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Algorithmic minimization of requirements for computing resources of technical systems of intelligent information processing in the field of 3d modeling

In the 3d printing industry, urban planning and many other areas, technologies for scanning space using photogrammetry methods are used. This method involves collecting photos and then calculating the intersecting details on them.

At the moment, a large amount of computing resources is spent on 3d scanning of the surrounding world. Moreover, the resulting models contain a large amount of redundant information, such as a huge number of vertices.

It is proposed to apply approximation algorithms and the technique of computing ordinary problems on the GPU for this problem. The result of the optimized algorithm should provide a reduction in the number of processed points of the model, and, consequently, a reduction in the computational complexity of working with them.

In the process of studying the effectiveness of algorithms for processing three-dimensional data, 4 code variants were implemented:

1. Sequential traversal of all data
2. Parallel data traversal using gpgpu
3. Sequential data processing using approximation
4. Parallel data processing using approximation and using gpgpu

For performance testing, sequential implementations of the algorithms were performed on a general-purpose processor. Parallel versions of the algorithms use a GPU.

The results of running all implementations are shown in Figures 1 and 2. As a general-purpose processor, the AMD Ryzen 3 2200G is used, as a graphics processor, the AMD Radeon Vega 8 video core is built into the same processor. It can be seen that on small (less than 4 thousand triangles) three-dimensional models, the processor has an advantage in execution speed. At the same time, with an increase in the number of processed geometries, parallel implementations of algorithms have an increasing gain in execution speed.

Features of the architecture of GPUs, such as a lot of small identical execution units, predictable work with memory, efficient implementation of multithreading, allows parallel implementations of algorithms to work faster with a large amount of similar data. However, at low volumes, the effectiveness of this approach makes no sense, since it takes additional time to transfer data from the general-purpose processor to the video core. In the 3d printing industry, urban planning and many other areas, technologies for scanning space using photogrammetry methods are used. Photogrammetry uses methods and techniques of various disciplines, mainly from optics and geometry.

In the simplest case, the spatial coordinates of the points of the object are determined by measurements made from two or more photos taken from different positions. At the same time, common points are found on each image. The line of sight is then drawn from the camera's location to a point on the object. The intersection of these rays determines the location of the point in space. More complex algorithms can use other information about an object that is known in advance: for example, the symmetry of its constituent elements, which in certain cases allows us to reconstruct the spatial coordinates of points from only one photographic image.

The algorithms used in photogrammetry are designed to minimize the sum of the squares of the error set, which is usually solved using the Levenberg-Marquardt algorithm, which is based on solving nonlinear equations by the least square’s method.

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