Screen Space Decals in Warhammer 40,000: Space Marine

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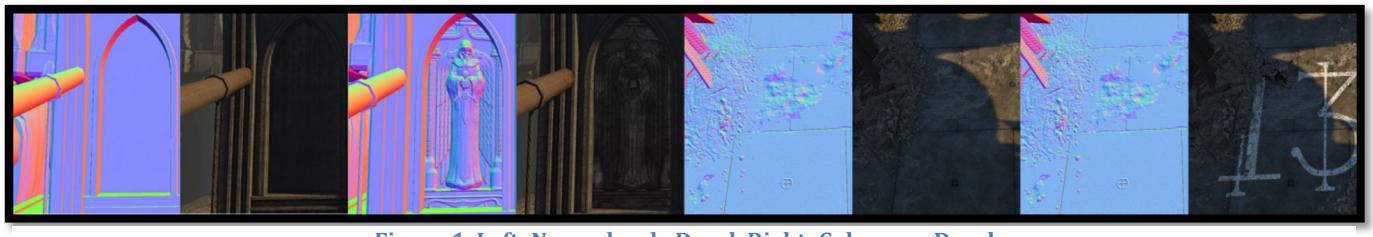

Figure 1. Left: Normal-only Decal, Right: Colour-on Decal

1 Introduction

Traditionally, a decal is drawn as a textured mesh patch duplicated from the underlying geometry. This works most of the time, but often suffers from various problems, such as Z-fighting between the underlying mesh and the duplicated decal mesh and stretched decal textures when the underlying mesh has sparse vertices.

The most notable previous work in this area is Volume Decals by Emil Perrson. This technique projects a convex volume mesh onto the underlying geometry, stored in a depth buffer, and applies a volume texture on the pixels rasterized onto the screen. This approach solves the problems described above, but we couldn't use it because we already had implemented the full 2D screen-space decal technique and had been using it in-game for about 2 years by the time his paper was published, at which point we looked into it but found out that our approach was more suitable for current-gen console games, such as Space Marine due to the memory footprint of volumetric textures. Furthermore, we also found that artists are very reluctant to author volume textures mostly due to the lack of acceptable volume texture support from mainstream art packages.

2 Screen Space Decals

Our approach uses a simple 3D box (projection box) mesh and 2D textures to achieve the same visual goal with a lower memory footprint and better artist workflow. Also we observed other unexpected benefits which will be described later.

Once the geometry buffer pass is rendered, we project a 3D box mesh onto the depth buffer to find the local position of each pixel in the local space of projection box. Once the local positions are calculated, we run two rejection passes: out-of-box rejection and orientation-based rejection. Orientation-based rejection is intended to solve the inherent side-stretching problem of 2D texture projection. We sample the normal from the underlying geometry and perform a simple dot product operation to reject any pixels which are facing away more than a certain angle, which is defined by artists on each decal. This allows different decals to have different stretching tolerance.

With our deferred lighting renderer, we also managed to support three different types of decals, such as decals modifying underlying geometry normals only, decals modifying underlying albedos only and decals modifying both normals and albedos. This greatly improved the re-usability of existing decals.

3 Results

Our new decal system removed the visual glitches of traditional decals and the complexities involved in authoring volume decals. Also we successfully implemented a few switches artists can easily turn on and off. This allowed our artists to go through more iterations very quickly and reuse existing decals with tweak-able decal types and cut-off angles. These techniques helped us achieve an excellent visual quality for Warhammer 40,000: Space Marine.

4 Other Benefits

Other than better visual quality and simpler artist workflow, we also observed two other benefits that we did not intend to achieve originally. The biggest unexpected benefit was that our collision detection pass became much faster since there was no need for high-resolution collision meshes to support the duplication of fine mesh patches for traditional decals. At the end, most of the collision meshes became very basic shapes.

With the deferred lighting engine, supporting transparent objects on current-gen console was not trivial. At the end, we used Screen Space Decals to support 90% of our transparent objects which are not particle effects. This was possible only because most of our transparent objects were essentially co-planar.

5 Conclusions

We successfully implemented Screen Space Decals with a 3D box mesh and 2D textures to solve the problems with existing decal techniques and to simplify artist workflow, both of which contributed to the enhanced visual quality of Warhammer 40,000: Space Marine.

References

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