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COMPARISON OF GPU MULTI-AGENT PATH PLANNING ALGORITHMS

Aldarmini S. (ITMO University)
Scientific supervisor – associate professor, doctor of technical sciences, Kolyubin S. A.
(ITMO University)

Abstract. In this research, we focus on making a comparative study between the path planning algorithm for multi-agent systems that are compatible with the GPU, regarding the main criteria like the success rate of the algorithm for finding a valid solution, the scalability of the algorithm, its run time compared with the CPU for a small number of agents and a big number of agents.

Introduction. Path planning for multi-robot systems has received huge interest from the scientific community because of its wide engineering applications. For instance, effective path planning in warehouse systems allows efficient use of the system resources like the storage space and load capacity of the robots [1]. Path planning algorithms for a group of robots have been proposed by many of the works [2]. However, the real-time execution of many multi-agent path planning algorithms is still questionable when the scale of the system increases dramatically. A promising solution is this problem is to depend on the GPU for multi-agent path planning. The GPU represents an effective tool to implement algorithms using parallel threads that are being executed simultaneously. However, the effective utilization of the GPU in non-graphical applications, such as route planning, is still a growing field (see for example [3]–[8]). Conducting a comparative study for existing path planning techniques using GPU, where the multi-threading property of the GPU is exploited, is a justified step toward developing efficient GPU multi-agent real-time path planning algorithms.

Main part. The main goal of implementing the path planning algorithm on a GPU is to speed up the path planning task. However, different scenarios can result in different performances for the algorithms. In other words, the speed-up acquired by the execution a path planning algorithm on a GPU might be hugely affected by the scenario that is taken into consideration. Regarding this fact, we focus on the following criteria:

- The success rate of the algorithm for finding a valid solution considering a variable number of robots in the systems.
- The scalability of the algorithm regarding the number of agents. That is, we consider the ability to increase the number of agents with a reasonable resource for the GPU like the memory.
- The run time when executing the algorithm. That is, we consider the required time to find valid paths for the agents taking into account a variable number of robots in the systems.
- The existence of a collision avoidance mechanism that plans the paths between the agents without collision.
- The suggested enhancements make the algorithm more suitable for some requirements that are not considered in the algorithm like collision avoidance between the agents.

Conclusion. The comparison between the algorithms shows that the existing GPU multi-agent path planning algorithms show non-unified performance because the parallelization degree of the algorithms is not similar, i. e. the ability to exploit the multi-threading property of the GPU is not the same for all the algorithms. However, a combination of the different parallelization techniques is a promising solution for speeding up the path-planning algorithms.

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