

Delaundo Analysis Interface Module (AIM)

Ryan Durscher
AFRL/RQVC

May 14, 2018

Contents

1	Introduction	1
1.1	Delaundo AIM Overview	1
2	Geometry Representation and Analysis Intent	1
3	AIM Inputs	1
4	AIM Shareable Data	3
5	AIM Outputs	3
6	Mesh Sizing	3
6.1	JSON String Dictionary	3
6.2	Single Value String	4

1 Introduction

1.1 Delaundo AIM Overview

A module in the Computational Aircraft Prototype Syntheses (CAPS) has been developed to interact with the 2D Delaunay mesh generator Delaundo, developed by J.-D. Müller. Details and download information for Delaundo may be found at <http://www.ae.metu.edu.tr/tuncer/ae546/prj/delaundo/>

Along with isotropic triangular mesh generation, Delaundo has limited anisotropic mesh generating capabilities. From the Delaundo website - "delaundo has also a rudimentary capability to create grids with stretched layers for viscous calculations that works well for moderate stretching factors of up to 100. Due to the simple implementation the stretched layers must completely wrap around a simply connected body such as an airfoil with a wake. It cannot do bump-like cases, where non-stretched boundaries are attached to stretched ones."

An outline of the AIM's inputs and outputs are provided in [AIM Inputs](#) and [AIM Outputs](#), respectively.

The accepted and expected geometric representation and analysis intentions are detailed in [Geometry Representation and Analysis Intent](#).

Details of the AIM's shareable data structures are outlined in [AIM Shareable Data](#) if connecting this AIM to other AIMS in a parent-child like manner.

2 Geometry Representation and Analysis Intent

The geometric representation for the Delaundo AIM requires the body be either a face body (FACEBODY) or a non-manifold sheet body(SHEETBODY). Furthermore, the attribute capsIntent should be set to CFD or ALL.

3 AIM Inputs

The following list outlines the Delaundo meshing options along with their default value available through the AIM interface. Please note that not all of Delaundo's inputs are currently exposed.

- **Proj_Name = delaundoCAPS**
This corresponds to the output name of the mesh.

- **Tess_Params = [0.025, 0.001, 15.0]**

Body tessellation parameters. Tess_Params[0] and Tess_Params[1] get scaled by the bounding box of the body. (From the EGADS manual) A set of 3 parameters that drive the EDGE discretization and the FACE triangulation. The first is the maximum length of an EDGE segment or triangle side (in physical space). A zero is flag that allows for any length. The second is a curvature-based value that looks locally at the deviation between the centroid of the discrete object and the underlying geometry. Any deviation larger than the input value will cause the tessellation to be enhanced in those regions. The third is the maximum interior dihedral angle (in degrees) between triangle facets (or Edge segment tangents for a WIREBODY tessellation), note that a zero ignores this phase

- **Mesh_Format = NULL**

Mesh output format. If left NULL, the mesh is not written in the new file format. Available format names include: "AFLR3", "VTK", "TECPLOT", "STL".

- **Mesh_ASCII_Flag = True**

Output mesh in ASCII format, otherwise write a binary file if applicable.

- **Edge_Point_Min = 2**

Minimum number of points along an edge to use when creating a surface mesh.

- **Edge_Point_Max = NULL**

Maximum number of points along an edge to use when creating a surface mesh.

- **Mesh_Sizing = NULL**

See [Mesh Sizing](#) for additional details.

- **Spatial_Ratio = 1.0**

This corresponds to SPCRAT in the Delaundo manual - Ratio between the spacing gradients at the points of highest and lowest spacing. Values higher than one will cause Delaundo to interpolate with a power law to extend the regions of fine spacing further into the domain.

- **D_Tolerance = 0.65**

This corresponds to DTOLER in the Delaundo manual - Specifies the fraction of the background mesh size that is being used as a minimum distance between nodes.

- **Q_Tolerance = 0.65**

This corresponds to QTOLER in the Delaundo manual - specifies the minimum fraction of the maximum side length that the smaller sides must have in order to make the triangle acceptable.

- **B_Tolerance = 2.0**

This corresponds to BTOLER in the Delaundo manual - specifies the minimum fraction of the background mesh size that is being used as a minimum distance between nodes in the background grid.

- **Delta_Thickness = 0.0**

This corresponds to DELTAS in the Delaundo manual - specifies the thickness of the stretched layer in the scale of the other points. No stretched region will be created if the value is less than or equal to 0.0 .

- **Max_Aspect = 20.0**

This corresponds to MAXASP in the Delaundo manual - specifies the maximum aspect ratio in the stretched layer.

- **Num_Anisotropic = 30,000**

This corresponds to MVISRO in the Delaundo manual - specifies how many stretched, viscous rows are to be built.

- **Num_Isotropic = 30,000**

This corresponds to MISORO in the Delaundo manual - specifies how many isotropic rows are to be built.

- **Transition_Scheme = 2**

This corresponds to ISMOOT in the Delaundo manual - specifies how many stretched rows of cells will be opened for isotropic re-triangulation once the stretched process has terminated. 0 does not allow any re-triangulation, 1 allows re-triangulation of the outermost cells, and 2 allows re-triangulation of the neighbors of the outermost cells as well.

- **Flat_Swap = True**
This corresponds to FLATSW in the Delaundo manual - if True this will make DELAUNDO swap diagonals in the final mesh in order to minimize the maximum angles.
- **Max_Angle = 120.0**
This corresponds to ANGMAX in the Delaundo manual - specifies the maximum tolerable cell angle before FLATSW kicks in.
- **Num_Swap = 10**
This corresponds to MCYCSW in the Delaundo manual - specifies how many swapping cycles will be executed.

4 AIM Shareable Data

The delaundo AIM has the following shareable data types/values with its children AIMs if they are so inclined.

- **Surface_Mesh**
The returned surface mesh after delaundo execution is complete in meshStruct (see meshTypes.h) format.
- **Attribute_Map**
An index mapping between capsGroups found on the geometry in mapAttrToIndexStruct (see miscTypes.h) format.

5 AIM Outputs

Delaundo only has one available output, "Mesh", which triggers the AIM to read the generated mesh file back into CAPS. Once read the mesh may be shared with other AIMs and/or written out in a specified mesh format.

6 Mesh Sizing

Structure for the mesh sizing tuple = ("CAPS Group Name", "Value"). "CAPS Group Name" defines the capsGroup on which the sizing information should be applied. The "Value" can either be a JSON String dictionary (see [Section JSON String Dictionary](#)) or a single string keyword string (see [Section Single Value String](#))

6.1 JSON String Dictionary

If "Value" is a JSON string dictionary (e.g. "Value" = {"edgeDistribution": "Even", "numEdgePoints": 100}) the following keywords (= default values) may be used:

- **edgeDistribution = "Even"**
Edge Distribution types. Options: Even (even distribution), Tanh (hyperbolic tangent distribution).
- **numEdgePoints = 0**
Number of points along an edge.
- **initialNodeSpacing = [0.0, 0.0]**
Initial (absolute) node spacing along an edge.
- **tessParams = (no default)**
Face tessellation parameters, example [0.1, 0.01, 20.0]. (From the EGADS manual) A set of 3 parameters that drive the EDGE discretization and the FACE triangulation. The first is the maximum length of an EDGE segment or triangle side (in physical space). A zero is flag that allows for any length. The second is a

curvature-based value that looks locally at the deviation between the centroid of the discrete object and the underlying geometry. Any deviation larger than the input value will cause the tessellation to be enhanced in those regions. The third is the maximum interior dihedral angle (in degrees) between triangle facets (or Edge segment tangents for a WIREBODY tessellation), note that a zero ignores this phase.

6.2 Single Value String

If "Value" is a single string, the following options maybe used:

- (NONE Currently)