PREDICTION OF FLOW FIELD OF A CEILING FAN
BY FLOW SINGULARITY MODELING

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Thesis submitted in partial fulfillment of the requirements for the degree
Master of Science

Department of Mechanical Engineering

University of Moratuwa
Sri Lanka

April 2012
DECLARATION OF THE CANDIDATE & SUPERVISOR

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The work is dedicated to my parents
ACKNOWLEDGEMENT
This Research was supported by University of Moratuwa Senate Research grant number SRC/LT/2010/02.

After gaining the experience in the master degree, I would like to thank number of people who have supported me. First of all, I would like to sincerely thank my supervisor Dr. A.G.T. Sugathapala, for his guidance at various stages of the research. Also I take this opportunity to give special thank for Prof. R.A. Attalage and Dr. R. Gopura, since their contribution was highly important when various difficulties occurred within the duration of the research.

The advice given by Mr. Tiwanka Wickramasooriya for the development of computational code is highly appreciated since those were very important for developing more efficient computational code. Also I like to remind the support given by Mechanical Engineering department of University of Moratuwa.

It is glad to recall the support given my colleagues, Gayan Sirimanna, Dulanjan Wijesinghe, Pubudu Welgama, Tharindu Dasun of University of Moratuwa.
Abstract

Three dimensional flow field of a ceiling fan is modelled numerically by assuming incompressible and inviscid flow. The fan blades modelled by vortex lattice method, in which surfaces are replaced by vortex boxes. The development of the wake is simulated by free wake method. Kutta condition, flow tangency at solid surfaces and zero fluid loading at the wake are taken as boundary conditions. The governing equations are solved by developing a computational code. The development of the flow field and the effects of the geometrical characteristics of fan blades and rotor parameters on the rotor performance are investigated. When the wake structure of the rotor evolves with time, the wake tends to flow upward at the root of the blade initially and wake instabilities, such as vortex pairing, occur in the tip vortex. But with time, the wake becomes ordered in the vicinity of the blade and wake distortions tend to flow downward. The wake contraction at the near wake was seen in fully developed wake structures. The comparison of the flow rates at different rotor speeds with that of experimental results shows a satisfactory agreement, indicating the validity of the present numerical model. Subsequently, effects of rotor speed, number of blades, blade aspect ratio, and blade profile on the ceiling fan performance are qualitatively and quantitatively analysed. Moreover numerical analysis is extended for investigating the effect of ceiling on the rotor performance. Presence of ceiling degrades the flow rate of a ceiling fan. It can be concluded that the present model is capable of modelling flow around ceiling fans including its aerodynamics performance.

Keywords: Ceiling fan, vortex lattice, free wake, near wake, ceiling effect
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