**Optimizing the TestTask**

This is a (hopefully) short overview of how I optimized the TestTask. For reference, this was done on a machine running an Intel Core i7 6800k @ 4.1GHz and an Nvidia RTX3070 @ 2160MHz Core/8170MHz Mem.

All profiling was done in the editor to save some time, as I assume what matters is this task is relative performance difference between pre and post optimization scenes. Framerate smoothing and VSync have been turned off.

I first wrote a quick C++ class for running a consistent benchmark. This moves the character and camera around for a few seconds while logging frametimes. I left this in the project, and it can be triggered using the B key. It's only made to be used from the starting position and will not work properly anywhere else.

From initial benchmarking, it's clear the bottleneck is on the GPU thread, and the main culprit is the massive amount of overdraw and transparency effects. The greatest offenders were the foliage layer and the SM trees. Hence, the first look was at the tree model's LOD and Material settings. I optimized LOD0 slightly by removing some of the leaves, and created 4 aditional LODs and an opaque leaf texture that is used for all levels beyond 0. Dynamic shadow casting was disabled for foliage trees.

Next I took a look at the grass and its material. The original model was incredibly dense, so I replaced it with a low geo model while still retaining the 3D look, and added two LODs. I manually UV'd and lightmapped the new model, since the original had maps of its own as well, however, since no texture was used, I was not worried about matching the maps. LOD2 has a simpler material (simple opaque lit material, without the world position offset network, since the player won't go near it), and the original grass material was slightly tweaked.

The last adjustment in terms of foliage was the actual amount of things in the scene. Impossible to see trees and grass was removed to make things a bit more reasonable.

Further tweaks were made to objects in terms of shadow casting, the two directional fill lights were removed since they added a lot to the lighting complexity while providing very little effect, the coin occlusion texture was fixed, and it, metallic and roughness were merged into a single texture. The coin animation was removed from the level blueprint and changed to a simpler shader-based one. The original material had the occlusion map connected to the metallic channel, so I preserved this.

LODs were also added to the houses, the ones in the distance were merged and simplified, and some of the house materials were tweaked slightly. SM trees were also grouped together.

Final benchmarks are as follows. They were done in standalone mode, with the editor minimized:

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| **Original Build** | |
| FPS | 50,95 |
| GPU Thread | 19,59ms |
| Render Thread | 7,67ms |
| Game Thread | 1,89ms |

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| **Optimized Build** | |
| FPS | 143,48 |
| GPU Thread | 6,91ms |
| Render Thread | 5,25ms |
| Game Thread | 1,63ms |

In terms of further optimization, I'd look at material usage next. Some of the house materials are very similar and could be redone as instances, and beyond that, with a proper UV layout and masking, for example, the material slots could be significantly reduced, thus bringing draw calls further down. The same process could be applied to the trees.

I did a few changes to some materials, such as the grass and landscame materials that I am not so sure would go over well. In a real world scenario, I'd have to ask other artists if those changes were acceptable or not. The same goes for the coin animation, which could require a proper animation to be set up, lighting changes and the final look of the coin material. I also reorganized the scene to make it easier to navigate, but am also not sure this would fall within my responsibilities.

Nanite, a proper HLOD setup and more conscientious usage of foliage could also bring frametimes further down. I did not use a distance culling volume, but it could also help with hiding some of the faraway foliage when not necessary.

Regardless of whether this test is a pass or a fail, if possible, I would love to get some feedback on what I could improve. Thank you very much!