Multipass Rendering

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Multipass Rendering uses Attachments -- What is a Vulkan Attachment Anyway?

"An attachment is an image associated with a renderpass that can be used as the input or output of one or more of its subpasses."

-- Vulkan Programming Guide

An attachment can be written to, read from, or both.

Subpass
Attachment
Subpass
Attachment
Framebuffer

Back in Our Single-pass Days

So far, we've only performed single-pass rendering, within a single Vulkan RenderPass.

Here comes a quick reminder of how we did that.

 Afterwards, we will extend that.

Back in Our Single-pass Days, I

VkAttachmentDescription vad[2];
vad[0].flags = 0;
vad[0].format = VK_FORMAT_B8G8R8A8_SRGB;
vad[0].samples = VK_SAMPLE_COUNT_1_BIT;
vad[0].loadOp = VK_ATTACHMENT_LOAD_OP_CLEAR;
vad[0].storeOp = VK_ATTACHMENT_STORE_OP_STORE;
vad[0].stencilLoadOp = VK_ATTACHMENT_LOAD_OP_DONT_CARE;
vad[0].stencilStoreOp = VK_ATTACHMENT_STORE_OP_DONT_CARE;
vad[0].initialLayout = VK_IMAGE_LAYOUT_UNDEFINED;
vad[0].finalLayout = VK_IMAGE_LAYOUT_PRESENT_SRC_KHR;
vad[1].flags = 0;
vad[1].format = VK_FORMAT_D32_SFLOAT_S8_UINT;
vad[1].samples = VK_SAMPLE_COUNT_1_BIT;
vad[1].loadOp = VK_ATTACHMENT_LOAD_OP_CLEAR;
vad[1].storeOp = VK_ATTACHMENT_STORE_OP_DONT_CARE;
vad[1].stencilLoadOp = VK_ATTACHMENT_LOAD_OP_DONT_CARE;
vad[1].stencilStoreOp = VK_ATTACHMENT_STORE_OP_DONT_CARE;
vad[1].initialLayout = VK_IMAGE_LAYOUT_UNDEFINED;
vad[1].finalLayout = VK_IMAGE_LAYOUT_DEPTH_STENCIL_ATTACHMENT_OPTIMAL;

VkAttachmentReference colorReference;
colorReference.attachment = 0;
colorReference.layout = VK_IMAGE_LAYOUT_COLOR_ATTACHMENT_OPTIMAL;

VkAttachmentReference depthReference;
deepReference.attachment = 1;
deepReference.layout = VK_IMAGE_LAYOUT_DEPTH_STENCIL_ATTACHMENT_OPTIMAL;
VkSubpassDescription vsd;
vsd.flags = 0;
vsd.pipelineBindPoint = VK_PIPELINE_BIND_POINT_GRAPHICS;
vsd.inputAttachmentCount = 0;
vsd.pInputAttachments = (VkAttachmentReference *)nullptr;
vsd.colorAttachmentCount = 1;
vsd.pColorAttachments = &colorReference;
vsd.pResolveAttachments = (VkAttachmentReference *)nullptr;
vsd.pDepthStencilAttachment = &depthReference;
vsd.preserveAttachmentCount = 0;
vsd.pPreserveAttachments = (uint32_t *)nullptr;

VkRenderPassCreateInfo vrpci;
vrpci.sType = VK_STRUCTURE_TYPE_RENDER_PASS_CREATE_INFO;
vrpci.pNext = nullptr;
vrpci.flags = 0;
vrpci.attachmentCount = 2; // color and depth/stencil
vrpci.pAttachments = vad;
vrpci.subpassCount = 1;
vrpci.pSubpasses = &vsd;
vrpci.dependencyCount = 0;
vrpci.pDependencies = (VkSubpassDependency *)nullptr;

result = vkCreateRenderPass(LogicalDevice, IN &vrpci, PALLOCATOR, OUT &RenderPass);

Back in Our Single-pass Days, II

Multipass Rendering

So far, we've only performed single-pass rendering, but within a single Vulkan RenderPass, we can also have several subpasses, each of which is feeding information to the next subpass or subpasses. In this case, we will look at following up a 3D rendering with some image processing on the outcome.

3D Rendering Pass Image Processing Pass Output

Subpass #0 Subpass #1

Multipass Algorithm to Render and then Image Process

Original Sharpened Edge Detected

No Noise

Noise

Multipass, I
VkAttachmentReference colorReference;
colorReference.attachment = 0;
colorReference.layout = VK_IMAGE_LAYOUT_COLOR_ATTACHMENT_OPTIMAL;

VkAttachmentReference depthReference;
depthReference.attachment = 1;
depthReference.layout = VK_IMAGE_LAYOUT_DEPTH_STENCIL_ATTACHMENT_OPTIMAL;

VkAttachmentReference outputReference;
outputReference.attachment = 2;
outputReference.layout = VK_IMAGE_LAYOUT_COLOR_ATTACHMENT_OPTIMAL;

VkSubpassDescription vsd[2];
vsd[0].flags = 0;
vsd[0].pipelineBindPoint = VK_PIPELINE_BIND_POINT_GRAPHICS;
vsd[0].inputAttachmentCount = 0;
vsd[0].pInputAttachments = (VkAttachmentReference *)nullptr;
vsd[0].colorAttachmentCount = 1;
vsd[0].pColorAttachments = colorReference;
vsd[0].pResolveAttachments = (VkAttachmentReference *)nullptr;
vsd[0].pDepthStencilAttachment = &depthReference;
vsd[0].preserveAttachmentCount = 0;
vsd[0].pPreserveAttachments = (uint32_t *) nullptr;
vsd[1].flags = 0;
vsd[1].pipelineBindPoint = VK_PIPELINE_BIND_POINT_GRAPHICS;
vsd[1].inputAttachmentCount = 1;
vsd[1].pInputAttachments = colorReference;
vsd[1].colorAttachmentCount = 1;
vsd[1].pColorAttachments = &outputReference;
vsd[1].pResolveAttachments = (VkAttachmentReference *)nullptr;
vsd[1].pDepthStencilAttachment = (VkAttachmentReference *) nullptr;
vsd[1].preserveAttachmentCount = 0;
vsd[1].pPreserveAttachments = (uint32_t *) nullptr;