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Parallel Numerical Algorithm for Natural Element Method

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There are two distinct alternative kinds of specification of flow field. The first, usually called the Eulerian type, is like the specification of an electoromagnetic field in that the flow quantities are defined as function of position in space and time. The primary flow quantitiy is the velocity of the fluid. This Eulerian specification can be thought of as providing a picture of the spatial distribution of fluid velocity at each instant during the motion.

The second, called Lagrangian type of specification, makes use of the fact that , as in particle mechanics, some of the dynamical or physical quantities refer not only to certain positions in space but also to identifiable pieces of matter. The flow quantities are here defined as functions of time and of the choice of a material element of fluid, and describe the dynamical history of this selected fluid element.

At that time, the mesh is fixed the space in Eulerrian method. But in the case of Lagragian method, the node moves in the space as the time-step progresses. For that reason, the mesh nodes is changed every time-step. In addition, the triangulation may collapse greatly.

An example is the case of advection in which the mesh nodes are attached to a deforming medium. Although an evolving mesh allows for material properties to be accurately transported at the nodes, large displacements quickly result in severe mesh distortion which in turn increases numerical instability and restricts accuracy.

Therefore, the Eulerian method is used in computational fluid dynamics. In eulerian techniques, since the nodes is fixed, the spatial mesh need not to be made to change. However, it is expected to deal with the problem of a big transformation and a free surface.

Natural Element Method is a new Lagrangian method which overcomes these problems proposed Jean Braun et al. This method is based on the fundamental geometrical concept of natural neighbours. The result is a the method which can be applied to problems where traditional eulerian and lagrangian techniques fail; for example, those involving large deformation, or fluid-solid interactions, The two essential features are the way in which both the mesh nodes and the connections between nodes are updated during the calculation to maintain an appropriate well shaped triangulation, and the use of natural neighbour interpolation and their derivatives to interpolate smoothly between arbitrarily distributed nodes. They use a two dimensional example of a sinking elasto plastic plate in a linear viscosity fluid to illustrate these features.

But, the method is required the longer computing time. Because the method is required the mesh nodes and the connections between nodes are updated every time-step and much arithmetic operations to make a matrix for the Natural Neighbour Interpolation. For these reasons, the method is expected to use the way of parallel computing.

The discretization done by using the flow velocity fractional method and the discretization is done by using the Galerkin method which was approximate analysis based on the method of weithted residual by using equation of motion and a continuous expression as a basic equation about time aout the space.

In this research, the calculation of the intermediate flow velocity, pressure, and the velocity was made parallel by using the parallel computer Cray-t3e. Moreover, the domain decomposition is used as a parallel computation technique and an analytical area is divided into the number of processor element(PE). At this time, the attention is to equal the load in each PE.

As an alalysis example, the flow of column surroundings in the steady state is alalyzed. An analytical result confirmed the flow which correspoinded to the Reynolds number 100.

The speed-up ratio is used as a standard by which this parallel algorithm evaluation.

Next, the speed-up ratio is examined between all calculation execution time in this parallel argorithm.

In this paper, we propose the parallel numerical algorithm for Natural Element Method using domain decomposition. Next, we propose the examination of scalability in the parallel algorithm for NEM about the above-mentioned viewpoint.