

ACCELERATING VISUALISATION IN VIRTUAL COLONOSCOPY

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Abstract - This paper presents a novel method to accelerate volume ray casting as used in virtual colonoscopy. The method exploits a pre-processing visibility technique to identify the potentially visible portions of the colon. Then it applies a space leaping technique based on the projection of the visible boundary voxels of the colon onto the image plane. The method has been tested using a synthetic data set and an average speed up of five times have been observed compared to basic ray casting.

I. INTRODUCTION

Colorectal cancer is the second most common cause of cancer deaths in industrialised societies. Virtual colonoscopy was introduced by Vining as a less invasive screening technique for colorectal cancer [1] and it has been reported that virtual colonoscopy using volume rendering is more sensitive and specific compared to the use of surface rendering [2]. However, the significant computational resources required for volume rendering prohibit its interactive use. In our previous work we reported on an acceleration method in which the space inside the colon is approximated by spheres and in the ray casting process this approximation is used to traverse the space efficiently [3]. In this paper we present an improved method based on combining a novel visibility determination technique with space leaping.

II. OVERVIEW OF THE METHOD

Our approach is to find the exact distance from any image plane pixel to the closest boundary voxel which intersects with the ray cast from that pixel. This distance is then used to start ray casting from an object boundary voxel. This distance is found by projecting all visible boundary cells on to the image plane, using a visibility algorithm devised for virtual colonoscopy.

A. Visibility Determination

The method determines which boundary voxels can be seen from the image plane. For maximum efficiency this is determined in a pre-processing step. We divide the colon into consecutive sections and then determine the visibility between these sections. When the image plane is inside one section, only those sections visible from that section need to be considered.

Our algorithm divides the colon into sections based on the curvature of the colon's centre line. The end of a section is specified by a portal (i.e. a cut plane whose boundary is the colon wall and which is perpendicular to the colon's local direction). We used a method based on the distance transform value at the colon centre line to find portals of minimum area (i.e. where the colon is narrowest). Figure 1 illustrates a synthetic colon divided into sections using this algorithm. The method then

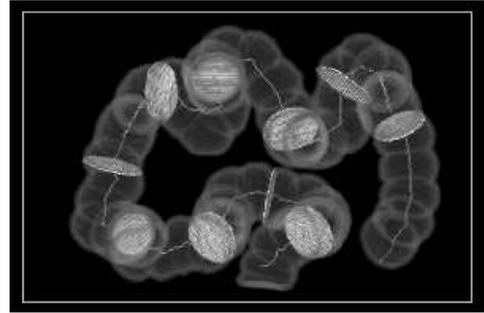


Figure 1 – The colon divided into sections

determines which sections are visible from any particular starting section. Our algorithm examines the visibility between portals to determine the visibility between sections.

B. Projection and Rendering

Before rendering each frame the boundary voxels of the visible sections and the section where the image plane is located are projected onto a distance buffer (z-buffer). During the ray casting process, as the image plane is constructed pixel by pixel, the corresponding entry in the distance buffer is used to skip the space and start the ray casting from a boundary cell.

III. RESULTS & CONCLUSION

We performed an animation based on the centre line of the colon and observed a five times acceleration compared to basic ray casting. The results were obtained using a personal computer with a synthetic colon. Pre-processing (i.e. calculating the distance transform and determining the visibility, etc) took approximately 40 seconds.

Our method represents an improved performance over previous methods from Wan et al [4] and Hong et al [5]. Finally, our method has potential for wider use and is not limited to virtual colonoscopy or even virtual endoscopy.

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