On the Effects of Micro-Vortex-Generators on a Finite Wing in a Subsonic Flow

על ההשפעות של מחוללי מערבולות זעירים על כנף סופית בזרימה תת־קולית

A Master's Thesis

by

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Abstract

- A good abstract explain in one line why the paper is important. It then goes on to give a summary of your major results, preferably couched in numbers with error limits. The final sentences explain the major implications of your work. A good abstract is concise, readable, and quantitative.
- Length should be 1-2 paragraphs, approx. 400 words.
- Abstracts generally do not have citations.
- Information in title should not be repeated.
- Be explicit.
- Use numbers where appropriate.
- Answers to these questions should be found in the abstract:
    1. What did you do?
    2. Why did you do it? What question were you trying to answer?
    3. How did you do it? State methods.
    4. What did you learn? State major results.
    5. Why does it matter? Point at least one significant implication.

Contents

List of Figures

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Chapter 1

Introduction

You can't write a good introduction until you know what the body of the paper says. Consider writing the introductory section(s) after you have completed the rest of the paper, rather than before. Be sure to include a hook at the beginning of the introduction. This is a statement of something sufficiently interesting to motivate your reader to read the rest of the paper, it is an important/interesting scientific problem that your paper either solves or addresses. You should draw the reader in and make them want to read the rest of the paper.

The next paragraphs in the introduction should cite previous research in this area. It should cite those who had the idea or ideas first, and should also cite those who have done the most recent and relevant work. You should then go on to explain why more work was necessary (your work, of course.)

What else belongs in the introductory section(s) of your paper?

1. A statement of the goal of the paper: why the study was undertaken, or why the paper was written. Do not repeat the abstract.
2. Sufficient background information to allow the reader to understand the context and significance of the question you are trying to address.
3. Proper acknowledgment of the previous work on which you are building. Sufficient references such that a reader could, by going to the library, achieve a sophisticated understanding of the context and significance of the question.
4. The introduction should be focused on the thesis question(s). All cited work should be directly relevant to the goals of the thesis. This is not a place to summarize everything you have ever read on a subject.
5. Explain the scope of your work, what will and will not be included.
6. A verbal "road map" or verbal "table of contents" guiding the reader to what lies ahead.
7. Is it obvious where introductory material ("Old stuff") ends and your contribution ("new stuff") begins?

Remember that his is not a reviewer paper. We are looking for original work and interpretation/analysis by you. Break up the introduction section into logical segments by using subheads.

Chapter 2

Methods

2.1 Overview

- Information to allow the reader to assess the believe-ability of your results.
- Information needed by another researcher to replicate your experiment.
- Description of your materials, procedure, theory.
- Calculations, technique, procedure, equipment, and calibration plots.
- Limitations, assumptions, and range of validity.
- Description of your analytic methods, including reference to any specialized statistical software.

2.2 Theory

Theory background.

- Governing equations.
- Passive flow control theory.
- Numerical methods being used.

2.3 Gridding

Deals with gridding process.

- Software
- Types of grids (Structured/Unstructured)
- Tolerances, No. of elements

2.4 Solver

Deals with solving process.

- Software
- B.C
- Numerical methods being used

2.5 Visualization

Visualization process description.

- Software (Paraview)
- Methods of visualization (LIC/Contours of equal x/Velocity profiles)

Chapter 3

Results

3.1 Overview

- The results are actual statements of observations, including statistics, tables and graphs.
- Indicate information on range of variation.
- Mention negative results as well as positive. Do not interpret results - save that for the discussion.
- Lay out the case as for a jury. Present sufficient details so that others can draw their own inferences and construct their own explanations.
- Use S.I. units (m, s, kg, W, etc.) throughout the thesis.
- Break up your results into logical segments by using subheadings
- Key results should be stated in clear sentences at the beginning of paragraphs.
- Describe the nature of the findings; do not just tell the reader whether or not they are significant.

An overview of the results (Ramp and then wing analysis). Explaining the differences between the two, and what to be tested in the addition of the down section of the wing. The swept/un-swept analysis done for the ramp and the vortex addition. Each result should contain a description of the following:

- Aerodynamic coefficients
- Separation zone (Quantitative/Relative) - LIC/Vortex
- Boundary layer study (Velocity profile)

3.2 Ramp

Explanation of the ramp setup. Including the two profiles chosen to enhance the separation effect. Swept vs unswept configuration and the vane addition.

3.2.1 Unswept

A description of the unswept ramp results

3.2.2 Swept

A description of the swept ramp results

3.2.3 Vane

A description of the vane ramp results

3.3 Wing

Explanation of the Wing setup. Swept and swept setups and vane addition.

3.3.1 Unswept

A description of the unswept wing results

3.3.2 Swept

A description of the swept wing results

3.3.3 Vane

A description of the vane ramp results

Chapter 4

Discussion

4.1 Overview

Start with a few sentences that summarize the most important results. The discussion section should be a brief essay in itself, answering the following questions and caveats:

- What are the major patters in the observations? (refer to spatial and temporal variations.)
- What are the relationships, trends and generalizations among the results?
- What are the exceptions to these patterns or generalizations?
- What are the likely causes (mechanisms) underlying these patterns resulting predictions?
- Is there agreement or disagreement with previous work?
- Interpret results in terms of background laid out in the introduction - what is the relationship of the present results to the original question?
- What is the implication of the present results for other unanswered questions in earth sciences, ecology, environmental policy, etc...?
- Multiple hypotheses: There are usually several possible explanations for results. Be careful to consider all of these rather than simply pushing your favorite one. If you can eliminate all but one, that is great, but often that is not possible with the data in hand. In that case you should give even treatment to the remaining possibilities, and try to indicate ways in which future work may lead to their discrimination.
- Avoid bandwagons: A special case of the above. Avoid jumping a currently fashionable point of view unless your results really do strongly support them.
- What are the things we now know or understand that we didn't know or understand before the present work?
- Include evidence or line of reasoning supporting each interpretation.

- What is the significance of the present results: why should we care?

This section should be rich in references to similar work and background needed to interpret results. However, interpretation/discussion section(s) are often too long and verbose. Is there material that doesn't contribute to one of the elements listed above? If so, this may be material that you will want to consider deleting or moving. Break up section into logical segments by using subheads.

4.2 Ramp vs. Wing

Deals with the discussion of the addition of the bottom part of the wing as opposed to the ramp (wall) solution.

4.3 Swept vs. Unswept Ramp/Wing

Deals with the effect of swept on the Ramp/Wing solutions.

4.4 Vane

Deals with the effects of a vane configuration on the ramp/wings.

Chapter 5

Conclusions

- What is the strongest and most important statement that you can make from your observations?
- If you met the reader at a meeting six months from now, what do you want them to remember about your paper?
- Refer back to problem posed, and describe the conclusions that you reached from carrying out this investigation, summarize new observations, new interpretations, and new insights that have resulted from the present work.
- Include the broader implications of your results.
- Do not repeat word for word the abstract, introduction or discussion.

Chapter 6

Recommendations

- Include when appropriate (most of the time)
- Remedial action to solve the problem.
- Further research to fill in gaps in our understanding.
- Directions for future investigations on this or related topics.

Chapter 7

Acknowledgments

Advisor(s) and anyone who helped you:

- Technically (including materials, supplies)
- Intellectually (assistance, advice)
- Financially (for example, departmental support, travel grants)

References

[1] John C. Lin, *"Review of Research on Low-Profile Vortex Generators to Control Boundary-Layer Separation"*. Progress in Aerospace Sciences Volume 38, Pages 389-420. November, 2002.

[2] Norman M. McFadden, George A. Rathert, Jr. and Richard S. Bray, *"The Effectiveness of Wing Vortex Generators in Improving the Maneuvering Characteristics of a Swept-Wing Airplane at Transonic Speeds"*. National Advisory Committee for Aeronautics, Technical Note 3523, Ames Aeronautical Laboratory. Moffett Field, California. September, 1955.

[3] Frank K. Lu, Qin Li, Yusi Shih, Adam J. Pierce and Chaoqun Liu, *"Review of Micro Vortex Generators in High-Speed Flow"*. 49th AIAA Aerospace Sciences Meeting. Orlando, Florida. 4 - 7 January, 2011.

Appendix A

First appendix

We'll cover the following aspects

- Grid sensitivity to No. of elements
- Matlab code for grid generation
- We'll add some other things