2019年11月6日 星期三

Computer Graphics

Targets:

wire framing,
ray tracing,
lighting,
key frame,
mapping,
texture,
3D animation,

Definition:

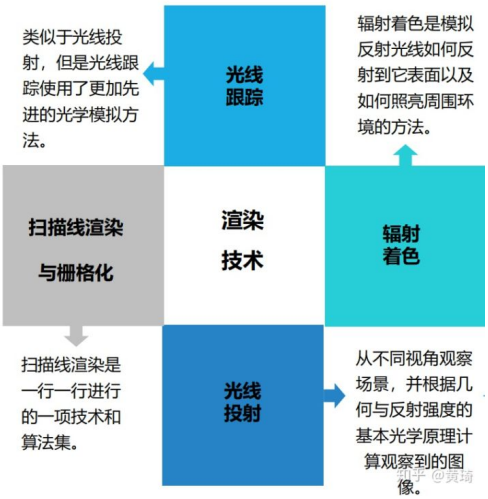
Computer graphics is the art or science of producing graphical images with the aid of computer

	图形（graphic）	图像（image）
数据来源	虚拟世界	客观世界
处理方法	几何变换、裁剪、隐藏线和隐藏面消除、明暗处理、纹理生成等	图像变换、图像增强、图像分割、图像理解、图像识别等
理论基础	仿射与透视变换、样条几何、计算几何、分形等	数字信号处理、概率与统计、 模糊数学等
用途	计算机艺术、计算机模拟、计算机动画等	遥感、医学、工业、航天航空、军事等

The basic meaning of computer graphics is to use computers to construct graphics on display devices through algorithms and programs. Graphics are designed and constructed by computer, not by cameras, scanners and other devices. The figure here can be the figure existing in reality, or it can be a completely virtual structure figure. It is presented in the form of vector graph, with more emphasis on the geometric representation of the scene and recording the shape parameters and attribute parameters of the graph. For example, the most basic graphic unit of engineering drawing is point, line, circle / arc, etc. its information includes geometric information and attribute information (explicit attributes such as color, line type, line weight, and implicit attributes such as hierarchy).

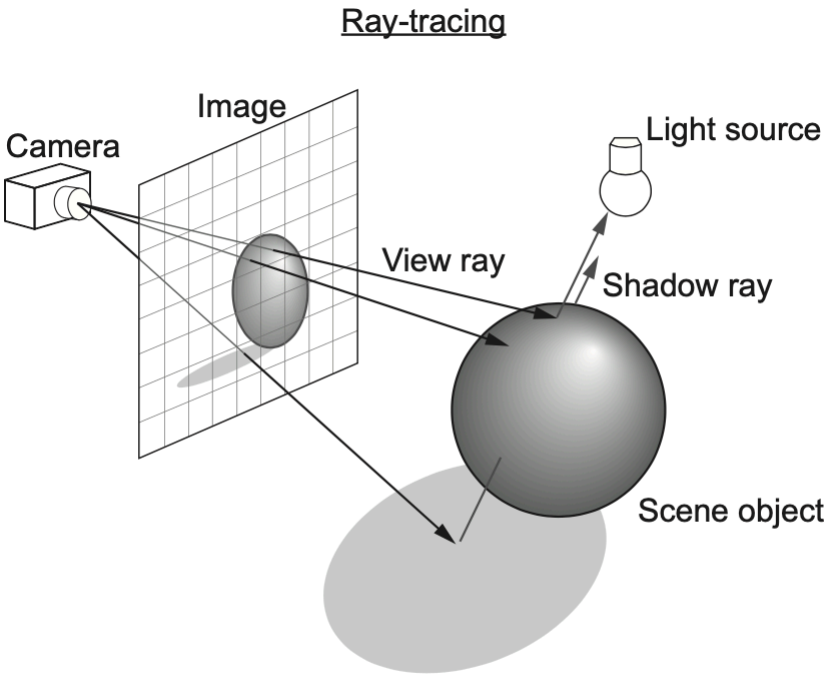
As shown above, we can deduce the framework of computer graphics in 4 parts, the base of mathematics, modeling, Rendering, and interaction.

Rendering, or called rendering, refers to the visual realization process of the model. The theories and algorithms of computer graphics, such as illumination and texture, need to deal with the model, which also needs a lot of geometric calculation.



Wire framing, also known as rasterization, is the process of transforming geometric data into pixels after a series of transformations, so as to present it on display devices. Rasterization transforms vertex data into slice elements, each element of which corresponds to a pixel in the frame buffer. The following diagram.

Ray-tracing involves exploring the path of light rays between the eye of the viewer (the “camera” in the diagram) and the light source, taking into account the different effects that the virtual objects have on the passage of lighting. Although the basic algorithm is quite simple to understand, as the number of objects in each frame increases os do the change of direction that the light rays can take. As the intensity and color of light at each pixel needs to be computed for each frame, the computational cost can be high. It is fundamentally a recursive process that needs too be limited.



[Source: adapted from Henrik, http://en.wikipedia.org]

Lighting: to observe the scene from different perspectives, and calculate the observed image according to the basic optical principles of geometry and reflection intensity, which is ray casting. The basic idea of ray casting algorithm is to emit a ray from each pixel of the view plane, pass through the volume data, and

accumulate the color and opacity along the ray direction based on the most basic ray absorption and emission model. When the light intersects the object, the color of the intersection can be calculated in several different ways. The simplest method is to use the color of the object at the intersection to represent the actual color of the point; it can also be determined by texture mapping; a more complex method is to calculate based on the local illumination model. In order to reduce the human error, we can average the light in several adjacent directions. Some other calculations involve the incident angle from the light source to the object, and calculating the luminance value of the pixel according to the intensity of the light source.

Lightning algorithm emits a group of rays from the viewpoint. The data on the three-dimensional data set that the rays pass through can be sampled evenly, which is similar to human real vision and suitable for perspective projection. Therefore, ray casting is mainly used in real-time simulation scenes, such as 3D computer games and animation, which often pay little attention to the details and can get better performance by making details artificially.

Key frame: In computer animation, frame is a single image with the smallest unit in the animation, equivalent to every frame on the film. On the timeline of animation software, the frame is represented as a grid or a mark. Keyframe - equivalent to the original painting in 2D animation. Refers to the frame in which the key actions of a character or object are moving or changing. The animation between keyframes can be created by software, which is called transition frame or intermediate frame.

Texture mapping:

Offsets the assumption that the BRDF doesn’t change in u and v coordinates along the object’s surface

Store a reflectance as an image called a **texture**

Map that image onto the object (one triangle at a time)

A **texture** image is defined in a 2D coordinate system

Texture mapping is a method of adding realism to a computer-generated graphic. An image (the texture) is added (mapped) to a simpler shape that is generated in the scene, like a decal pasted to a flat surface. This reduces the amount of computing needed to create the shapes and textures in the scene. For instance, a sphere may be generated and a face texture mapped, to remove the need for processing the shape of the nose and eyes.

As graphics cards become more powerful, in theory, texture mapping for lighting becomes less necessary and bump mapping or increased polygon counts take over. However, in practice, the trend has recently been towards larger and more varied texture images, together with increasingly sophisticated ways to combine multiple textures for different aspects of the same object. (This is more significant in real-time graphics, where the number of textures that may be displayed simultaneously is a function of the available graphics memory.)

The way the resulting pixels on the screen are calculated from the texels (texture pixels), is governed by texture filtering. The fastest method is to use exactly one texel for every pixel, but more sophisticated techniques exist.