

# Unsteady adjoint optimization with grid adaptation

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# Background and Current Position

## Background

- Born in Khulna, Bangladesh
- B.Sc. in Mechanical Engineering from Bangladesh University of Engineering & Technology
- M.Sc. in Computational Mechanics from University of Duisburg-Essen, Germany

## Current Position

- Joined WUT as ESR 14 on October, 2013
- Supervised by Prof. Jacek Szumbariski



# Objectives

## Primary Goal

- Adjoint solver for unsteady Navier-Stokes (including check pointing)
- Shape optimization using unsteady adjoint solver with option for optimal control
- Optimize the performance with grid adaptation and optionally multi-grid



# Work Plan

## Preliminaries

- Unsteady adjoint for a simple ODE with check pointing
- optimal control for simple ODE

## Prerequisites

- Unsteady Euler/NS solver (Residual Distribution Scheme)

## Primary Task

- Implementation of unsteady adjoint in the NS solver
- Implementation of moving geometry
- Gradient-based shape optimization



# Work Plan - continued

## Testing and evaluation

- Testing of the Euler/NS code on non-stationary cases
- Testing of the obtained gradients against finite difference
- Testing of a complete optimization

## Performance improvements

- Hessian-of-solution based mesh refinement
- Goal-oriented based mesh refinement



# Progress

## Training

- Literature review
- In house training on adjoint-based mesh adaptation and optimization
- Training workshop attended on AD tools organized by AboutFlow project
- Training workshop attended on MPI organized by HLRS, Germany

## Current Status

- Development of Adjoint implementation on Euler solver is underway.



## RWTH

- Envisaged Feb-March 2015
- Familiarization in parallelization of adjoint solvers
- Review of AD tools for parallel application
- Implementation of operator overloading based AD to develop Adjoint solver
- Participation in courses on AD and scientific computing



# Secondment

## Rolls Royce

- Planned October 2015
- Familiarization with the industrial flow cases
- Training on industrial approach to optimization
- Investigation of turbo-machinery problem using the developed adjoint solver
- Application of grid adaptation tool chain available in WUT for turbo-machinery test cases
- Benchmarking of developed approaches with current practices





## Expected Outcome of the Project

- Expected to become conversant with the CFD code development
- Robust adjoint solver with shape optimization and grid adaptation capability
- Experience gain in cfd solver development and application to industrial flow problems
- Collaboration with academia and industry



# Future Plans

## Research

- Expected to employ adjoint technique for higher order RDS scheme
- GPU implementation of the developed adjoint solver

## Career

- Phd thesis submission in the last quarter of 2016
- Continue to engage in research on Adjoint optimization in academia or industry



# Acknowledgements

This work has been conducted within the **About Flow** project on “Adjoint-based optimization of industrial and unsteady flows”.

<http://aboutflow.sems.qmul.ac.uk>

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