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ESEIAAT

Study for the computational resolution of conservation equations of mass, momentum and energy. Possible application to different aeronautical and industrial engineering problems: Case 1B

Project Charter

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1 Aim

The main objective of this paper is to provide knowledge in the computational resolution of the fundamental equations of fluid dynamics and mass and heat transfer by developing simulation codes. A second objective would be to apply the developed and verified codes in a specific case.

2 Scope

First, some basic cases concerning the equations of mass, momentum and energy are going to be solved in order to learn the fundamentals of the mathematical formulation and the computational and programming techniques that are going to be needed to develop the whole study. With the help of these cases, some simulation codes are going to be developed. A second part of this paper is going to be the application of the knowledge acquired to a practical case, that may be an engineering system or any other physical system.

In order to accomplish the objectives mentioned above, these are the following tasks to be developed:

- Previous research of the state of the art.
- Theoretical approach of the fluid dynamics behind all the cases and study of the mathematical formulation that should be applied.
- Development of the necessary numerical simulation tools. All the codes will need to be validated to ensure they are correct.
- Application of the acquired knowledge in simulation codes to an specific system.
- Analysis of the results.
- Conclusions.

3 Requirements

- Codes must be developed in C or C++.
- Simulations should provide realistic and accurate results.
- Codes should be able to be executed in a normal computer.
- No external libraries or solvers can be used.

Finally, there are no economical or legal requirements because the software used for this study is completely open source.

4 Justification

4.1 Need that is being covered

Conservation equations of mass, momentum and energy appear in a variety of cases. Most thermal and engineering problems require to solve these equations to achieve the desired result. However, they usually do not have an analytical solution, so a computational approach is often necessary. A huge amount of cases have been solved in the recent years, but there are still other problems that need to be studied and developed.
A better understanding on the computational resolution of the conservation equations can lead to better results in the numerical simulations. As a consequence, they could improve the actual knowledge in a variety of subjects, such as the temperature variation inside an engine or the way the air moves inside the lunges. Furthermore, they could also be used in the optimization of different engineering systems; for example, more efficient wings for future airplanes.

4.2 Advantatges and drawbacks

The main advantage of the approach explained in the scope is that the study of the computational resolution is started from basic cases and its difficulty is upgraded with every case of fluid dynamics that is proposed. That way, the comprehension on the developed simulations is higher, which makes the codes more reliable. As previously mentioned, the simulation codes are being developed from zero. This is an advantage because no previous errors are going to be introduced on the program, but it is also a drawback because its development could take some time.

Anyhow, this project can be useful in the study of new engineering and thermal problems that need to be solved using the conservation equations of mass, momentum and energy; and can lead to other new studies of computational resolution of these equations.

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