GSoC'21 : Implement an Unsteady Vortex Lattice aerodynamic element

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1 Introduction

MBDyn's aerodynamic formulation is based on the unsteady strip theory formulation. While extremely useful to quickly obtain reasonably accurate solutions to many aeroelastic problems, it has many limitations: it is a 2D model, it relies on the availability of C81 aerodynamic coefficients' tables and the modelling of control surfaces is not feasible.
The project aims to develop an unsteady 3D vortex lattice element can be coupled with the finite volume MBDyn's beams through the radial basis function interpolation method.

2 Code development

While searching for a proper way to implement the UVLM solver we came across a pre-written UVLM library by Imperial college, London. The software can be found here.
Thus our target was to create a coupling between the MBDyn solver and the pre-complied library of UVLM solver. Following are the steps which we took to properly couple the two subsystems.

- Create a user-defined module. In our case we defined a class *UvlmInterfaceBaseElem* which is our user-defined module. This class contains functions for reading inputs from the MBDyn input script. This class also contains functions for communicating back and forth the kinematic data and computed results between the MBDyn subsystem and the UVLM subsystem.

- Create UVLM subsystem. In this part we defined all the necessary inputs required for by the UVLM library. We ended up creating an Aerodynamic grid along with classes for straight wake generation and steady velocity field generation. Once all the functions and the classes were defined, we called the functions from the library by passing the required arguments and the results were then sent back to the MBDyn subsystem.

3 Future modifications

For now the coupled system is restrictive in a sense that there are certain aspects which could be added which would make the solver more flexible and robust. Some of the key features which could be implemented are:

- Implement control surface deflection.
- Time varying force inputs can be added to the beam nodes.
- Right now only Straight wake model is implemented. We can also implement a helicoidal wake model.
- Right now only steady velocity field model is added. We can add other velocity models too like turbulent velocity model, gust velocity field, shear velocity field etc.
- Right now the rigid body velocity in the ground frame of reference is considered to be 0. We can input some values for this to make the solver more flexible.
- Only loose coupling is implemented for now. Tight coupling should be implemented next.
- gamma_dot filtering should be implemented.