The Graphics Pipeline

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1 Concept

Graphic pipeline is a process from logical representation of visual information to output signal.Commonly,we use a set of software and hardware to render 3D geometry onto a 2D raster representation.
For instance, once a 3D model has been created in a video game, the graphics pipeline is the process of turning that 3D model into what the computer displays on its screen.

1.1 Object

Graphic starts with object geometry which is defined as a set of connected points.Commonly,we call these connected points vertices.Each vertice of the mesh include some attributes,such as position,color,texture coordinates and so on.These vertices are connected into different forms,such as triangle,fan and strip.Then these connection information and attributes are sent as a completed vertex buffer to the graphics driver.

Since the scene is created out of geometric primitives. For further procesing, we traditionally use triangles as primitives because they always exist on a single plane.So that vertices are assembled into primitives(triangles) and attributes of triangles are gathered.

Now object is shown in terms of itself in 3D object coordinate.In order to transform vertices from 3D object coordinate space to 3D world coordinate space.We need to complete some transformations including scaling,rotation,translating and so on.

Then we can put a camera in the world and transform the 3d world coordinate system into the 3d camera coordinate system, with the camera as the origin.

Furthermore,because our goal is to render 3D geometry onto a 2D raster representation.So that objects are needed to be transformed from 3D into the 2d view of the camera,the object which is in the center of 3D view will still be in the center of the 2D view of camera.The distance between objects and camera will decide the size of objects shown in the 2D view of camera.For instance,we can divide the X and Y coordinates of vertices of primitives(triangles) by Z coordinate which represent the distance from the camera in the process of perspective projection.

After that,triangles are clipped against the view frustum and may be optionally culled front or back facing.Clipping is what you do to your fingernails,and you don't clip off your entire fingernail,you only clip off the portion of it that hangs over your finger.Culling is much easier because we just need to take out the entire thing which is outside of our camera view.So that clipping means that we just take off piece of something and culling is where you take out the entire object.

The whole process of these above transformations can be defined as a concatenated matrix of several transforms.Generally,we use vertex shader to achieve these transformations.

1.2 Rasterization

After the vertex shader,these triangles will be rasterized by scanning row by row and interpolating vertex attributes.Rasterization is the process by which the 2D image is converted into raster format and the correct resulting pixel values are determined. From now on, operations will be carried out on each single pixel.

1.3 Image

The results of rasterization are pixel fragments that are individually processed by fragment shader.At this stage of graphics pipeline,fragments

are assigned a color based on values interpolated from rasterization,from textures , or from a shader program.

Textures we use here can be some kind of actual image or some maps for surface lighting effects.In one word,textures are things that cover 3D geometry. Commonly,we are able to transform a bitmap image to an arbitrary plane of a given 3D model as a texture.

Finally,we compute the potential matching between each pair of fragments based on their geometry and color.Some novel multi-piece matching algorithm can be proposed to reassemble all these fragments.After that, we can use some graph optimization algorithm to refine the reassembly result.

1.4 Display

Normally,image data and image identification information(height, width, palette data, and color) will compose a complete image which can be displayed. But for saving storage space,different formats and mechanisms of image compression coding have been developed and widely used,such as GIF,BMP,TIFF and so on.

In general,programmable shading is a program that can run directly on a graphics processing unit (GPU). In other words,it resembles an assembler that enables you to send instructions to a central processing unit (CPU). Unlike the traditional fixed rendering pipeline.Without restrictions of the fixed rendering pipeline.A variety of image effects can be calculated and achieved with editable and programmable shading.This greatly improves the image quality.