libgraphics: Design and Implementation

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Introduction

Libgraphics is a 3D computer graphics library that provides a way to setup a scene, fill it up with a bunch of models (with their own meshes and materials), lights and cameras, and start taking pictures at the user request. It implements a fully concurrent retained mode software renderer, with support for vertex and fragment/pixel shaders written in C (not GPU ones, at least for now), a z-buffer, front- and back-face culling, textures skyboxes, directional and punctual lights, tangent-space normal mapping, ???

The renderer

The *renderer* is the core of the library. It follows a **retained mode** model, which means that the user won't get a picture until the entire scene has been rendered. Thanks to this we can also clear and swap the framebuffers without their intervention; they only need to concern themselves with shooting and developing a camera.

Its implemented as a tree of concurrent processes, connected by Channels as seen in **Figure 1**, spawned with a call to initgraphics(), each representing a stage of the pipeline:

- The **renderer** process, the root of the tree, waits on a channel for a Renderjob sent by another user process, specifying a scene, a camera and a shadertable. It walks the scene and sends each Entity individually to the entityproc.
- The **entityproc** receives an entity and splits its geometry equitatively among the tilers, sending a batch for each of them to process.
- Next, each **tiler** gets to work on their subset of the geometry (potentially in parallel, see **Figure 2**). They walk the list of primitives, then for each of them apply the **vertex shader** to its vertices (which expects clipspace coordinates in return), perform frustum culling and clipping, back-face culling, and then project them into the viewport (screenspace). Following this step, they build a bounding box, used to allocate each primitive into a rasterization bucket, **tile**, managed by one of the rasterizers; this is illustrated in **Figure 3**. If it spans multiple tiles, it will be copied and sent to each of them.
- Finally, the **rasterizers** receive the primitive in screenspace, slice it to fit their tile, and apply a rasterization routine based on its type (only *points*, *lines* and *triangles* are supported). For each of the pixels, a **depth test** is performed, discarding fragments that are further away. Then a **fragment shader** is applied and the result written to the framebuffer.

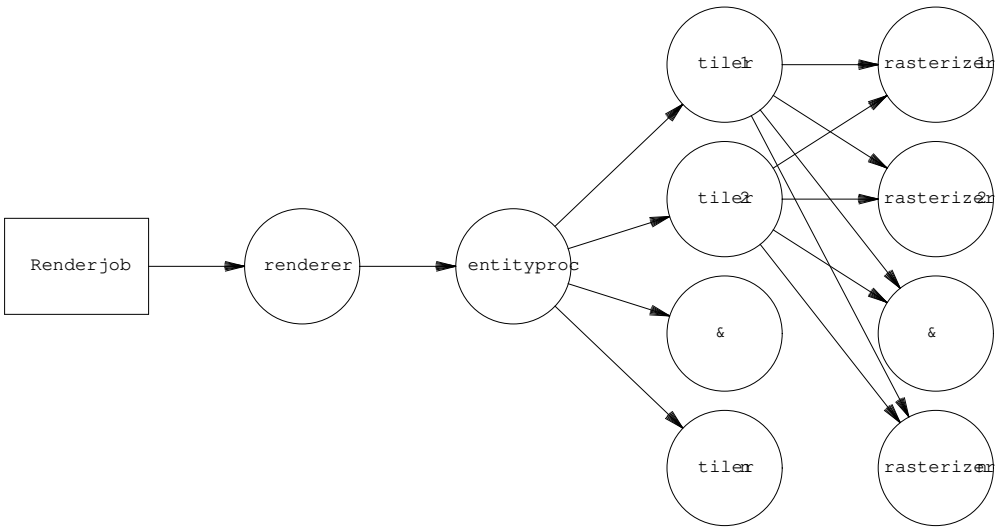


Figure 1 : The rendering graph for 2n processor machine.

Tile–based rendering

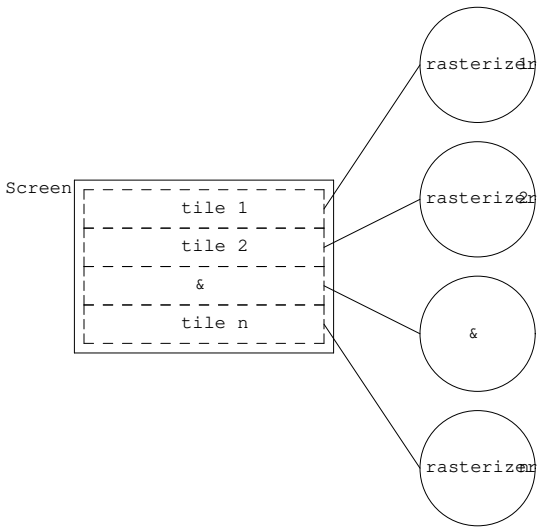


Figure 2 : Per tile rasterizers.

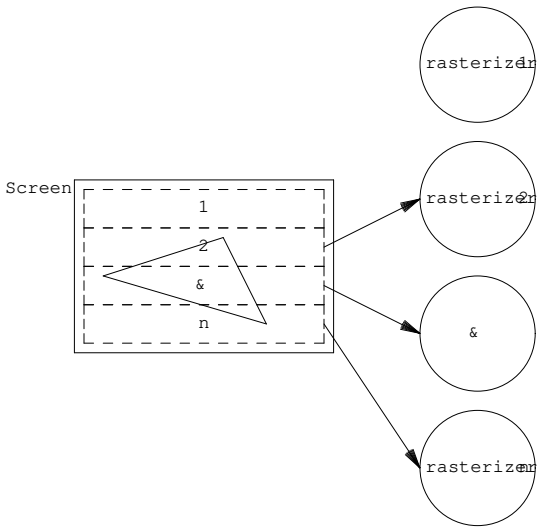
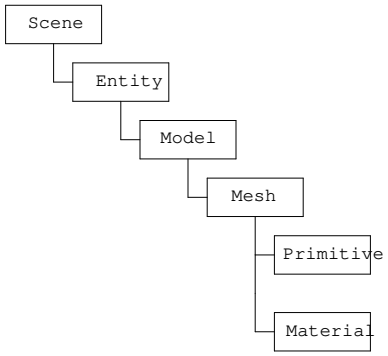


Figure 3 : Raster task scheduling.

The scene



Frames of reference

Frames are right-handed throughout every stage.

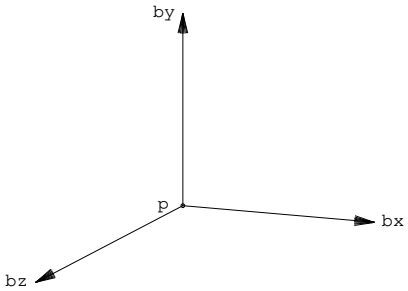


Figure 4 : Example right-handed rframe.

Viewports

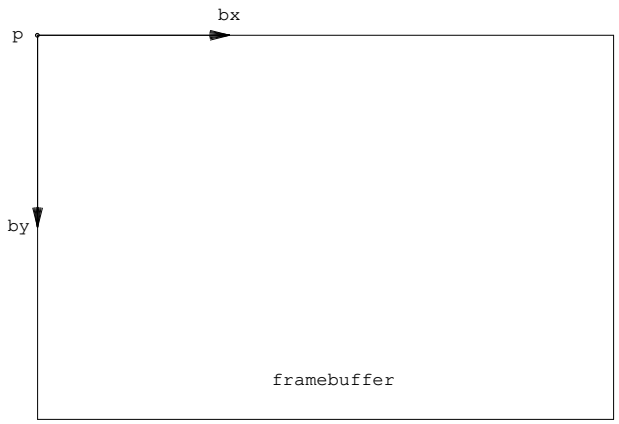


Figure 5 : Illustration of a 3:2 viewport.