Numerical Simulation of Navier-Stokes Equation Based on Object Orientation

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Abstract

A Background and Purpose

It will require a great deal of labor to write a program for a computer to solve some complicated flow,such as flow with complicated shape,flow with heat transfer.In spite of the above effort,the constructed program is no use against the extension to applied some other analysis of problems.Whether we can trust in simulation or not we cannot still establish. To find a way of the above problems the simulation on object orientaion have been studying.But no excellent results have obtained yet.

The theory of the finite difference equations on object-oriented methodology is proposed by Hatakeyama and others.But the lines to solve some complicated flow,with complicated shape,with heat transfer,e.t.c. are not laied down.

This paper describes the study of numerical simulation based on object orientation.In this study,for the purpose of solving the above problems the object-oriented conception is introduced for the flexible and accuracy modeling.Consequently,it is demonstrated that the proposed model are more flexible and higher trusted than the past model.

Modeling System

First,we set grid point at infinitesimal volume object and we simulated heat transfer problem of Poisson equation in this model.It is confirms that the model on object orientation can be used in simulation.

In order to simulate Navier-Stokes Equation,we proposed object model with discretized equation in MAC(Marker and Cell) Method into class method. Supperclass,that is, grid object class lead subclass,here pressure class, velocity class to its class in relation to physical. Subclass inherite some special property such as class,attribute,method to Superclass.

This object model is extended to the model to be able to treat heat transfer problem.temperaure object class is added to the object model. In this step,the problem that proposed model can hardly deal with some flow with complicated shape.In addition,generally there is one problem that execution time is late as grid object number increase.

we try to improve model more flexible and efficiency with the intension of application in complicated flow and getting high performance to parallel calculation. For the reason,the domain in original target world is setted at the domain object.The relation between grid object and domain object is aggregate.Using this model in connection with module,it is expected that the inner compicated management is hidden under information hiding effect, that is,the complicated management is diminished to a minimum.

Result

Obtained result in this study is described in that follow intermittently.

(1) Constraction of much higher reliable model by inducing some subclass from superclass,grid class in relation to physical

(2) Flexible extension of the above model in the problem heat accompanied

(3) Much higher reliance of extended model compared with the past model to receive benefit of reuse from the above model

(4) Reducing of complicated management by information hiding effect to aggregate between domain class and grid class

(5) Flexible modification to flow with complicated shape to take some domain object instance.

(6) Possible execution of local heating on domain object in relation to the above model

(7) Possibility of parallel calculation to asign one or some domain object to one processor

It is mensioned from result(1) that the modeling of object model with discretized equation of MAC Method is performed in subdivision.Accordingly, the proposed model hardly make a mistake againt the past model do something,such as a physical variable calls no-used function.

Proposed object model by Hatakeyama and others includes all physical attribute in grid class.it is confirms our model has higher reliable.Further,it is suggested about brief extension of 3D problem.

From the result(2),the above-mentioned model is extended easily against flow with heat transfer is given.

In connection to the result(2),the result(3) says that the extension object model receive benefit of reuse from the based model.This is a consequence that object oriented merit is used effectively.

From the result(4), it is suggested that the trouble in operation of link between objects saved to a certain extent.

It is mentioned from the result(5) that flow with complicated shape is easier simulation to communicate between domain objects.

From the result(6),since domain model includes the conception of grid object model,flow is included effect of heat transfer,is shown.

It is mentioned from result(7) that parallel calculation to asign one or some domain object to one processor would be performed easier.

The proposed domain object model is added merit by itself to the advantage with grid object.Consequently,the proposed modeling in this study have demonstrated have much higher reliance and much flexible compared with the past model used finite difference method.

In this study,the problem,that is,flow analysis with complicated, programing,all manner of problem in relation to porgram modification or extension e.t.c.,is improved considerably.It is thought that the approach which we change basic model to extend model is proposed.

Problem to be solved

This study proposed flexible and higher reliable model. But difficulty may be occured to simulate flow with movement boundary or compressible flow. Another modeling or considerable object getting will be nesessary to that solution.Parallel calculation will be also too.