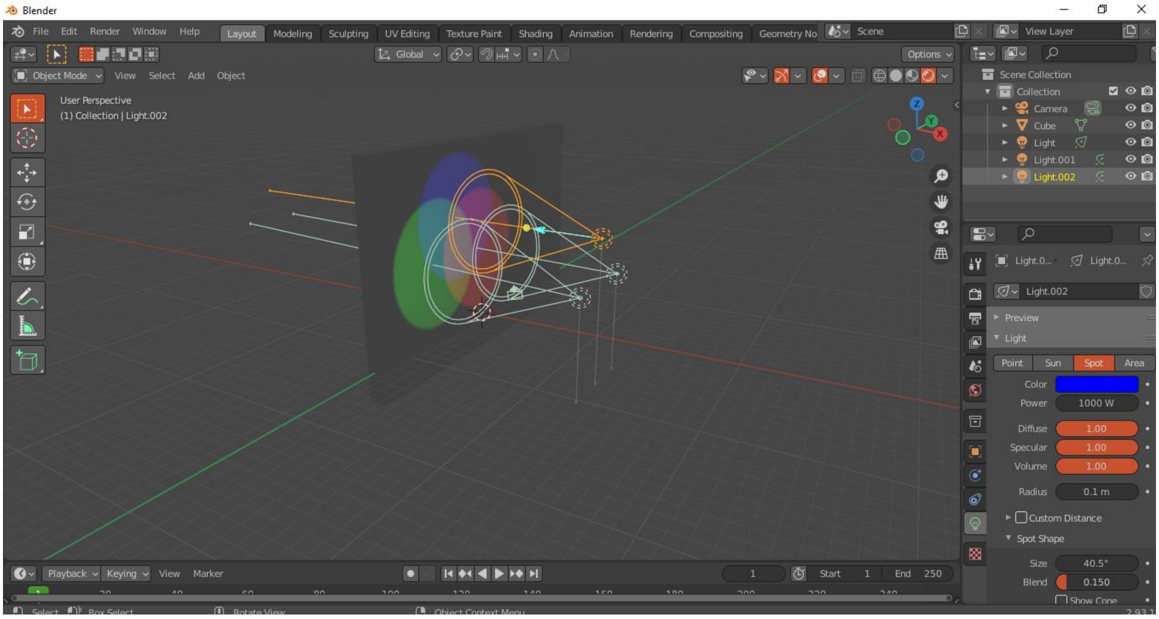

Figure 6 Three-Dimensional Light in Blender

Common Types of light in 3D

There are 4 types of light exist in blender: -

- Point light
- Sun light
- Spot light
- Area light

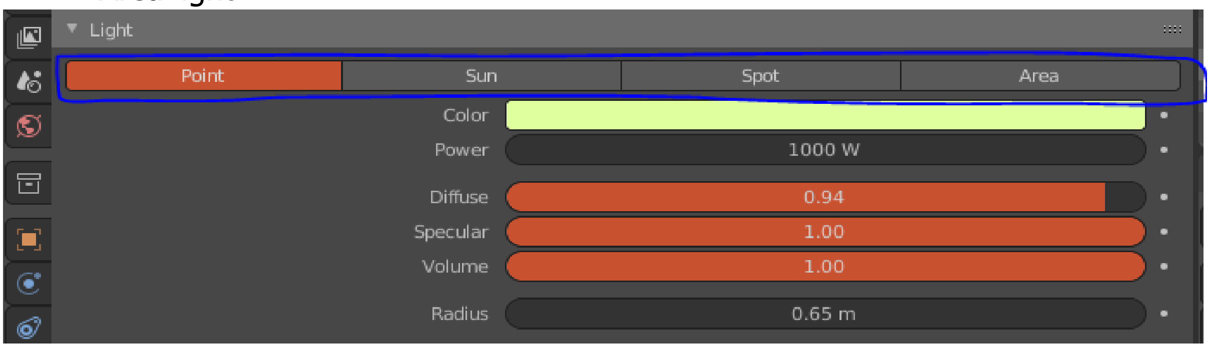

Figure 7 Types of light

Point light

This light emits in all directions from a single point. With appropriate falloff, it can resemble a candle or a small lightbulb. It is very useful for rim light effects, where parts of an object need to be lit in order to stand out from the background.

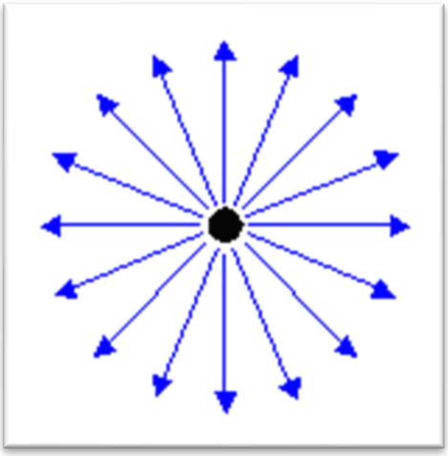

Figure 8 Point Light

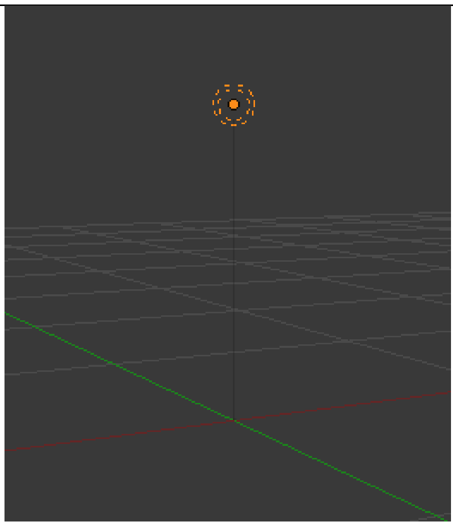

Figure 9 Point Light in Blender

The point light is an omni-directional point of light, that is, a point radiating the same amount of light in all directions. It's visualized by a plain, circled dot. Being a point light source, the direction of the light hitting an object's surface is determined by the line joining the light and the point on the surface of the object itself. It can be used as simple model of e.g., a light bulb.

Light intensity/energy decays based on (among other variables) distance from the point light to the object. In other words, surfaces that are further away will be rendered darker.

Power

Power of the light in Watts. Higher values increase the intensity of the light. Negative values can be set, but should be avoided for predictable and physically based result.

Radius

When larger than zero, light will be emitted from a spherical surface with the specified radius. Lights with larger size have softer shadows and specular highlights, and they will also appear dimmer because their power is distributed over a larger area.

Sun light

Sun light otherwise known as a directional light; this is light that floods a scene from a given angle. It gets its name because it is similar to how the sky lights the world: flooding the scene from a given direction, not from a single point. Location does not affect sun lights; it is the rotation that is important. Whichever way a sun light is rotated, the whole scene gets light from that particular angle with parallel light rays.

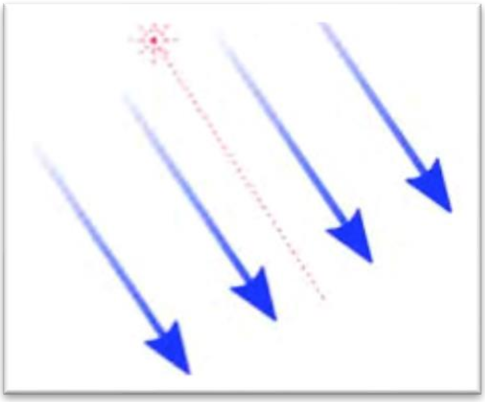

Figure 10 Sun light

A sun light provides light of constant intensity emitted in a single direction from infinitely far away. It can be very handy for a uniform clear daylight open-space illumination. In the 3D Viewport, the sun light is represented by an encircled black dot with rays emitting from it, plus a dashed line indicating the direction of the light.

Note

This direction can be changed by rotating the sun light, like any other object, but because the light is emitted from a location considered infinitely far away, the location of a sun light does not affect the rendered result.

Strength

Strength of the lights in Watts per square meter. Typical values are around 250 for an overcast day and 1000 or more for direct sunlight. See more details at Power of Lights.

Angle

The size of the sun light according to its angular diameter as seen from earth.

Power of Lights

The power of sun lights is specified in Watts per square meter. The power of point lights, spot lights, and area lights is specified in Watts. But this is not the electrical Watts that consumer light bulbs are rated at. It is Radiant Flux or Radiant Power which is also measured in Watts. It is the energy radiated from the light in the form of visible light.

If you want to set the power to real world values, you have to convert the wattage of consumer bulbs or LED lights to radiant flux, but it is not a straightforward process. The wattage of bulbs means the electrical power required to power them. LED lights have a "Watt equivalent" which is neither the electrical power they require nor the amount of light they put out. Some consumer lights specify lumens or luminous flux which is the radiant flux weighted with the wavelengths perceived by the human eye.

To save you from doing the conversion, here is a table of typical power values for point, spot, and area lights:

Real world light	Power	Suggested Light Type
Candle	0.05 W	Point
800 l m LED bulb	2.1 W	Point
1000 l m light bulb	2.9 W	Point
1500 l m PAR38 floodlight	4 W	Area, Disk
2500 l m fluorescent tube	4.5 W	Area, Rectangle
5000 l m car headlight	22 W	Spot, size 125 degrees

And a table of typical Strength values for sun lights:

Sun type	Strength
Clear sky	1000 W/m²
Cloudy sky	500 W/m²
Overcast sky	200 W/m²
Moonlight	0.001 W/m²

These values will likely produce much brighter or dimmer lights than you would expect, because our eyes adapt while a render engine does not. So, to compensate, adjust the Exposure in Render ▸ Film.

To get realistic results, remember to also set the light size and color to realistic values. The color of your lights will also influence how bright they appear to the human visual system. If you leave the power unchanged, a green light will seem the brightest, red darker and blue the darkest. Thus, you might want to manually compensate for these perceived differences.

Spot light

This is similar to a point lamp, but within a restricted V-shape direction. A spot light emits a cone-shaped beam of light from the tip of the cone, in a given direction. This light works very much like a theatre spotlight. It casts a circle on a surface it is aimed at, and has settings to control the softness of the circular edges.

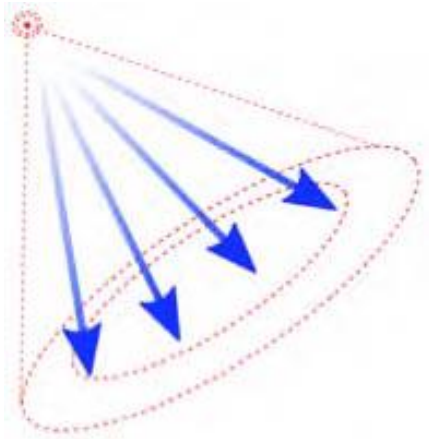

Figure 11 Spot Light

Power

Power of the light in Watts. Higher values increase the intensity of the light. Negative values can be set, but should be avoided for predictable and physically based result.

Radius

When larger than zero, light will be emitted from a spherical surface with the specified radius. Lights with larger size have softer shadows and specular highlights.

Beam Shape

Changing the spot options also changes the appearance of the spotlight.

Size

The size of the outer cone of a spot, which largely controls the circular area a spot light covers. This slider in fact controls the angle at the top of the lighting cone, and can be between (1.0 to 180.0).

Blend

The Blend slider controls the inner Cone of the spot. The Blend value can be between (0.0 to 1.0). The value is proportional and represents that amount of space that the inner cone should occupy inside the outer cone Size.

The inner cone boundary line indicates the point at which light from the spot will start to blur/soften; before this point its light will mostly be full strength. The larger the value of Blend the more blurred/soft the edges of the spotlight will be, and the smaller the inner cone's circular area will be (as it starts to blur/soften earlier).

To make the spot have a sharper falloff rate and therefore less blurred/soft edges, decrease the value of Blend. Setting Blend to 0.0 results in very sharp spotlight edges, without any transition between light and shadow.

The falloff rate of the spot light is a ratio between the Blend and Size values; the larger the circular gap between the two, the more gradual the light fades between Blend and Size.

Blend and Size only control the spot light cone's aperture and softness ("radial" falloff); they do not control the shadow's softness as shown below.

Changing the spot Size option.

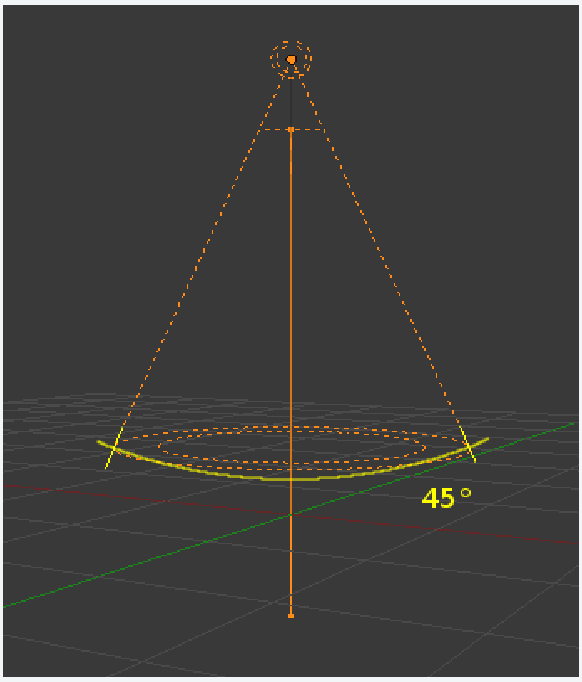

Figure 12 changing size of spot light

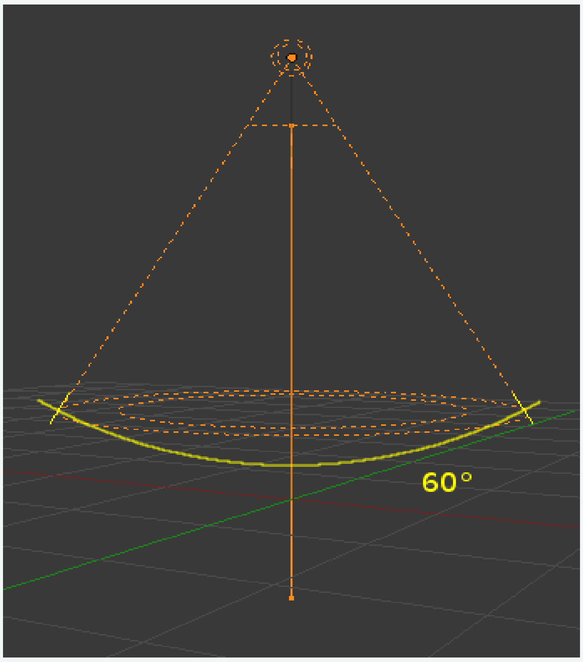

Figure 13 changing size of spot light

Notice in the picture above that the object's shadow is sharp as a result of the ray tracing, whereas the spotlight edges are soft. If you want other items to cast soft shadows within the spot area, you will need to alter other shadow settings.

Show Cone

Displays a transparent cone in 3D Viewport to visualize which objects are contained in it.

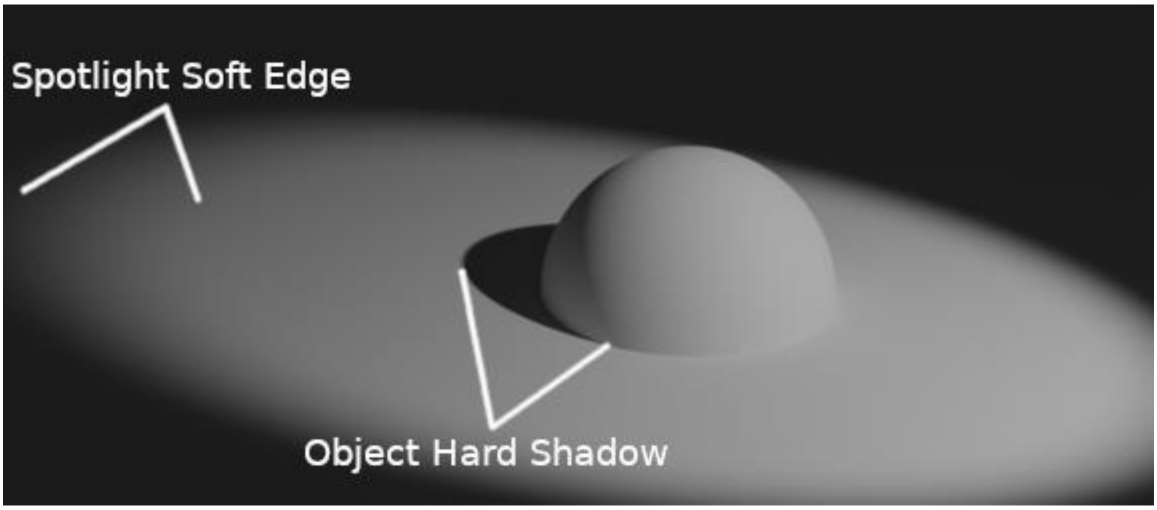

Figure 14 Render showing the soft edge spotlighted area and the sharp/hard object shadow.

Area light

An area light is like having a cluster of lights over an area of a specified size. It is useful for creating light emitted from a surface, such as a TV or the back of a fridge. The area light simulates light originating from a surface (or surface-like) emitter. For example, a TV screen, office neon lights, a window, or a cloudy sky are just a few types of area light. The area light produces shadows with soft borders by sampling a light along a grid the size of which is defined by the user. This is in direct contrast to point-like artificial lights which produce sharp borders.

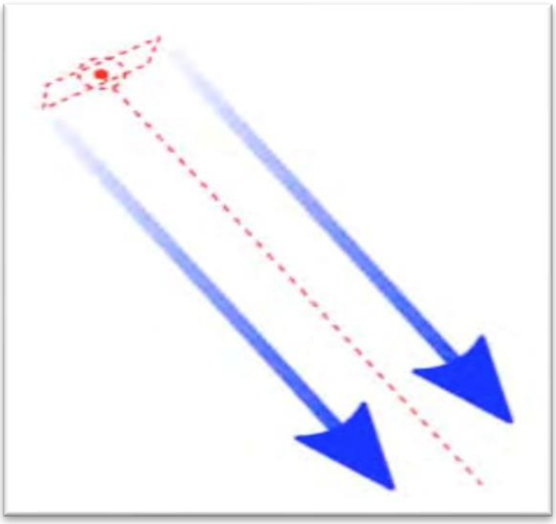

Figure 15 Area Light

Power

Power of the light in Watts. Higher values increase the intensity of the light. Negative values can be set, but should be avoided for predictable and physically based result.

Shape

Shape of the light.

Rectangle

The shape of the light can be represented as a rectangle and changed with the "X" and "Y" values.

Square

The shape of the light can be represented as a square and changed with the Size property.

Disk

The shape of the light can be represented as a disk and changed with the Size property.

Ellipse

The shape of the light can be represented as an ellipse and changed with the X and Y values.

Tip

Choosing the appropriate shape for your area light will enhance the believability of your scene. For example, you may have an indoor scene and would like to simulate light entering through a window. You could place a rectangular area light in a window (vertical) or from neon (horizontal) with proper ratio for Size X and Size Y. For the simulation of the light emitted by a TV screen, a vertical square area light would be better in most cases.

Size / Size X / Size Y

Dimensions for the Square or Rectangle.

Beam Shape

Spread Cycles Only

How wide the emitted light fans out controlling how diffused the light is. Larger values create soft shadows while smaller values create sharper light simulating a gridded softbox.

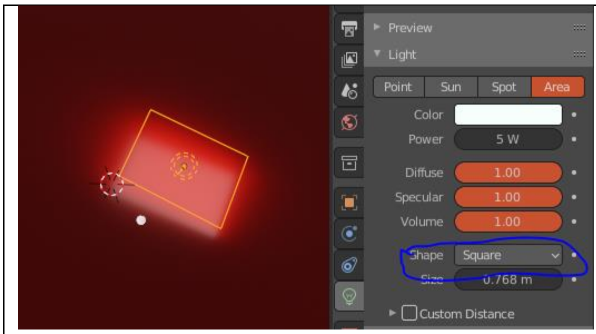

Figure 16 Square Example

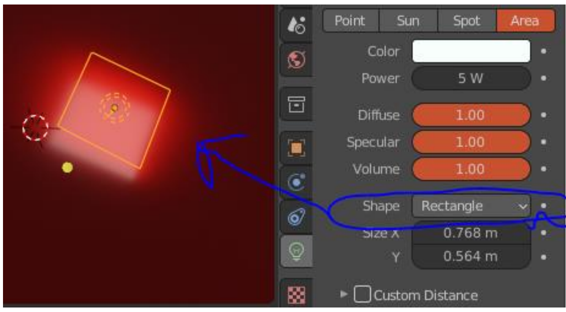

Figure 17 Rectangle Example

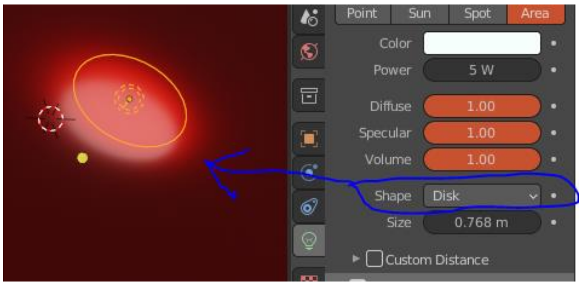

Figure 18 Disk Example

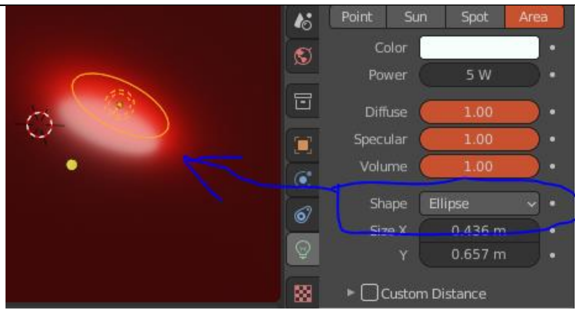

Figure 19 Ellipse Example

Common Properties of light

There are two importance properties of light are: -

- Color
- Power
- Diffuse
- Specular
- Volume

Figure 20 Point Light

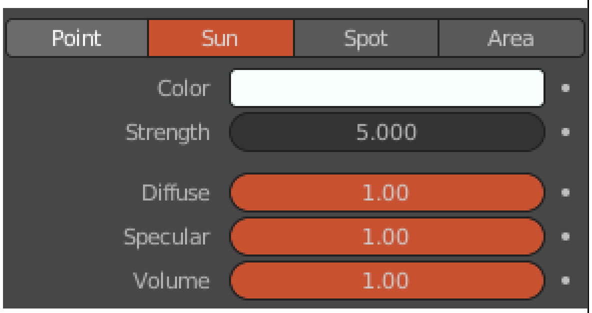

Figure 21 Sun light

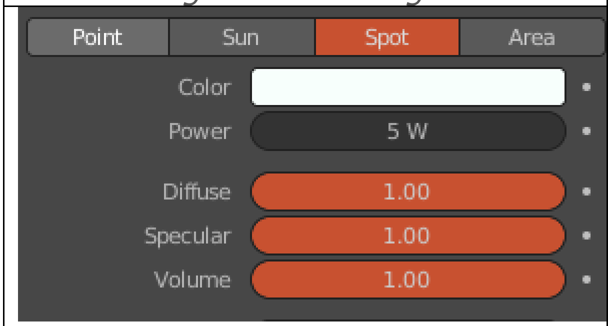

Figure 22 Spot light

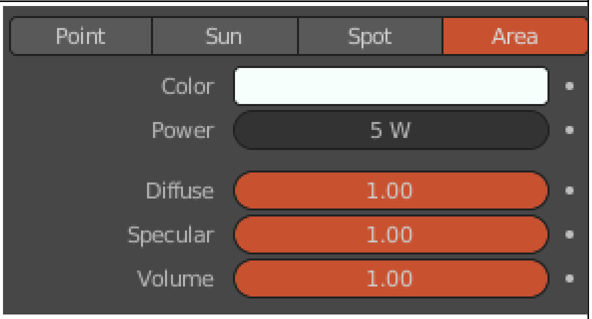

Figure 23 Area Light

Color

Light have many color to choose for realistic seen of object and environment

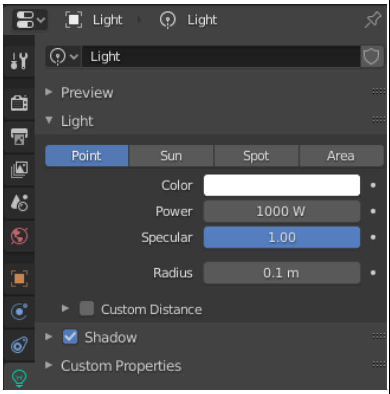

Figure 24 White color light

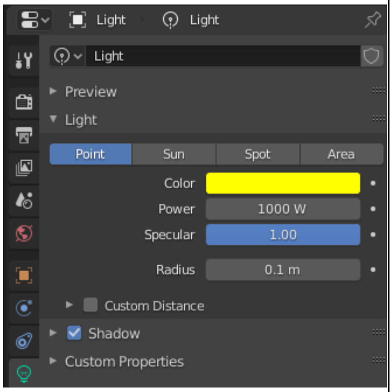

Figure 25 Yellow color light

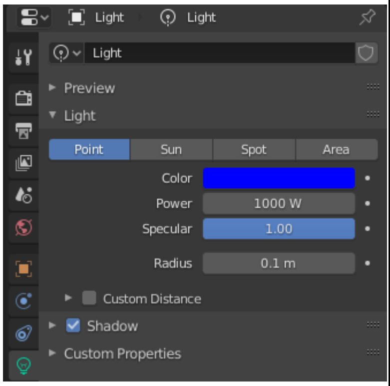

Figure 26 Blue color light

Power

Power means, power of light shine through. Example light of sun in summer, or lights of sun in winter. Both have different energy.

Even normal bulb also has different power depends on their watts.

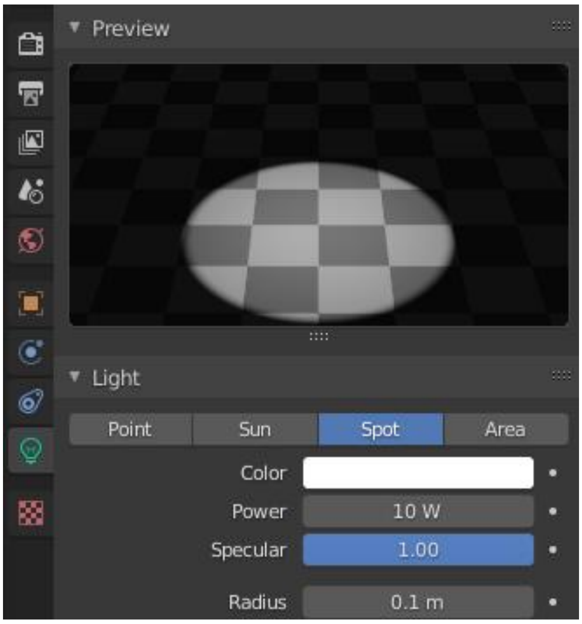

Figure 27 Light with Power 10W

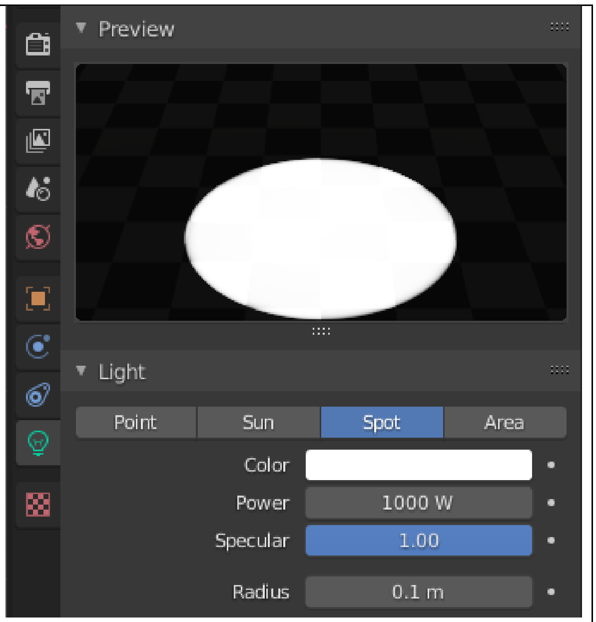

Figure 28 Light with power of 1000W

Diffuse

This is the constant color of the light. The diffuse pass is multiplied with the base color of the objects and the specular pass is added on top. MatCaps, that only have a diffuse pass tend to look very metallic, with a separate specular pass it is possible to simulate a wider variety of materials.

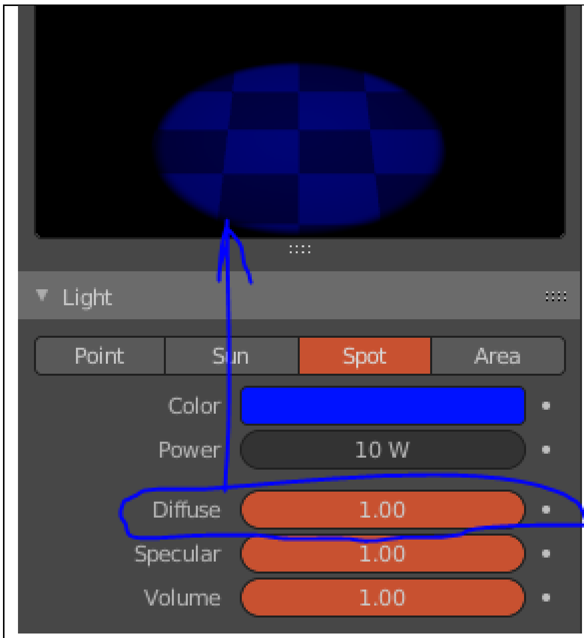

Figure 29 Diffuse effect in light before

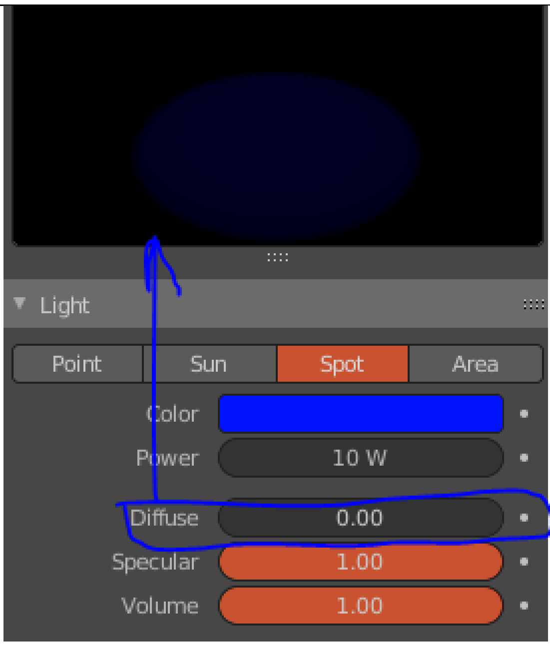

Figure 30 Diffuse effect in light after

Specular

Specular Light intensity multiplier. Use it for more artistic control. Setting this to anything but 1.0 will yield non-photorealistic result.

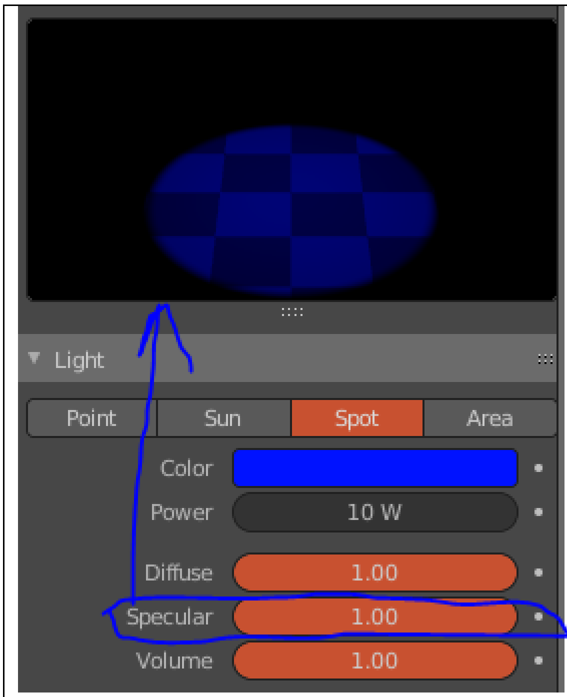

Figure 31 Specular effect in light before

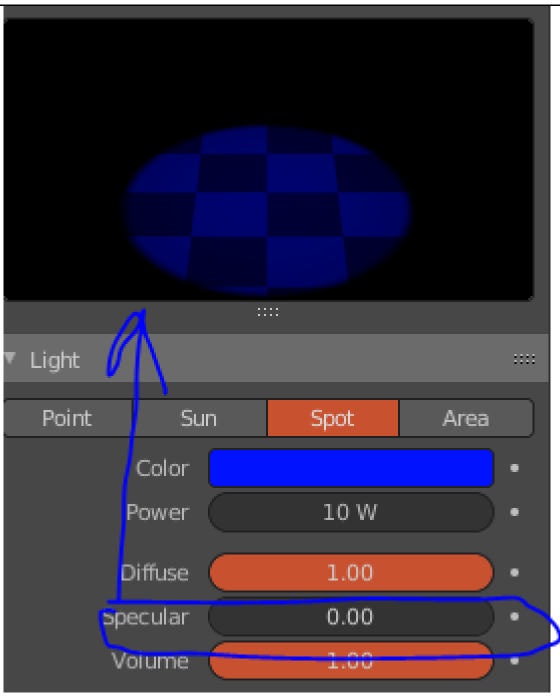

Figure 32 Specular effect in light after

Volume

will absorb part of the light as it passes through the volume. This can be used to shade for example black smoke or coloured glass objects, or mixed with the Volume Scatter node. This node is similar to the transparent BSDF node, it blocks part of the light and lets another light pass straight through.