Laplace's Equation on a 2-D unstructured mesh

Department of Aeronautics and Astronautics
Stanford University

AA-215B: Advanced CFD
Professor A. Jameson

Britton J. Olson

April 9, 2010

Abstract

Unstructured discretizations of domains has huge advantages when solving equations which govern engineering processes. Often times, such processes occur in a domain containing complicated geometry which cannot be fitted to a standard structured grid. The Finite Element method is well suited for this class of problems. We apply the finite element method for a general unstructured 2d mesh on the model Laplace equation. The solution is that of a steady-state and is compared to analytic results on a number of meshes.

Contents

Chapter 1

Report

1.1 Finite Element Method

Shock boundary layer interactions exist in many engineering and scientific applications. These complex interactions depend heavily on viscous scales which at time dwell outside the range of experimental instrumentation. Also, numerical schemes can only resolve down to a certain length scale and for this case, models must be used. The physical problem of this final project proposes the passage of super-sonic air flow, $M_0 = 2.96$, over a flat plate where a turbulent boundary layer forms. This boundary layer then encounters a 25 degree wedge. This shock boundary layer interaction causes a separation in the flow and compression waves from this region of flow turning eventually become non-linear when they coellesce into a shock wave.

1.2 Numerical Method