Implementation of Radio wave propagation loss calculation using RT core

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1. INTRODUCTION

In recent years, GPUs have shown remarkable performance improvements and are used as computation accelerators in various fields such as numerical simulation and machine learning. On the other hand, some recent GPUs are equipped with dedicated hardware that enables high-speed ray tracing processing, which was not possible in the past. Since ray tracing processing can be applied to applications other than image rendering, we are planning to use it in the field of computational science.

In this study, we implemented the computation of radio propagation loss using the ray tracing acceleration hardware (RT core) of the NVIDIA GPU by using OptiX programming environment. The performance was evaluated by comparing with CPU using OpenMP and GPU using OpenACC.

2. IMPLEMENTATION

2.1 RT CORE

The RT core is hardware that accelerates ray tracing processing [1]. The RT core takes care of some of the calculations for the ray tracing process, which speeds up the overall process.

2.2 OPTIX 7

The NVIDIA OptiX 7 API is an application framework for achieving optimal ray tracing performance on the GPU [2]. OptiX 7 programming model is illustrated in Figure 1. Except for the hardware acceleration part, which is represented in green in Figure 1, we need to write our own description. The data structures and program flow handled by OptiX 7 are very different from those of ordinary scientific computing programs.

2.3 RADIO WAVE PROPSGSTION LOSS CALCULATION

The radio wave propagation loss calculation is a calculation used to easily estimate the characteristics of radio waves emitted from an antenna or the like. The idea of ray tracing can be applied to this calculation [3]. Therefore, in this study, we implemented the computational part where ray tracing can be used.

3. PERFORMANCE EVALUATION

The performance evaluation environment is as follows.
- **CPU: Intel(R) Core(TM) i7-7700 CPU @ 3.60GHz**
- **GPU: NVIDIA GeForce RTX 2080 super**
  - Driver Version : 470.82.00, CUDA version : 11.4
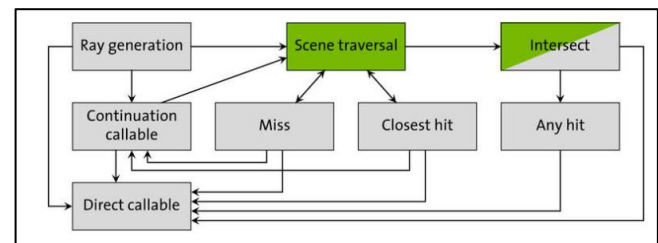- **OS : Ubuntu 20.04.3 LTS**

Table 1 shows the execution time for each problem size with different implementations of radio wave propagation loss calculation.

The problem size corresponds to the number of iterations of the ray tracing calculation, and is expressed in two dimensions as (a,b). From the table, we can see that implementation on the RT core with OptiX 7 is the fastest for any problem sizes.

To utilize RT core in computational science applications, the differences between OptiX and ordinary programming models are important issue. To solve this issue is our important future work.

Table 1. Execution time of Radio wave propagation loss calculation by size for each implementation

Size	OpenMP	OpenACC	OptiX 7
(2500, 1250)	0.0825[s]	0.0123[s]	0.000816[s]
(5000, 2500)	0.326[s]	0.0457[s]	0.00304[s]
(10000,5000)	1.32[s]	0.16[s]	0.0349[s]
(20000,10000)	5.33[s]	0.628[s]	0.0499[s]

Figure 1 OptiX 7 programming model [2]

REFERENCES

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[2] NVIDIA https://raytracing-docs.nvidia.com/optix7/index.html (Accessed Nov. 22th 2021)

[3] M. Kusaka. 2017. Speed-up techniques for ray tracing on the analysis of indoor radio propagation characteristics, Doctoral Dissertation, Chiba University, pp.79. (in Japanese)