Depth-map Computer Generated Holograms Algorithm for Reducing Fast Fourier Transform Computation Steps using Localization Method

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1. Introduction

Holography is a technology to record and reproduce information of an object by using the phenomenon of light interference, and it is the ideal goal of the next generation 3D display. The Computer Generated Holograms (CGH) can be generated by various methods such as point cloud [1], polygon [2], and depth-map methods [3]. The Depth-map method is more efficient for calculating curved and complex objects than other methods, and can generate 2D intensity and depth information images without the need for an image conversion process. However, the Fast Fourier Transform (FFT) computation amount increases considerably depending on its resolution, it is necessary to develop a CGH generation engine equipped with the reducing algorithm for FFT computation in order to process in high resolution and moving 3D contents. In this paper, we introduce the localization method that can speed up the content generation by reducing the FFT computation amount in the depth-map CGH generation process.

2. Localization Method

When generating depth-map CGH, FFT calculation is the factor that has the greatest impact on the amount of computation, depending on resolution. Therefore, the calculation efficiency is improved by using the localization method which dividing the calculation area of the input 2D image. As shown in Fig.1, when the 2D image of N x N resolution is calculated by 2D FFT and the localization method as as the m x m fragment, the complexity becomes $N^2 \log_2 N^2$ and $N^2 \log_2 N^2 - N^2 \log_2 m^2$, respectively. The complexity is reduced by $N^2 \log_2 m^2$, and it is possible to perform more efficient calculation for high resolution.

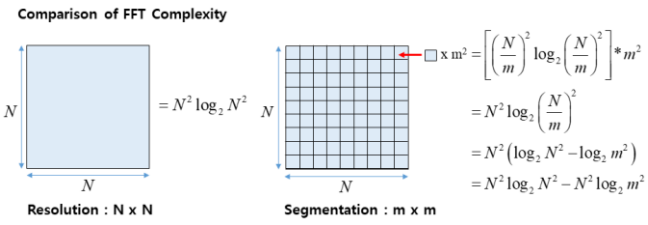

Fig. 1. Comparison of FFT complexity for conventional and localization method.

When the image is calculated by localization method, it is necessary to calculate the CGH of each piece and then stamping it again. At this step, it is confirmed that the diffraction pattern occurs at the boundary regions of the stamped image because the information of the diffraction at the boundary of the stamped CGH is not properly combined. Therefore, we have to add zero-padding to the image of each piece and synthesize it by superimposing the diffraction range.

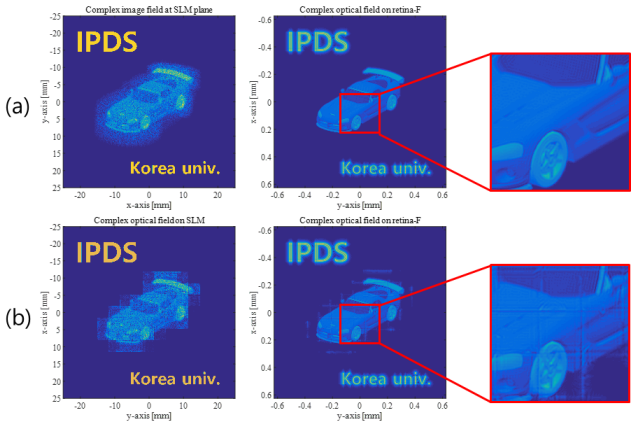

Fig. 2. Boundary diffraction pattern problem (a) conventional method (b) localization method

3. Conclusions

In this paper, we propose an accelerating method to reduce the FFT complexity using the localization method of Depth-map CGH. And we compare and analyze the results of our simulation with conventional methods.

References

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