**Computational Fluid Dynamic Lecture 2**

***Mathematical Approaches to Computational Fluid Dynamics***

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Mathematics and especially numerical solutions play a very important part in the problems dealing with CFD. It is essential to make sure that the student is aware of the solutions of differential equations (including partial and non linear differential equations) in analytical way. Of course, the student should also be aware of the limitations of obtaining solutions to these types of differential equations. For example, Navier-Stokes equations that are used widely throughout fluid dynamics are a good example for these types of non-solvable differential equations.

However, this is where the power of numerical methods comes in as it allows you to use approximate solutions to these differential equations. There are numerous numerical methods that you can use for these types of solutions. However, with some differential equations (particularly those that deal with complex fluid flows), there are significant problems involved with their solutions even with numerical methods. Thus, this problem is dealt with by utilizing a computer to do the calculations for you in numerical methods. By increasing the number of iterations, your convergence on the correct solution increases greatly.

Of course, it is also essential to state that none of the numerical methods even with the aid of supercomputers can produce exact solutions. You will have to use your own intuition to make sure that the necessary solutions are producing usable solutions. Also, there will be a certain percentage of error, depending upon the number of iterations that you are performing. In addition, your initial approximation of the boundary conditions as well as the grid mesh in which you define your problem will also be interest to you for more correct results.

There are three main methods that you can use for solving computational fluid dynamics problems. These problems include:

1. Finite Difference Methods
2. Finite Volume Methods
3. Finite Elements Methods

Of course, no matter which method that you use, it is essential for you to make sure that you use the correct grid system for your analysis. The correct selection of the grid can make the difference between success and failure. Moreover, the proper selection of the grid will also ensure that there is less error when the end results are received.

Some types of grids that you can use include:

1. Structured Grid for Cartesian Solutions on 2d Platforms for Simple Flow Solutions
2. Block Structured Grid for cylinder flows and for more complex flow domains
3. Composite Grids for calculating rotating cylinder flow domains
4. Unstructured Grids for any non regular geometrical approaches to flow solutions