InsightCAE Inflow-Generator Add-on

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October 4, 2022

Contents

1 Copyright

2 Disclaimer

This document and the InsightCAE program are subject to change without prior notice, due to the manufacturer's continuous development program.

InsightCAE has been developed and implemented with great care using algorithms that have been tested by silentdynamics GmbH. Nevertheless, InsightCAE is based on third-party software, especially OpenFOAM and Code_Aster, which are not developed by silentdynamics GmbH itself and can be tested and checked by silentdynamics GmbH only to a reasonable extent. In order to ensure the reliability of InsightCAE for a certain application, it is therefore always necessary to validate the software by means of suitable test cases.

Users are assumed to be knowledgeable in the information of the output reports. Users are assumed to recognize that the input data can have a significant effect on the solution and must be selected carefully. Users should have a thorough understanding of the relevant theoretical criteria.

3 Introduction

This document describes the usage of an add-on for the software InsightCAE. The add-on provides methods to generate synthetic turbulence at the inlet boundaries of turbulence-resolving simulations.

This document extends the general documentation of InsightCAE. The general documentation can be found here: https://github.com/hkroeger/insightcae-documentation/insightcae-manual.pdf

4 Installation

The add-on can be placed in the source code tree of the InsightCAE base software. After recompiling, the analyses of this add-on will be available to the user.

For each support customer, silentdynamics GmbH provides a special binary package which contains the InsightCAE base software together with all requested add-ons and necessary third-party tools.

4.1 Source Code Repository

The current source code is maintained in a git-repository. When the repository is cloned, the whole version history can be inspected and previous states of the code can be restored. It is also possible to maintain own extensions and/or changes to the code while still being able to merge updates from silentdynamics GmbH. Please refer to the official git documentation for an extensive coverage of the matter: https://git-scm.com/doc.

To insert the add-on into the InsightCAE project, the source code has to be placed in the source tree of the InsightCAE base software. Thus change directory to the addons folder in the source tree and clone the repository there:

```
1 $ cd /path/to/insight/src/addons
```

```
$ git clone https://rostock.silentdynamics.de/git/silentdynamics/insight-inflowgenerator.git
```

When asked for username and password, the same credentials as for the binary repository above have to be used.

After inserting the add-on source, change to the build directory and re-run cmake. It will detect the add-on code and produce the additional makefiles. Then rebuild the InsightCAE project by executing “make” in the build directory. This will compile the add-on.

4.2 Compiling the OpenFOAM Boundary Condition Library without the InsightCAE project

For users who don’t want to take advantage of the numerous InsightCAE tools, it is possible to compile the inflow generator boundary condition library alone without building the entire InsightCAE project. Therefore, a configuration for OpenFOAM’s wmake build system is provided (in a directory called Make). Although only the inflow generator BC library is build, still the while InsightCAE source tree needs to be present since there are some dependencies on other source code files from the InsightCAE project.

To build the library containing the boundary condition, execute the following steps:

1. First check out the InsightCAE source tree:

   ```
   git clone -b next-release https://rostock.silentdynamics.de/git/silentdynamics/insight.git
   ```

   Use the provided credentials to authenticate with silentdynamics’ git repository server.

2. then change into the add-ons subdirectory and place the inflow generator code there:

   ```
   cd insight/src/addons
   ```

3. clone the inflow generator add-on there

   ```
   git clone -b master https://rostock.silentdynamics.de/git/silentdynamics/insight-inflowgenerator.git
   ```

4. change further down into the inflow generator BC library source directory:

   ```
   cd insight-inflowgenerator/extensions/openfoam/inflowGeneratorBC
   ```

5. there, one or more wmake configurations are present. First select and check a configuration (see section 4.2.1). Then build the library by executing

   ```
   wmake libso
   ```

4.2.1 Adapt wmake Configuration

Several predefined wmake configurations can be present in the source directory of the BC library. They are stored in respective directories which names are of the pattern `Make.*`.

One of the configurations can be selected by creating a symbolic link to one of the predefined directories. For example:

```
ln -s Make.OFesi2106_Mint_Debian_Edition5 Make
```

The following items of the selected wmake configuration should be checked:

- the version of OpenFOAM with which the library is to be compiled.

  In `Make/options`, there is a line of the pattern:

```
-DOF_VERSION=060505 \
```

  The number behind the preprocessor symbol `OF_VERSION` can be changed switch compatibility with a different OpenFOAM version. The following choices are currently supported:

Label	OpenFOAM version	`OF_VERSION` value	fork
OF16ext	1.6.0	010600	extend
fx31	1.6.1	010601	extend
fx32	1.6.2	010602	extend
fx30	1.6.3	010603	extend
fx41	1.6.4	010604	extend
of21x	2.1.0	020100	vanilla
of22x	2.2.0	020200	vanilla
of22eng	2.2.0	020200	engys
of23x	2.3.0	020300	vanilla
of24x	2.4.0	020400	vanilla
of301	3.0.1	030001	vanilla
ofplus	4.0.0	040000	esi
of1806	6.0.0	060000	esi
of1906	6.5.0	060500	esi
of2112	6.5.5	060505	esi
ofdev	7.0.0	070000	vanilla

- the include directory for VTK should be added with a `-I` option to `EXE_INC`. For example:

```
-I/usr/include/vtk-9.0 \
```

- the VTK libraries should be added with appropriate `-l` options to `LIB_LIBS`. For example:

```
-lvtkIOLegacy-9.0 -lvtkCommonSystem-9.0 \
```

- likewise, the libraries for Armadillo should be added with appropriate `-l` options to `LIB_LIBS`. For example:

```
-larmadillo -lgsl -lgslcblas \
```

- the library output path in Make/files. By default, the library is put into the user's own library directory (FOAM_USER_LIBBIN):

```
LIB = $(FOAM_USER_LIBBIN)/libinflowGeneratorBC
```

5 Using the Inflow Generator Boundary Condition in OpenFOAM Cases

To use the inflow generator boundary condition in an OpenFOAM case, these two steps are required:

1. ensure that the solver executable loads the shared library containing the boundary condition code. Therefore, the appropriate library should be added to the list `libs` in `system/controlDict`. For example:

```
libs (
       "libinflowGeneratorBC.so"
    );
```

2. Then add an appropriate entry in the `boundaryField` section of the velocity field file `0/U`. For example:

```
   inlet
   {
      type inflowGenerator<hatSpot>;
      //type inflowGenerator<anisotropicVortonAnalytic>;
      //type inflowGenerator<anisotropicVortonNumerical>;
      //type inflowGenerator<anisotropicVortonPseudoInverse>;

       UMeanSource linearProfile (0 0 0) (0 0 1) "$FOAM_CASE/Umean.dat";
       RSource linearProfile (0 0 0) (0 0 1) "$FOAM_CASE/R_ij.dat";
       LSource linearProfile (0 0 0) (0 0 1) "$FOAM_CASE/L_ii.dat";
       calibrationFactorSource uniform 1;
       scaleToMassFlow true;
       value uniform (0 0 0);
   }
```

   The following configuration keywords need to be specified:

   - the spot type is selected by the keyword in the angular brackets after the keyword `inflowGenerator`,
   - the mean velocity is provided by the statement after the keyword `UMeanSource`.

     The syntax used for all the `*Source` keywords is described in the general InsightCAE manual in section 8.1.1.
   - The reynolds stress is provided by the statement after the keyword `RSource`,
   - the length scales are provided by the statement after the keyword `LSource`. Three length scales need to be provided. The first is the length along the largest principal direction of the reynolds stress tensor, the second along the second largest principal direction and so on.
   - An optional calibration factor can be specified by the keyword `calibrationFactorSource`.
   - Finally, the fluctuations can be scaled such that the integral of the velocity in patch-normal direction is always identical to that of the prescribed mean velocity field. This can be switch on and off by the `scaleToMassFlow`.

6 Getting Help and Reporting Errors

In the case of problems with our software, or if you have proposals for new features or improvement, please create a ticket in our issue tracker at https://github.com/hkroeger/insightcae/issues. In the case of errors, please provide as much of the following informations, as possible:

- short description of the problem
- log file

Either save it from the workbench (button “Save as...” in the “Output” tab) or copy the output from the console and paste into a file.

- Input file (*.ist)
- The geometry and further referenced input files, if your data protection rules allow so.

Alternatively, you can of course email or call your silentdynamics GmbH contact person.