Massively Parallel Processing for Monte Carlo Ray Tracing

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1 Introduction

Now, the image sysnthesis technology in the computer graphics is used in a variety of applied fields like the movie, construction, and the game and the simulation, etc... The image sysnthesis technology especially used for the movie, can synthesize the realistic image, that real or CG is not understood. It is important that a point sampling algorithm uses the Monte Carlo ray tracing in a realistic image sysnthesis. It is known to cost a huge calculation to obtain the high quality image by the Monte Carlo ray tracing method, and it is very useful to be able to solve this at high speed. Moreover, the problem besides parallel computation the sampling problem. In the Monte Carlo ray tracing, it appears a noise in the image if sampling is insufficient. Therefore, it is necessary to take a lot of samples, and, as a result, the calculation cost grows.

In this research, we proposes the parallel variance balanced algorithm to solve the above-mentioned two problems caused the Monte Carlo ray tracing. As a result, a useless sampling is omitted, and the system can do a high-speed parallel processing.

2 Basic of Rendering Algorithm

Rendering is to synthesize the image from numerical values of geometry data and light sources, etc. In a realistic image synthesis, light energy propagation is treated by a physical simulation called "global illumination". This energy is reflected by defining BRDF that is the bidirectional reflectance distribution function on the surface of the object, and this propagation is formulated as a rendering equation. The rendering equation is an integral equation, and the Monte Carlo integration is used to solve this. The algorithm of the rendering equation solved by Monte Carlo integration is called the Monte Carlo ray tracing, and becomes the most important method in a realistic image synthesis, now. In this research, the parallel rendering system is constructed by using the path tracing that is a kind of this Monte Carlo ray tracing.

3 Parallel Rendering

It costs a large calculation to rendering, especially using the ray tracing. Therefore, the method of speed-up of rendering are researched, and the parallelization is enumerated as one in that. And the approach of parallelization changed by problems for solution.

In related works, parallel rendering can be divided roughly into two kinds (the image space subdivision and the object space subdivision). This corresponds to a demand drive model and a data parallel model, and is a model of a basic parallel computing. Today's parallel computer system offers an enough amount of the memory, and doesn't feel the necessity for subdivide the object space as long as it is not very big scene data in a single processor. Then, we use the technique of parallelization that is based by the image space subdivision in this research.

4 Parallel Variance Balanced Algorithm

In parallelization by image space subdivision, it is difficult to controll the task, because image space had treated with pixel or set of pixels as a unit task. It is difficult in the Monte Carlo ray tracing to keep the loading

balance between pixels by the influence of the sampling technique. There is a large difference in the computational complexity in each pixel by the difference of the number of polygons of scene, and a large amount of ray is needed to sample the pixel.

In this chapter, to solve this problem, we proposes the parallel variance balanced algorithm. This is a technique for keeping the constant image quality in the time slice, while rejection a useless sampling in the pixel by dividing the evaluation of the variance of each pixel in the small layer. This is achieved by making it from the image space to the sample space subdivision that is the more small parallelization size. This technique is implemented and evaluates, and the validity of the proposal technique is shown.

5 Performance Evaluation

In this chapter, the parallel variance balanced algorithm is evaluated from the viewpoint of parallelization and adaptive sampling.

In the evaluation of parallelization, there was a change at the processing speed, between proposed and previous algorithm. In the adaptive sampling, pixel rejection scheduling is generated. The schedule part is overhead, and to slow compared with the previous technique in the scene with little number of polygons. However, when the scene with large number of polygons, an excellent scalability is shown so that the processing cost per task may increase.

In the evaluation of adaptive sampling, concentrating the computation resource on the pixel with large variance value became possible. As a result, to controll sampling process became possible, but the perceivable big difference did not appear in the synthesis image, to our regret. A little more verification is necessary because there is a possibility when the seen data is changed.

6 Conclusion

In this thesis, we proposed, as one proposal of parallel rendering using the Monte Carlo ray tracing, the algorithm that concentrates the computation

to large variance pixel of the image. In parallelization, an adaptive sampling can be done by the pixel decentralization by selecting an appropriate sample grain degree without dropping the quality of the processing speed and the scalability, etc. Moreover, a very good loading balance can be kept by dynamic task demand by the Master-Slave method. In the adaptive sampling, it succeeded that concentrating the computation on the pixel with a large variance.