

**APPLICATION OF BOUNDARY ELEMENT METHOD  
TO INVISCID FLOW AROUND THIN AIRFOILS**

**By**

**AZNIJAR BIN AHMAD YAZID**

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,  
in Fulfilment of the Requirements for the Degree of Master of Science**

**June 2004**

In the name of Allah, the Most Gracious, the Most Merciful. All praise is due to Allah the Exalted, and may peace be upon Muhammad, the Seal of the Prophets, and upon his brothers Prophets and Messengers and upon his family, his companions and whoever follows him with benevolence until the Day of Resurrection.

This work is dedicated to my small family, especially my late mother, Nik Jah binti Mohammad ( May Allah provide her with bounties of rahmah and be placed in Jannah), who has weathered alone all her life to raise my brother, Zaini and me; you'll be forever in our hearts, to my loving and patient wife, Wan Marini binti Wan Hamzah and my cheerful and forever-happy son, Adam. The late Idris ( May Allah provide him with bounties of rahmah and be placed in Jannah), Adam's younger brother, is not forgotten too.

Appreciation is also accorded to my mentor and supervisor, Professor Dr. Ir. Shahnor bin Basri for all his patient words and guidance and fellow colleague at the Department of Aerospace Engineering who continued supporting me through all trials and tribulation.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia  
in fulfilment of the requirement for the degree of Master of Science

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**Chairman: Professor Ir. Shahnor bin Basri, Ph.D.**

**Faculty: Engineering**

With the continuous development of faster and cheaper computers of late, application of computational methods in solving engineering problems has become increasingly popular. New techniques are continuously being researched and developed in order to bring the numerical solution nearer to reality. A Boundary Element Method is developed in the research to solve aerodynamic problems. Investigations revealed that the solution obtained using boundary element method is slightly superior to the solution provided by the currently used Panel Method. It was also found that the new technique also manages to obtain better result employing a lower number of nodes during solution, reducing the computational time. However, the adoption of potential theory means that the stall conditions of airfoils could still not be predicted at all.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia  
sebagai memenuhi keperluan untuk ijazah Master Sains

**PENGGUNAAN KAEDAH UNSUR SEMPADAN DALAM PENYELESAIAN  
MASALAH KERANGKA UDARA NIPIS DALAM ALIRAN TAK MAMPAT**

**Oleh**

**Aznijar bin Ahmad Yazid**

**Jun 2004**

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Dengan perkembangan terkini teknologi yang menghasilkan komputer yang lebih murah tetapi berkuasa tinggi, penggunaan kaedah penyelesaian berkomputer menjadi semakin popular dalam menyelesaikan masalah kejuruteraan. Teknik-teknik terbaru sentiasa diselidik dan dibangunkan bagi memastikan penyelesaian berangka dengan menggunakan komputer ini menghampiri keadaan sebenar. Atucara komputer berasaskan kaedah unsur sempadan telah dibangunkan dalam penyelidikan ini bagi menyelesaikan masalah aerodinamik. Keputusan yang dicapai telah menunjukkan bahawa kaedah baru ini berjaya mencapai keputusan dengan lebih baik jika dibandingkan dengan kaedah yang sedang diguna-pakai dewasa ini, iaitu kaedah Panel. Penggunaan kaedah baru ini juga dapat memastikan walaupun menggunakan jumlah node yang lebih rendah, ia dapat meningkatkan ketepatan keputusan yang dicapai, dan mengurangkan masa yang diambil untuk menyelesaikan masalah. Walaubagaimanapun, penggunaan Teori Keupayaan dalam penyelidikan ini menyebabkan keadaan pegun bagi airfoil masih tidak dapat dipastikan sama sekali.

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I certify that an Examination Committee has met on the 17<sup>th</sup> June 2004, to conduct the final examination of Aznizar bin Ahmad Yazid on his Master of Science thesis entitled “Application of the Boundary Element Method to the Inviscid Flow Around Thin Airfoils” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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## **DECLARATION**

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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**AZNIJAR BIN AHMAD YAZID**

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## TABLE OF CONTENTS

	<b>Page</b>
DEDICATION	ii
ABSTRACT	iii
ABSTRAK	iv
ACKNOWLEDGEMENTS	v
APPROVAL	vi
DECLARATION	viii
LIST OF TABLES	x
LIST OF FIGURES	xi
GLOSSARY OF TERMS	xiii
<b>CHAPTER</b>	
1 INTRODUCTION	1
1.1 Introduction	1
1.2 Objective of Research	3
1.3 Content of This Thesis	3
2 REVIEW OF PREVIOUS WORK	5
2.1 Different Approaches to Meshless Method	5
2.2 A Review of Computational Methods	6
3 MODELLING	17
3.1 Outline of The Technique	17
3.2 Implementation of The Present Method	28
3.3 Program Coding - Convergence Criteria	29
3.4 Verification	31
3.5 Closure	32
4 RESULTS AND DISCUSSIONS	33
4.1 Pressure coefficient	34
4.2 Lift coefficient	48
4.3 Summary	66
5 CONCLUSSION	68
REFERENCES	70
APPENDICES	74
BIODATA OF THE AUTHOR	160

