h-p Adjoint-based Error Estimation
for Thermo-acoustic Coupling in Turbulent Premixed Flames

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1 Introduction and Motivation

Computational Fluid Dynamics (CFD) was developed as to reduce the cost of fluid flow experiments whose lifecycle spanning from conception to testing involved numerous design iterations and modifications. The initial applications of CFD focused on aerodynamic and hydrodynamic flows within the engineering industry. At the present time, its role has grown to include a vast spectrum of modern day industries. This is due to the ever-increasing power of computers as predicted by Gordon Moore, namely, that computing power would double approximately every two years. [**?**]

2 Scope of Research

3 CFD Techniques to Model Combustion

3.1 The Finite Volume Method

3.2 Favre Averaged Navier Stokes Equations

3.3 High Order schemes

3.4 Large Eddy Simulation

3.5 Explicit Filtering and Commutation Errors

4 Adjoint Method for Error Estimation

4.1 Introduction

4.2 Derivation

4.3 Solution of Linear Systems

5 Anisotropic Mesh Refinement

5.1 Techniques

5.2 Benefits of Parallelization

6 Summary of Progress to Date and Future Work

6.1 Progress to Date

Task	Completion Date
Literature Review	September-October 2014
Trelis Meshing Software	November 2014
CFFC Group Code Flux Jacobian Analysis	December 2014
Trilinos Package solution for example Poisson Problem in serial and parallel configurations	December 2014

6.2 Future Work

Task	Completion Date
Implementing the approximate Adjoint Derivative to the Flux Jacobians testing on Euler Equations	April 2015
Extension to Mesh adaptation	May 2015
Application of Adjoint Problem to Navier Stokes	June 2015
Explicit Filters for High Order FVM implementation	October 2015
Conference Paper I draft	November 2015
Coupling of High Order method with Adjoint-based AMR	December 2015
CFD simulation of Cold Flow	January 2016
CFD simulation of Laminar Non-Premixed Flame	February 2016
CFD simulation of Laminar Diffusion Flame	February 2016
Journal Paper I	April 2016
Conference Paper II draft	April 2016
CFD simulation of Turbulent Non-Premixed Flame	May 2016
Journal Paper II	July 2016
Conference Paper I Presentation	July 2016
Conference Paper II draft	October 2016
Journal Paper III	October 2016
CFD simulation of Full Thermo-coupling	October 2016
Conference Paper III draft	November 2016
Thesis write-up	September 2017