

Using Ocean-Going Robots to Observe Wave Conditions: CS

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Oregon State University

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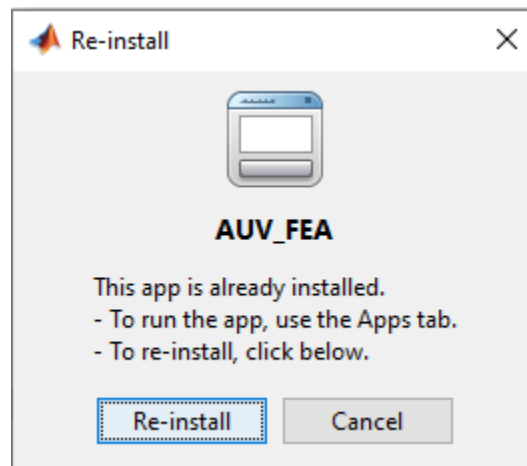
May 23, 2022

Required

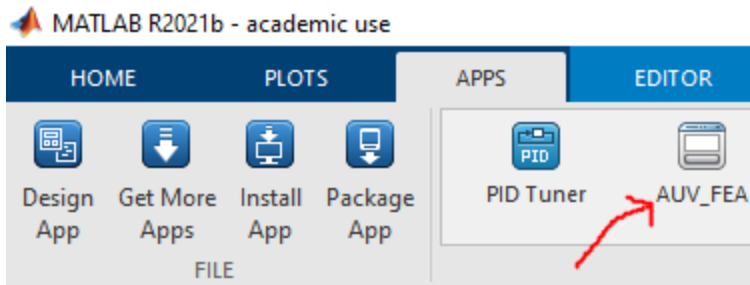
- MatLab
 - Parallel Computing Toolbox
 - Partial Differential Equation Toolbox
- An STL file of the floating object to model
 - The object should be defined so with the correct roll in mind since the app does not currently account for roll when positioning the object to be neutrally buoyant.
- A CSV file of the floating object's estimated point masses
 - The file's extension doesn't matter, but the file browser looks for .TXT files by default.
 - Each line of the file will represent a single point mass in the form:
mass, xpos, ypos, zpos
 - Finally, the points should use the same coordinate system as the in the STL file

Installation

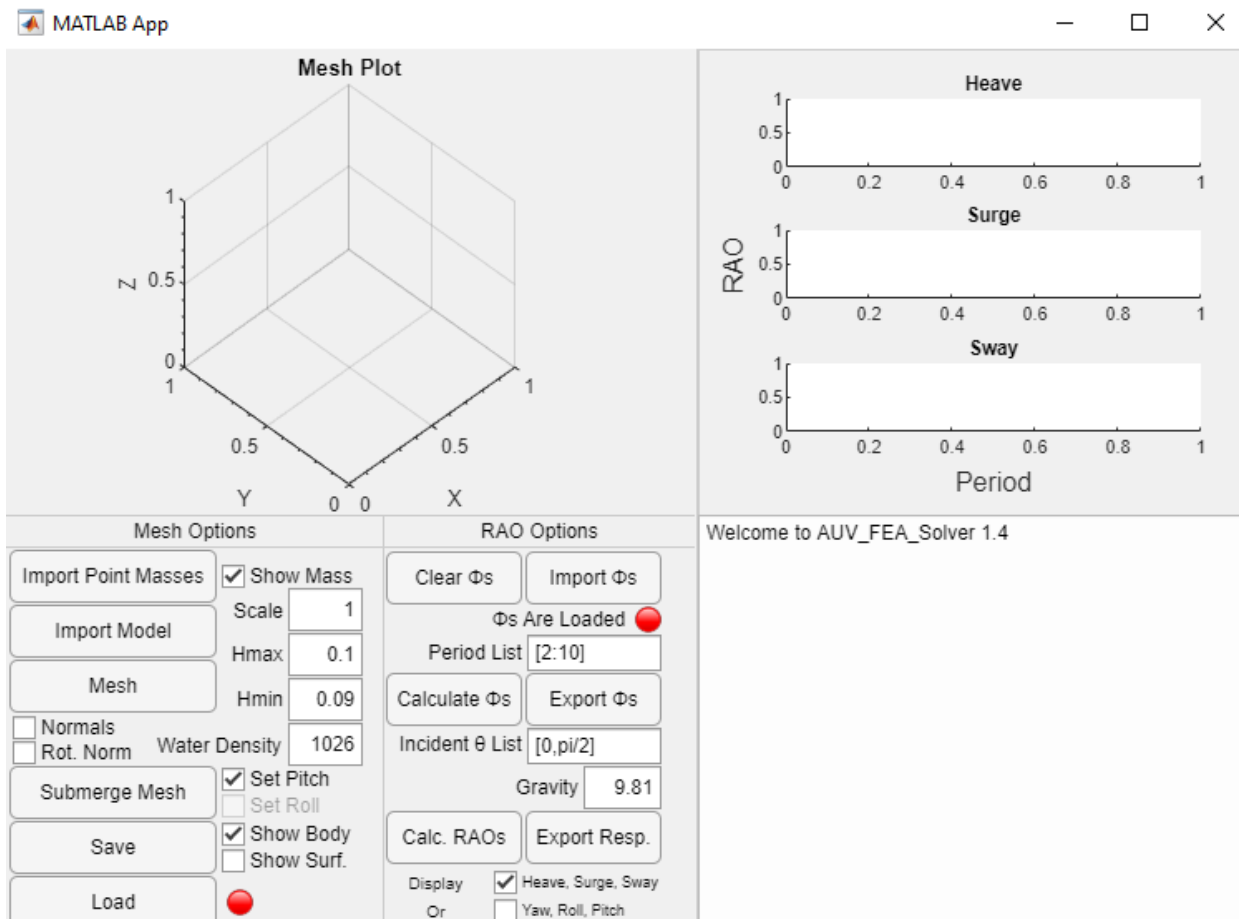
1. Instructions to install Matlab with the Parallel Computing Toolbox, Control System Toolbox, and Partial Differential Equation Toolbox can be found here: <https://www.mathworks.com/help/install/install-products.html>. Or, if you already have Matlab, these toolboxes can be installed from Home > Add-Ons > Get Add-Ons
2. Download and run the file named AUV-FEA.mlappinstall from <https://github.com/exleyt/Glider-FEA>
3. Click Install



4. In Matlab, navigate to Apps > AUV-FEA. Clicking this button will run the project.



Application Layout (Version 1.4)

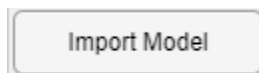


Work Flow (Version 1.4)

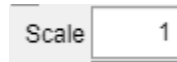
1. Import your point mass file with the "Import Point Masses" button
 - a. Masses can be toggled on the 3d plot with the "Show Mass" checkbox



2. Import your object STL binary file with the "Import Model" button



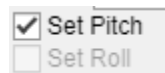
- a. Scale the model by changing the “Scale” field if needed



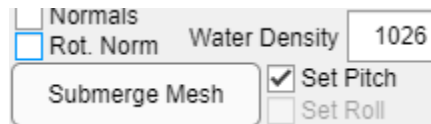
3. Mesh the object using the “Mesh” button and fields “Hmin” and “Hmax.” The lower the values of H, the more accurately the mesh will resemble the model.



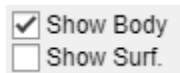
- a. Mesh uses the built-in MatLab function generateMesh(). Specifically, generateMesh(Model,'GeometricOrder','linear','Hmin',Value,'Hmax',Value); <https://www.mathworks.com/help/pde/ug/pde.pdemodel.generatemesh.html>
 - b. Once the object has meshed, you can use the checkboxes “Normals” and “Rot. Norm” to display the normal and rotational normal vectors respectively.
4. Next, determine if the object is symmetrical about x and y-axis rotations. If so, then uncheck “Set Roll” and “Set Pitch” respectively to tell the app to ignore finding those rotations.



- a. “Set Roll” is a feature still in development. For now, neutral buoyancy can only be obtained through pitch rotations and vertical movement.
5. Now, set the expected water density and click the “Submerge Mesh” button to automatically move the mesh to a position and angle of neutral buoyancy. This will also create a surface mesh of the submerged object.



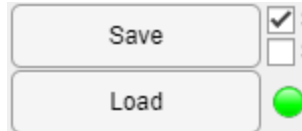
- a. Afterward, you can switch between viewing the original body and the new submerged body using “Show Body” and “Show Surf.” respectively.



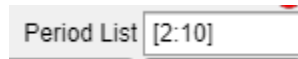
- b. Note that the units used are all relative, so it is on you to keep them consistent.
6. Once the object’s position is set, you can then use the Mesh button again, with larger Hmin and Hmax values, to re-mesh the object with fewer triangles.



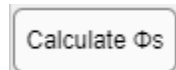
- a. If you have your own CAD software that you want to use for the mesh then skip this step.
7. If everything went well, then the light next to “Load” should turn green. Now you are free to “Save” your object and continue. You can also “Load” an existing save file to skip to this step.



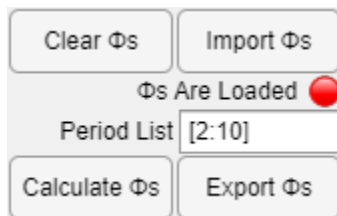
- a. If you have you want to re-mesh the object with your own CAD software, then open the save folder and change the “SurfaceMesh.STL” file. Then, after loading the save, double-check that mesh hasn’t been improperly scaled. If it has, the issue will need to be fixed before continuing.
8. Set "Period List" to a list of periods you want results for using a standard Matlab vector definition. <https://www.mathworks.com/help/matlab/ref/colon.html>



9. Now click “Calculate Phis” to begin the discrete velocity potential calculation.



- a. You will get a message of the estimated number of minutes the entire process will take and updates on how far along it is. However, once it is started, it can only be stopped through the task manager, so make sure you have enough time to run it.
- b. Velocity potentials are accumulated. In other words, you can calculate for periods [2:4] and then again for [6:8], and internally the potentials for periods [2:4] union [6:8] will be stored.
- c. To fully utilize your system, make sure to set the preferred number of parallel pool workers to the number of cores + hyperthreads on the system. <https://www.mathworks.com/matlabcentral/answers/125161-hyperthreading-number-of-cores-parallel-computing-toolbox>
10. Once you have calculated velocity potentials for all of your periods, the light above periods will turn green indicating you can continue.
 - a. You can now clear all of the potentials calculated with “Clear Phis”, export them to a file with “Export Phis”, or import them from file with “Import Phis” to skip to this step.



- b. Note that importing velocity potentials will clear any already calculated. You can add more to an imported file, but not combine files by importing one and then the other.
11. Define a list of incident wave angles as a vector in “Incident Theta List” like with “Periods List” and choose an estimate of gravity for where you are deploying.

Incident θ List	[0,pi/2]
Gravity	9.81

- a. “pi” can be used like a number and will correctly translate to 3.1415...
 - b. Angles are defined counter clockwise from $x = 1, y = 0$ from the topdown perspective and act toward $x = 0, y = 0$.
12. Finally, calculate the object’s responses and response amplitude operators at the given periods and angles with “Calc. RAOs”

Calc. RAOs	Export Resp.
Display	<input checked="" type="checkbox"/> Heave, Surge, Sway
Or	<input type="checkbox"/> Yaw, Roll, Pitch

- a. This process is quick and will hang at the end while the plots are updated.
- b. The RAOs can be switched between heave, surge, and sway motions and yaw, roll, and pitch motions with their respective checkboxes.
- c. The “Export Resp.” button can then be used to export the object’s responses (not RAOs) for use elsewhere. The export file button is defined as such:
 - i. The first line has the number of angles followed by each angle in the order it appears and padding zeros. (All separated by commas)
 - ii. The second line has the number of periods followed by each period in the order it appears and padding zeros. (All separated by commas)
 - iii. Every 6 lines afterward are the response for each of the 6 degrees of freedom for the corresponding angle where each direction of freedom is on a new line (x,y,z,rx,ry,rz). Each individual line has the response for corresponding periods separated by commas.