Overview

I have started a PhD in April 2009 at EPFL in the:

Department of Mathematics:

CMCS - Modelling and Scientific Computing - Prof. Alfio QUARTERONI

Collaboration with: Dott. Nicola PAROLINI

PHD Topics:
- CFD around boats
  - Steady state simulations (drag prediction)
  - Sea keeping behavior (6 dof)
  - Planind condition and sprays (Level Set vs VoF)
- Shape optimization
  - Adjoint code
  - Reduced Models/Basis
Results So Far

**CFX:**
- Validated steady state simulations on test case boat Series 60
- Developed a 6dof Fortran program to be coupled with CFX, results validated on test case boat Series 60

**Openfoam:**
- Set up simulation for test case boat Series 60
- Obtained steady state converged solutions (not that easy…)
  Unfortunately results are not very accurate and varies significantly when varying settings:
  - Up to 30% difference in drag for different spatial discretization schemes
  - Up to 10% difference in drag for different **temporal** schemes!!!
- Some basis for the implementation of Level set scheme (but not working…)
- Some use and modification of a 6dof solver (based on ShipFoam, found on the forum) but (usually) not working in parallel.
Results So Far: CFX
## Results So Far: OpenFoam

### Openfoam

<table>
<thead>
<tr>
<th>Mesh Type</th>
<th>Pressure X</th>
</tr>
</thead>
<tbody>
<tr>
<td>NewMesh-Media(upwind-limited)-KEpsilon</td>
<td>5.68</td>
</tr>
<tr>
<td>NewMesh-Media(upwind-limited)-KEpsilon-Yplus</td>
<td>5.60</td>
</tr>
<tr>
<td>NewMesh-Media(upwind-limited)-SST</td>
<td>4.90</td>
</tr>
<tr>
<td>NewMesh-Media(2nd order-limited)-KEpsilon</td>
<td>4.95</td>
</tr>
<tr>
<td>NewMesh-Media(2nd order-limited+GradSchemesCorrected)-KEpsilon</td>
<td>4.37</td>
</tr>
<tr>
<td>NewMesh-Media(2nd order-limited+GradSchemesCorrected)-KEpsilon-Yplus</td>
<td>5.05</td>
</tr>
<tr>
<td>NewMesh-Fine</td>
<td>5.24</td>
</tr>
<tr>
<td>NewMesh-Fine(restarted from Interpolated Media mesh converged solutions)</td>
<td>5.24</td>
</tr>
<tr>
<td>NewMesh-FINE(2nd order-limited+GradSchemesCorrected)-KEpsilon</td>
<td>4.91</td>
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<tr>
<td>NewMesh-Laminar</td>
<td>1.90</td>
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<tr>
<td><strong>NewMesh-Media(2nd order-limited+GradSchemesCorrected)-SST</strong></td>
<td><strong>3.75</strong></td>
</tr>
<tr>
<td>BigHull-Media</td>
<td>5.76</td>
</tr>
<tr>
<td>BigHull-Media(2nd order-limited+GradSchemesCorrected)-KEpsilon</td>
<td>5.14</td>
</tr>
<tr>
<td>NewMesh-FineYplus(2nd order-limit+GradSchemesCorr)-SST(eulerorBackward)</td>
<td>3.54</td>
</tr>
</tbody>
</table>
Objectives for the summer school

Ideally:
• Understand more deeply the structure and the potential of the code
• Improve accuracy/consistency of the steady state solver
• Develop a level Set scheme that works..
• Develop a 6dof solver that works in parallel
• Investigate GGI capability of OpenFoam
• Develop a basic NS adjoint code
• Start collaboration with other people interested to the same topics..

… in reality to accomplish half of those points would already be more than enough…
What has actually happened?

• Understand more deeply the structure and the potential of the code: **OK**

• Improve accuracy/consistency of the steady state solver:
  • Modification of discretizations schemes:
    • no real difference
  • Development of a SteadyState solver:
  • Still under investigation:
    • Relaxation parameters
    • Interface scheme
      • Convective velocity
      • Resharpening of the interface
      • Coupling with NS stokes
  
• What about “classical” rasInterFoam with relaxations?
SteadyRasInterFoam: Wigley
What has actually happened?

• Develop a level Set scheme that works..
  • develop a new reconstruction scheme that seems to be working (more testing needed)

• Develop a 6dof solver that works in parallel
  • RasInterDynFoam seems to be the answer, but haven’t had time to test it (but I hope it will work smoothly..)

• Investigate GGI capability of OpenFoam
  • Understood GGI structure and theoretically the BOX3dGGI is working with it. (Still crashes sometimes..)

• Develop a basic NS adjoint code
  • Not even started thinking about it..

• Start collaboration with other people interested to the same topics..
  • DONE! Thanks everyone…
Conclusions

... in reality to accomplish half of those points would already be more than enough...

So:

- I am happy because my knowledge of OpenFoam has been greatly improved
- I am happy because I have accomplished some of the tasks I wanted to fulfill (although in most cases I have just set up the basis and it still need to be proven if they will actually work..)
- I am happy because I have met many nice and interesting people

- I am unhappy because no real answer to the drag prediction problem has been found. (Unfortunately there was no easy answer to the problem...)

- I am VERY happy because I have found out that I am not the only one who loses lots of time on stupid errors and is often very frustrated by OpenFoam...
Conclusions

I WAS NOT SLEEPING!!