Development of Parallel Algorithm for Element-Free Galerkin Method

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A large-scale problem is taken up by the advancement of the computer in recent years in the field of the numerical analysis. For the analysis,the difference method and other analysis technics are used, and there are a lot of things to use the finite element method especially by the complex flow scene and structural analysis. The finite element method(**FEM**) can simulate the behavior even of the problem of the complex flow and structure so long as the shape and the boundary condition are made clear by high accuracy. In addition, the calculation technique and the algorithm are advanced in accuracy and high-speed to obtain the solution by the thing to do the parallel processing with a super-parallel computer and the research is advanced. Most of the calculation is a systematized matrix operation, and a suitable calculation technique for the computer though the finite element method needs a lot of amounts of the calculation.
However, if the analytic model, the mesh division, and the calculation condition, etc. are incorrect, the thing not obtained is faults of the finite element method in the result with good accuracy. Especially, the thing for the quality of the mesh division to control the quality of the result directly is known. The part by the experience is actually large though how etc. to put the mesh to which accuracy improves are researched.

Therefore, large time will be spent in the preparation stage where the calculation condition is set though the calculation speed of the analysis has improved by the development of the computer. The problem will be a important problem that become more large-scale problem and the cost of the preparation for the mesh with good accuracy, because it is thought to complicate more and more in the future. Only the analytical execution person defines the area if the auto partition technique of the area researched in recent years is used, and element division and lattice division necessary for the analysis will be generated

automatically.

On the other hand,to reduce the complexity of the preparation for the analysis, **the mesh-less method** which does not need the element division is actively researched. Element-Free Galerkin Method (below **EFGM**) can put up seamless correspondence to the Galerkin method which is finite element analysis in the mesh-less method.
This method is not to need the mesh division where the labor is required for the preparation by finite element analysis like the name, and do the thing to arrange only the node freely. If the node is arranged even if it is a difficult model to set up the mesh, it will be possible to calculate, and the labor which hangs in the preparation for the analysis can be reduced. But it takes a lot of time for EFGM to calculate the interpolation function compared with the general finite element method.Because it is necessary to have to retrieve the node around the integration point. Time is needed for the calculation by there are a lot of numbers of nodes because the retrieval is done in each integration point. Because the memory is consumed, it is thought no so much good policy though the retrieval time is not wasted if information on the endpoint node on each integration point is memorized.

In this research, making EFGM parallel is assumed to be the final target and the research is advanced. The reason for doing of shortening the retrieval time around the integration point and shortening the making time of coefficient matrix is to be imagined easily if EFGM is made parallel.
However,the thing whose free node arrangement and relation of the radius of 'Support'are problems was understood from the experiment as a problem of EFGM before that. EFGM chooses the node around the integration point according to the distance which is called the radius of 'Support'. If this radius of Support is large, a lot of nodes will be included. However, when too a lot of nodes are included, the allowable error to obtain the solution is exceeded. Then, the method of controlling the radius of Support from the number of nodes with EFGM oppositely in each integration point was proposed. Being able to decide the radius of Support easily compared with fixed that, and obtaining the solution no fixation by this changeable radius of Support in tolerance became easy.
Before it became making to parallel, Burgers equation was assumed to be an one-dimensional nonlinear problem,2-dimensional Poisson equation and Navier-Stokes equation and a continuous expression as a problem of the incompressible fluid flow were analyzed by EFGM. Moreover,the verification was advanced while actually adjusting about a changeable radius of Support. It verified by the thing to calculate the two dimension non-compression steady flow of making of EFGM a final target parallel.

By the way,making as EFGM to the parallel is just making of the calculation of the basis function. Because, if the calculation of the basis function is excluded, the procedure in the calculation with a general Galerkin method does not have the difference. However, it is a problem the parallel computation is done that the node included in the thing and the radius of Support with a free node arrangement changes. In addition, it becomes a problem with an important area division from the viewpoint of diversification of loads. It thinks about the area division according to node density of each area method.