3D visualization of spacecraft dynamics

Introduction to MATLAB Simulink 3D animation toolbox

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- MATLAB Simulink and its 3D animation toolbox
- Basic knowledge to take into account
- Flowchart for the development of a virtual simulator
- Simulation of orbital dynamics
- Simulate of attitude dynamics

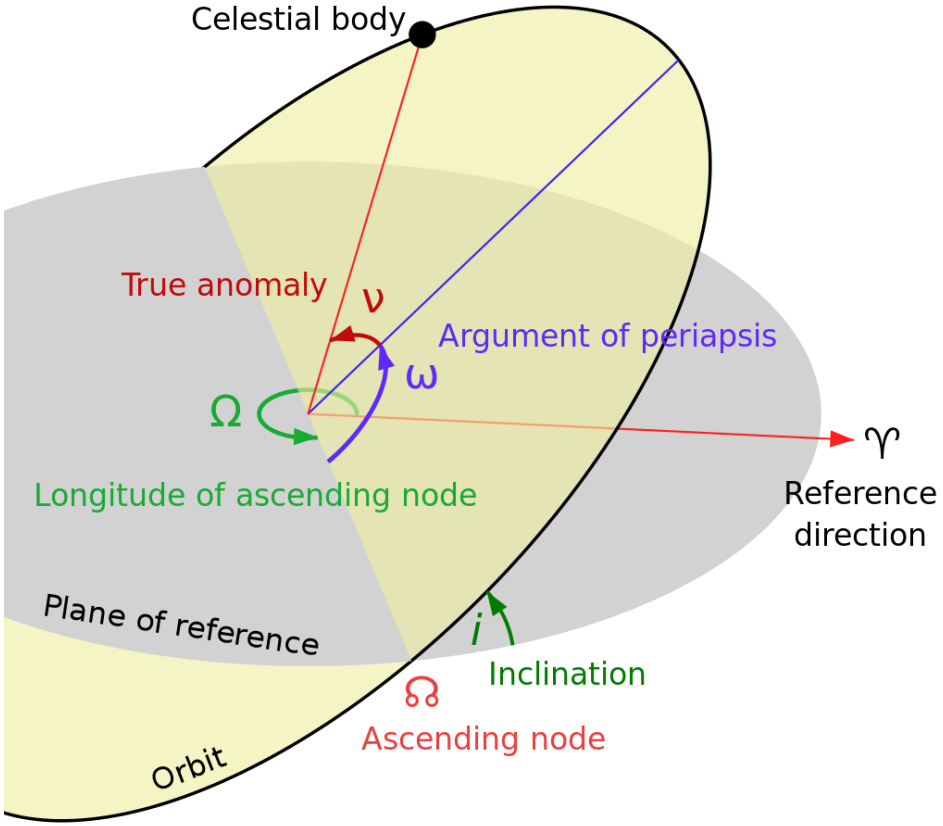
Why it is very useful?

3D visualization helps to improve the understanding of the spacecraft's dynamics

Orbital elements

Two-line orbital elements:

- Right ascension of ascending node (Ω)
- Inclination (*i*)
- Eccentricity (*e*)
- Argument of perigee ω)
- Mean anomaly (*M*)
- Mean motion (*n*)



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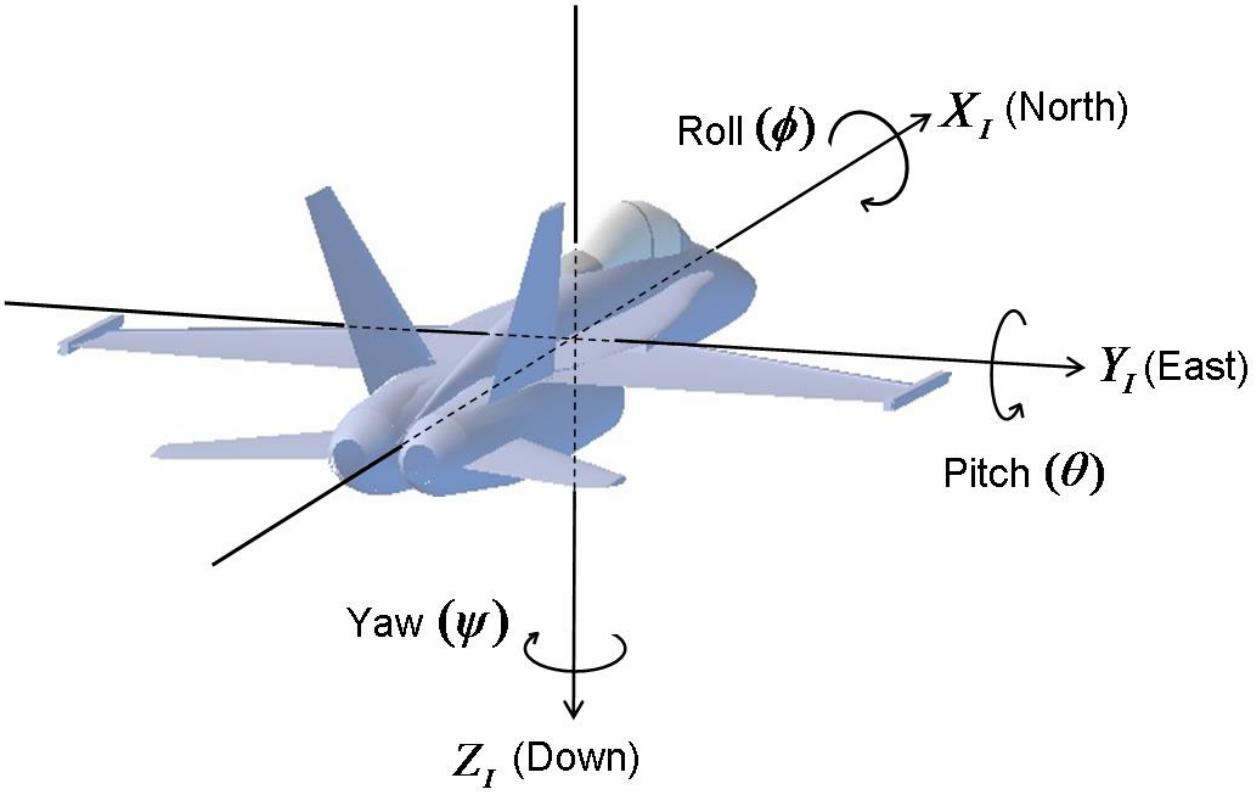
Attitude of a body expressed in Euler angles



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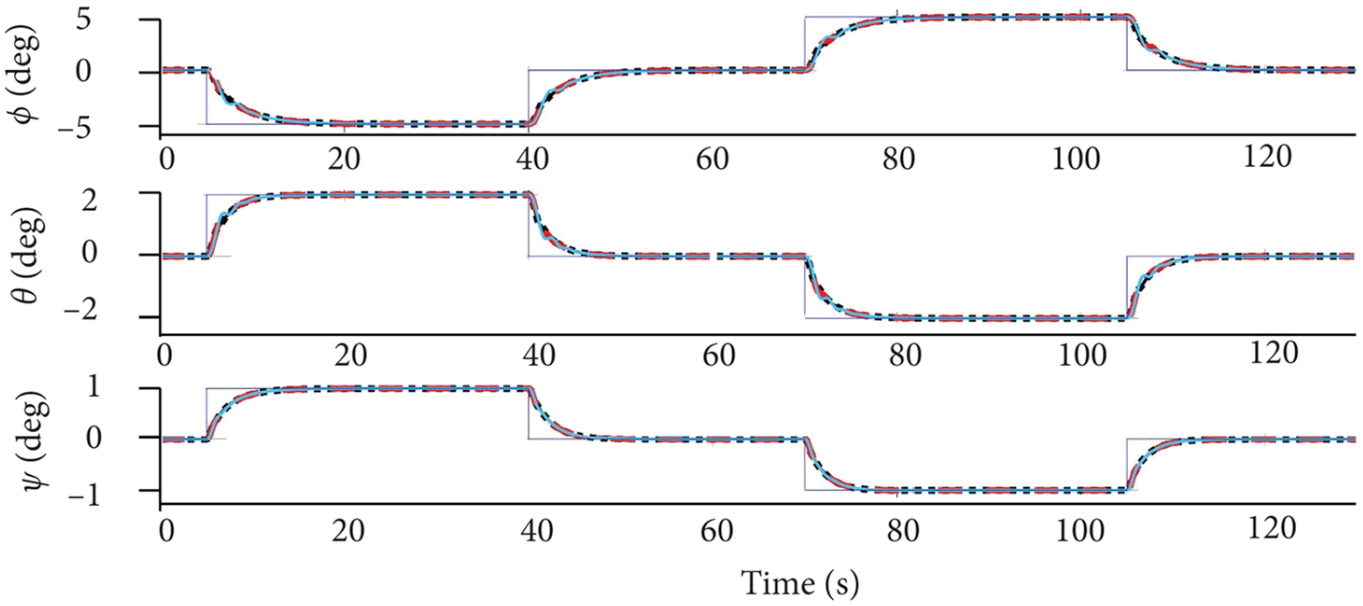

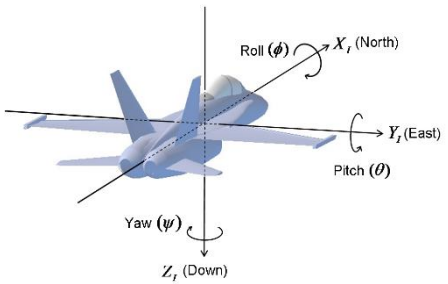

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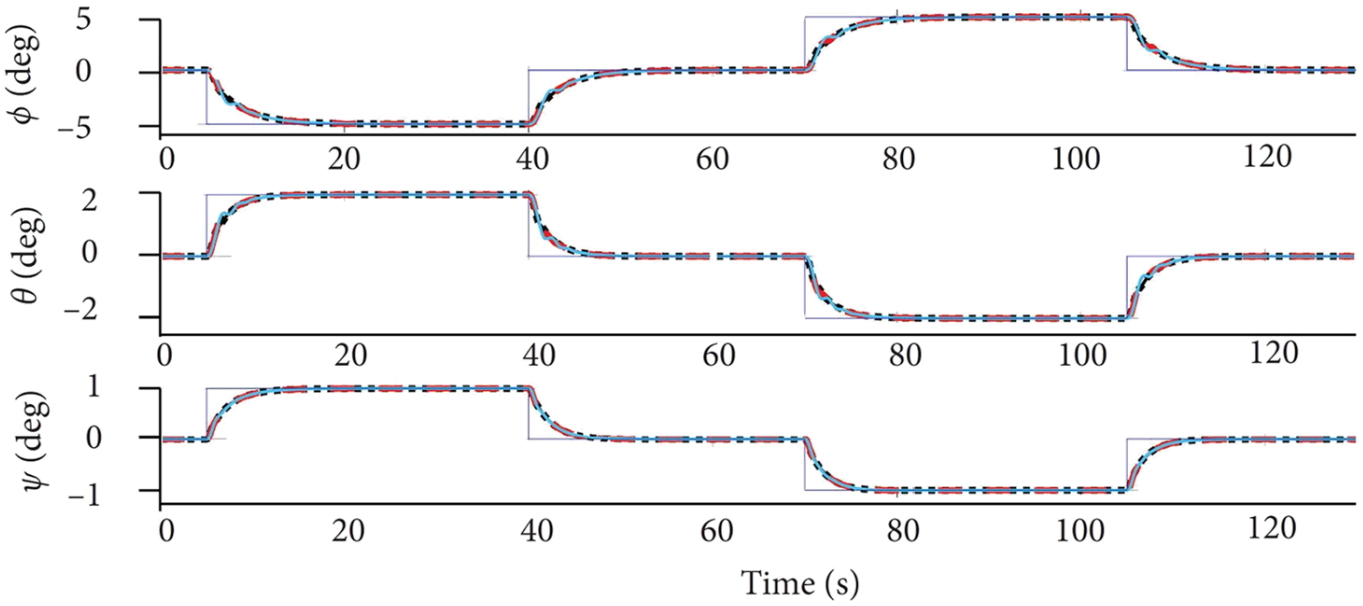

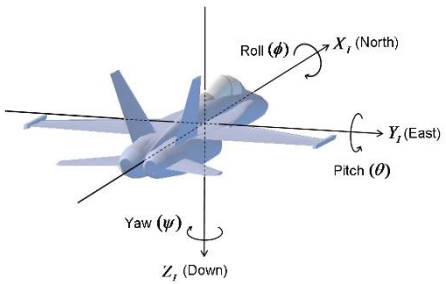

Easy to understand

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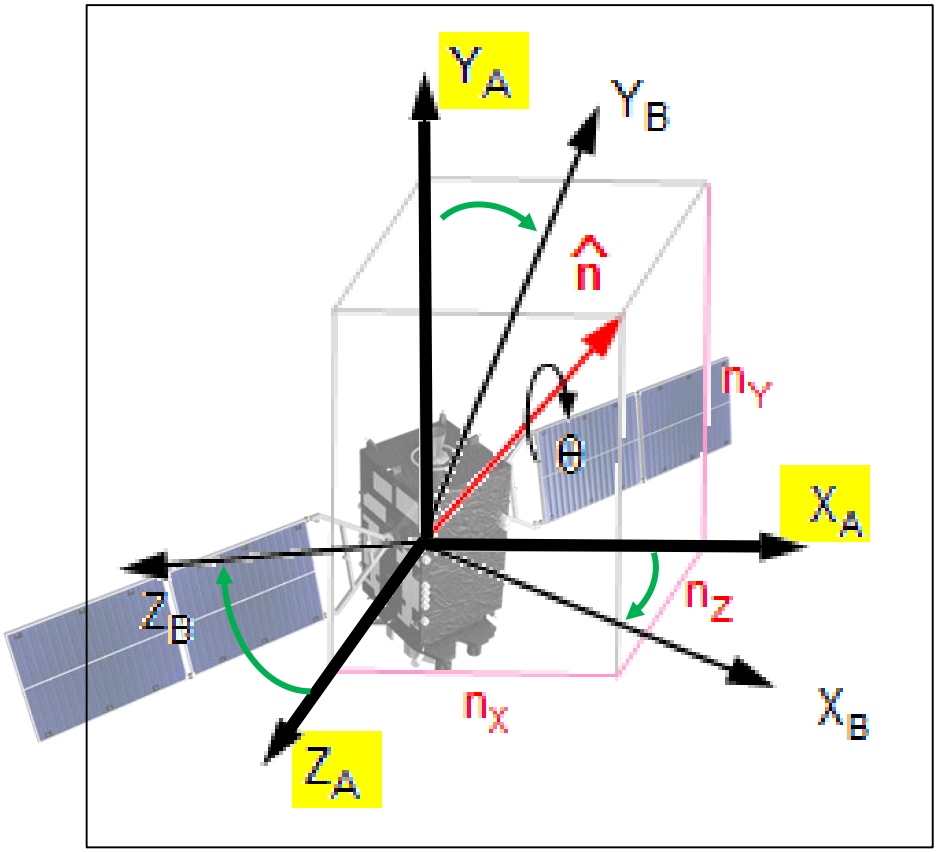
Attitude of a body expressed in quaternions



$$q = \begin{bmatrix} q_s \\ q_x \\ q_y \\ q_z \end{bmatrix} = \begin{bmatrix} \cos\frac{\theta}{2} \\ \|\vec{e}\| \cdot \sin\frac{\theta}{2} \end{bmatrix}$$

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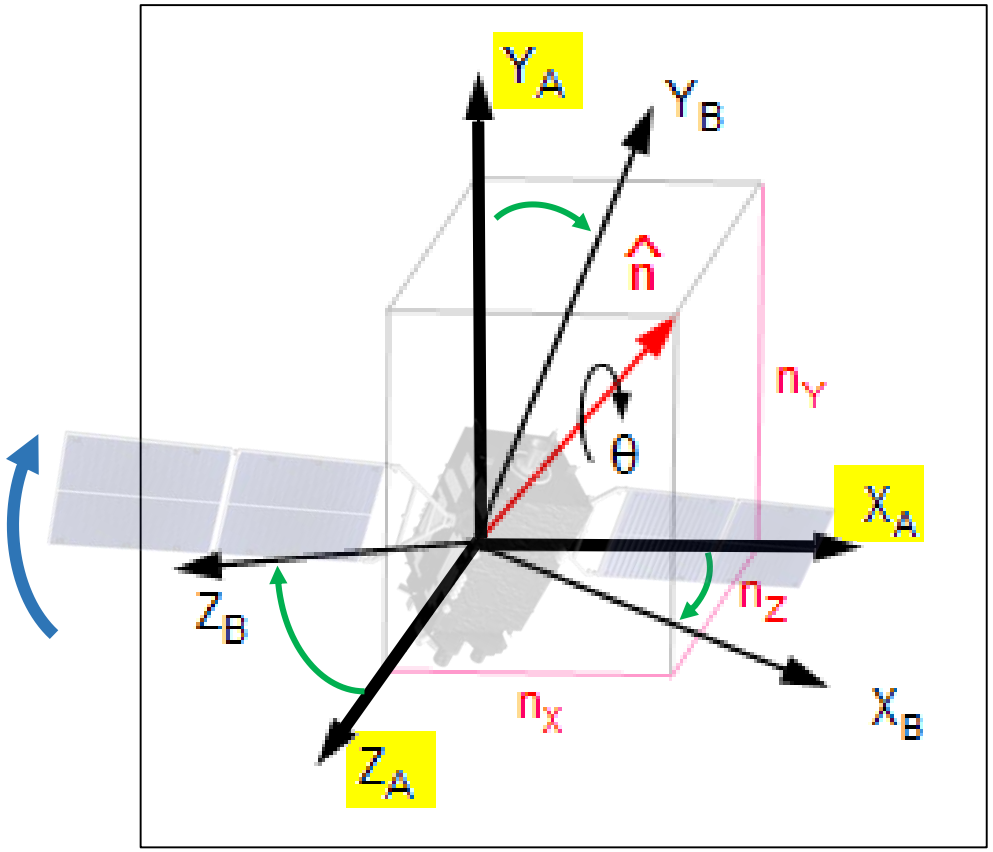

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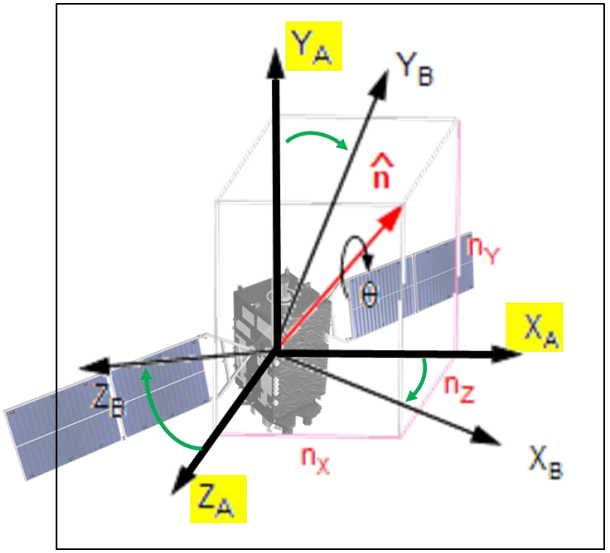

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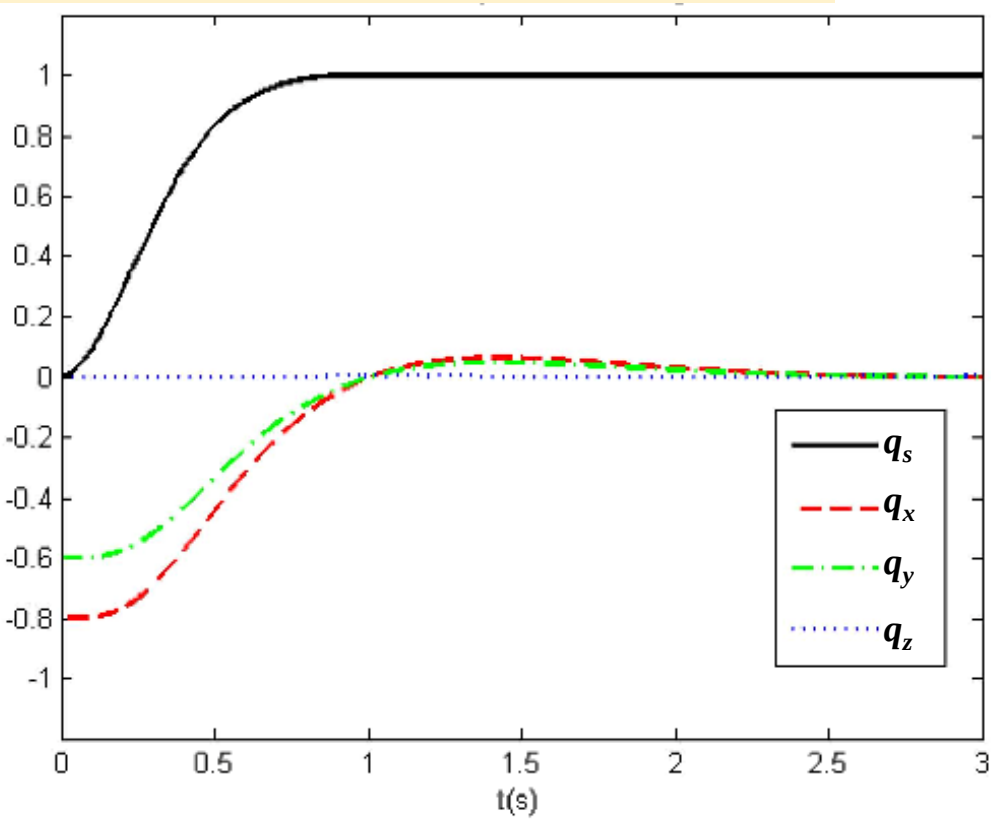

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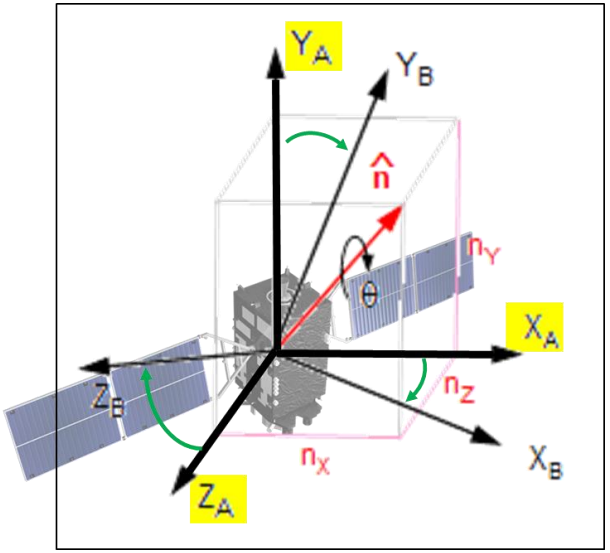

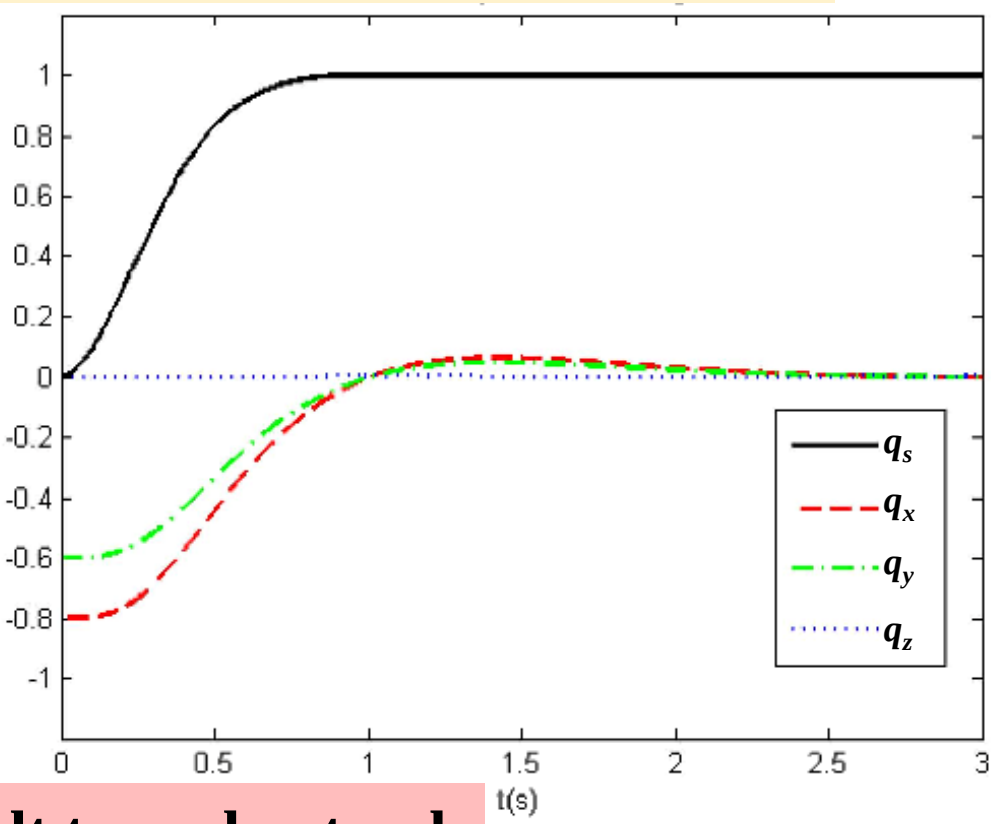

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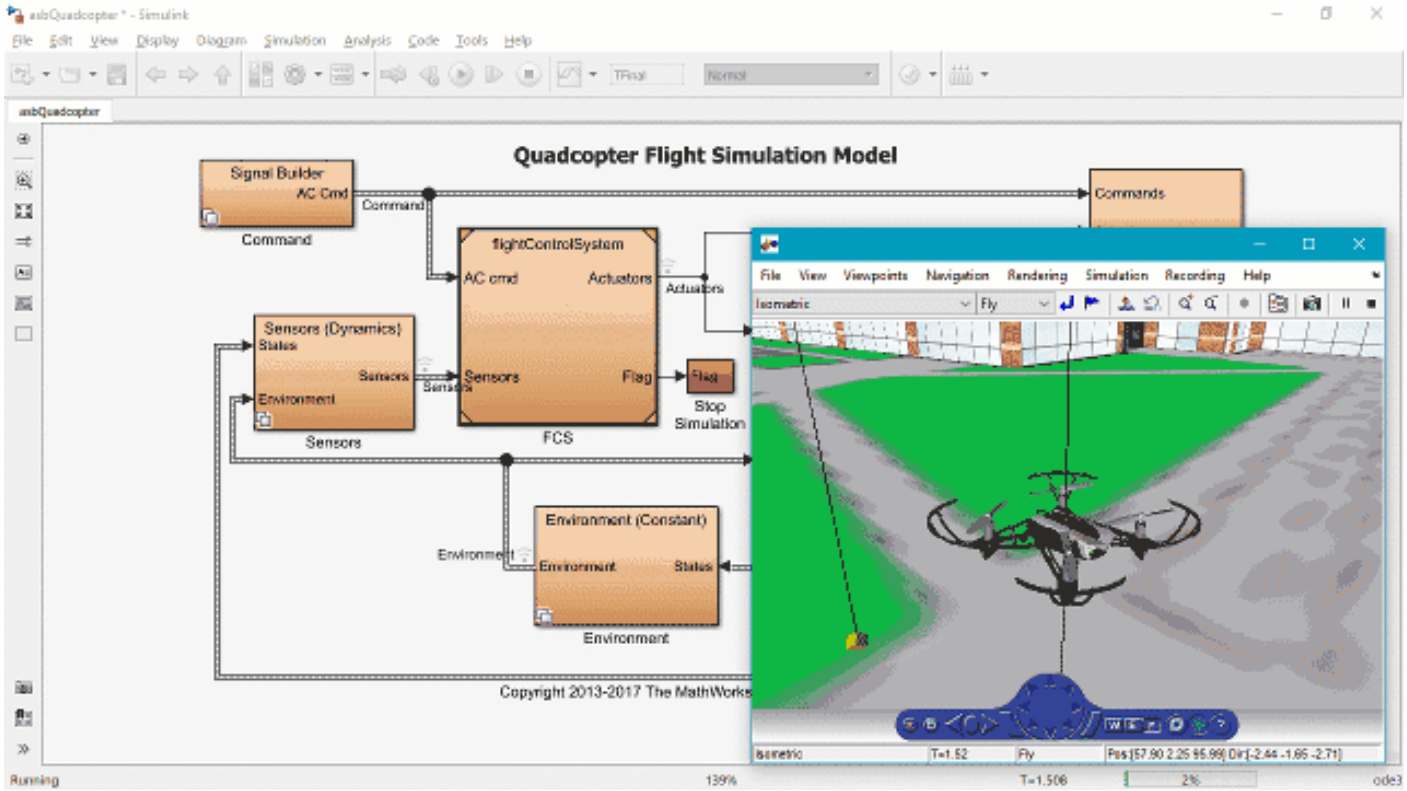
Difficult to understand

MATLAB Simulink and its 3D animation toolbox

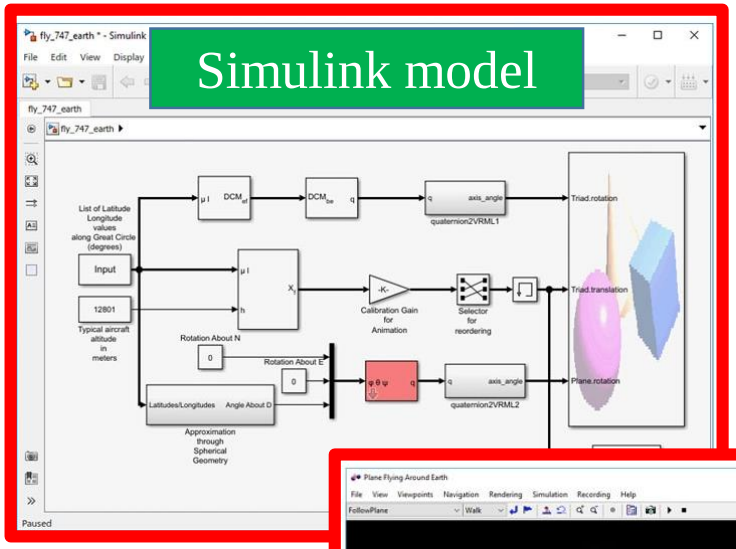
Simulink 3D animation toolbox allows the **connection between a physical model and a 3D virtual environment**



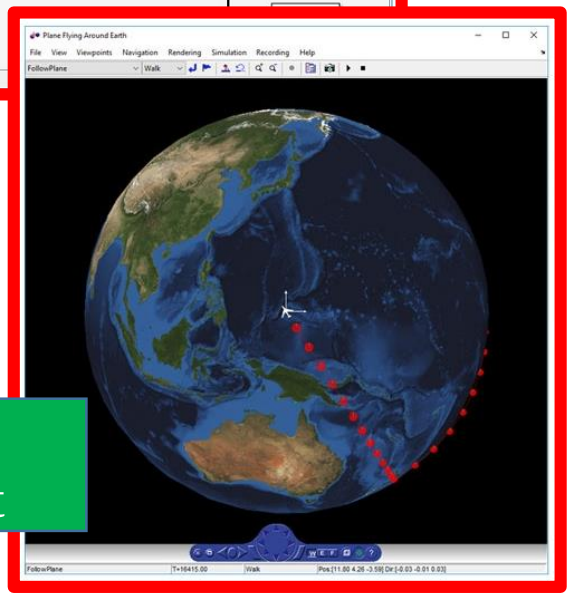
MATLAB Simulink and its 3D animation toolbox

Elements required:

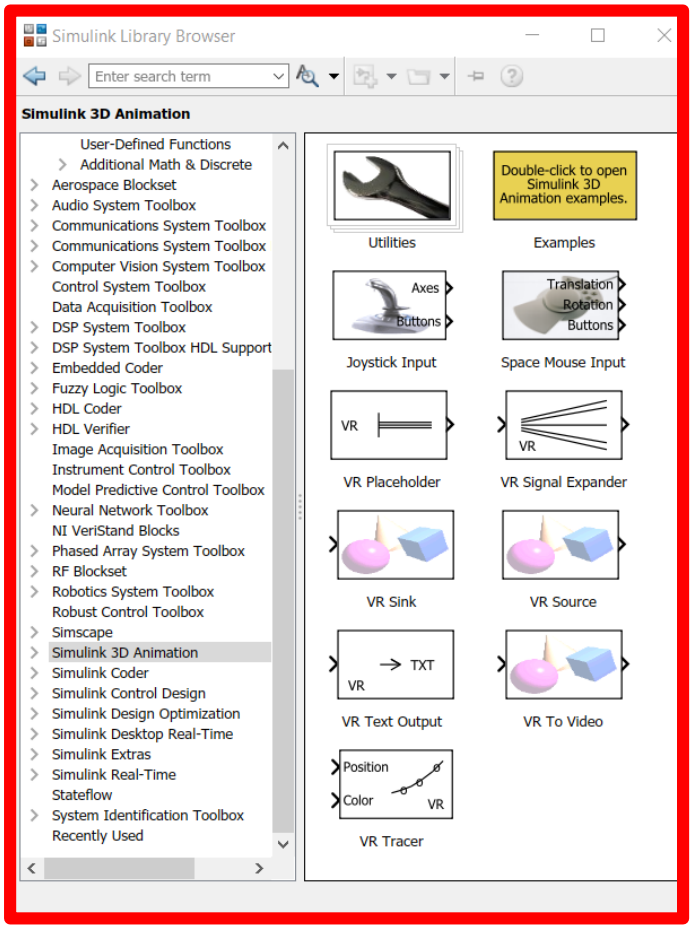
Simulink model



Virtual environment



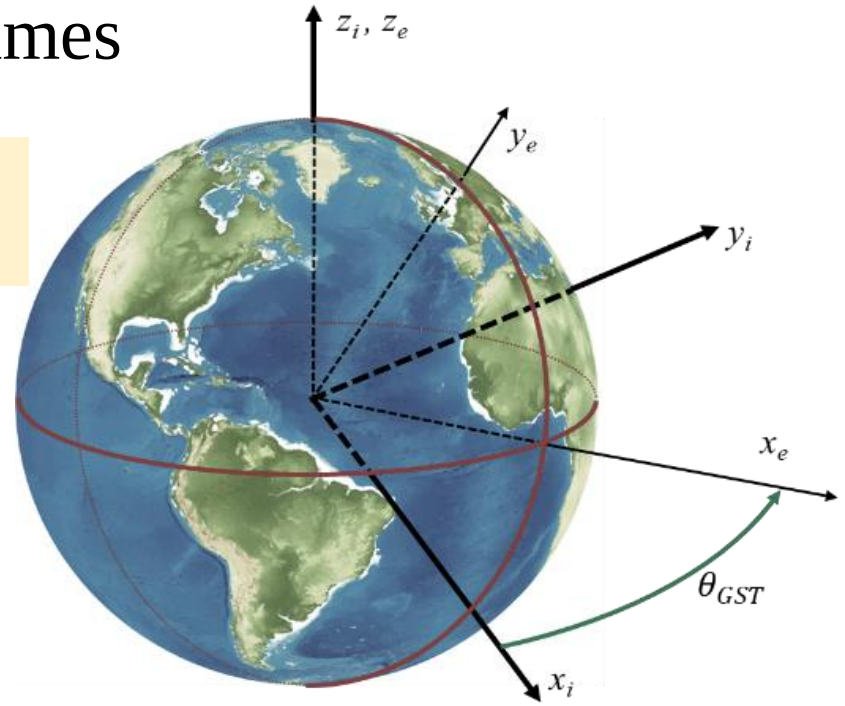
Connection between the model and the virtual environment

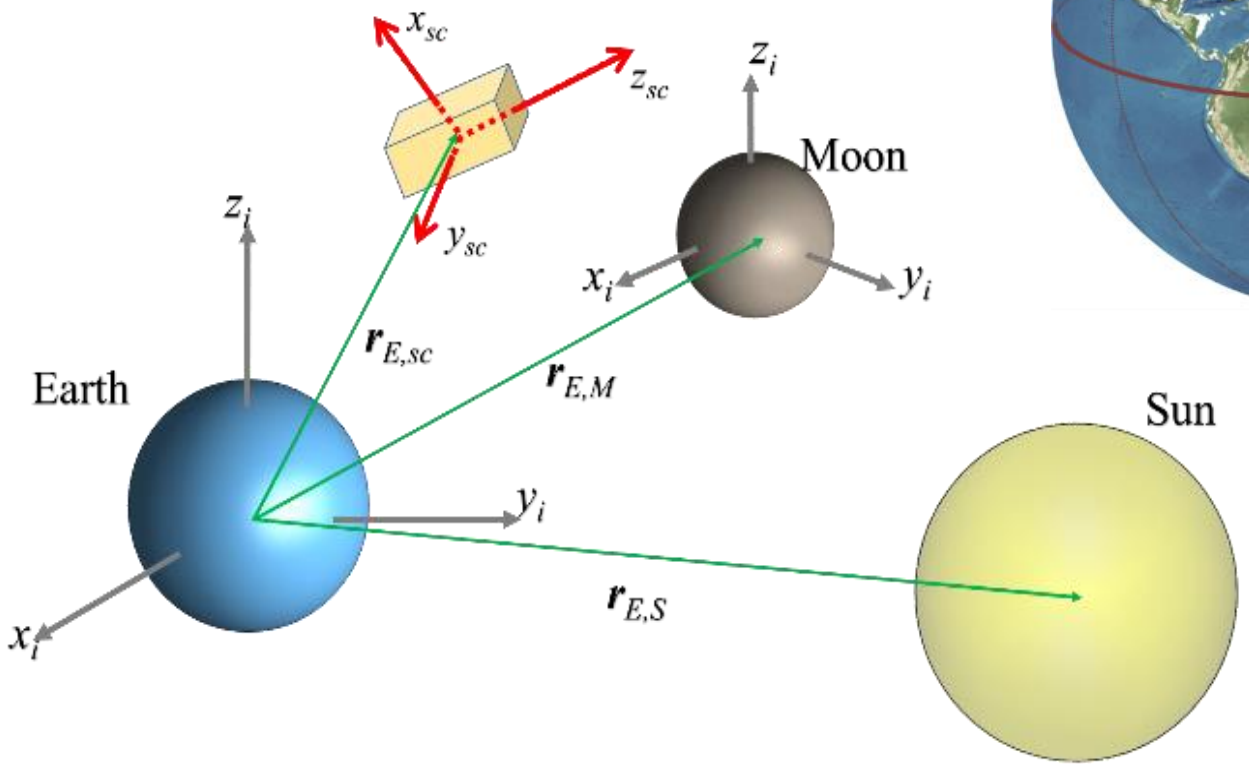


Basic knowledge to take into account

Inertial and fixed reference frames

Defining a reference frame is the first task to do before designing a 3D scenario





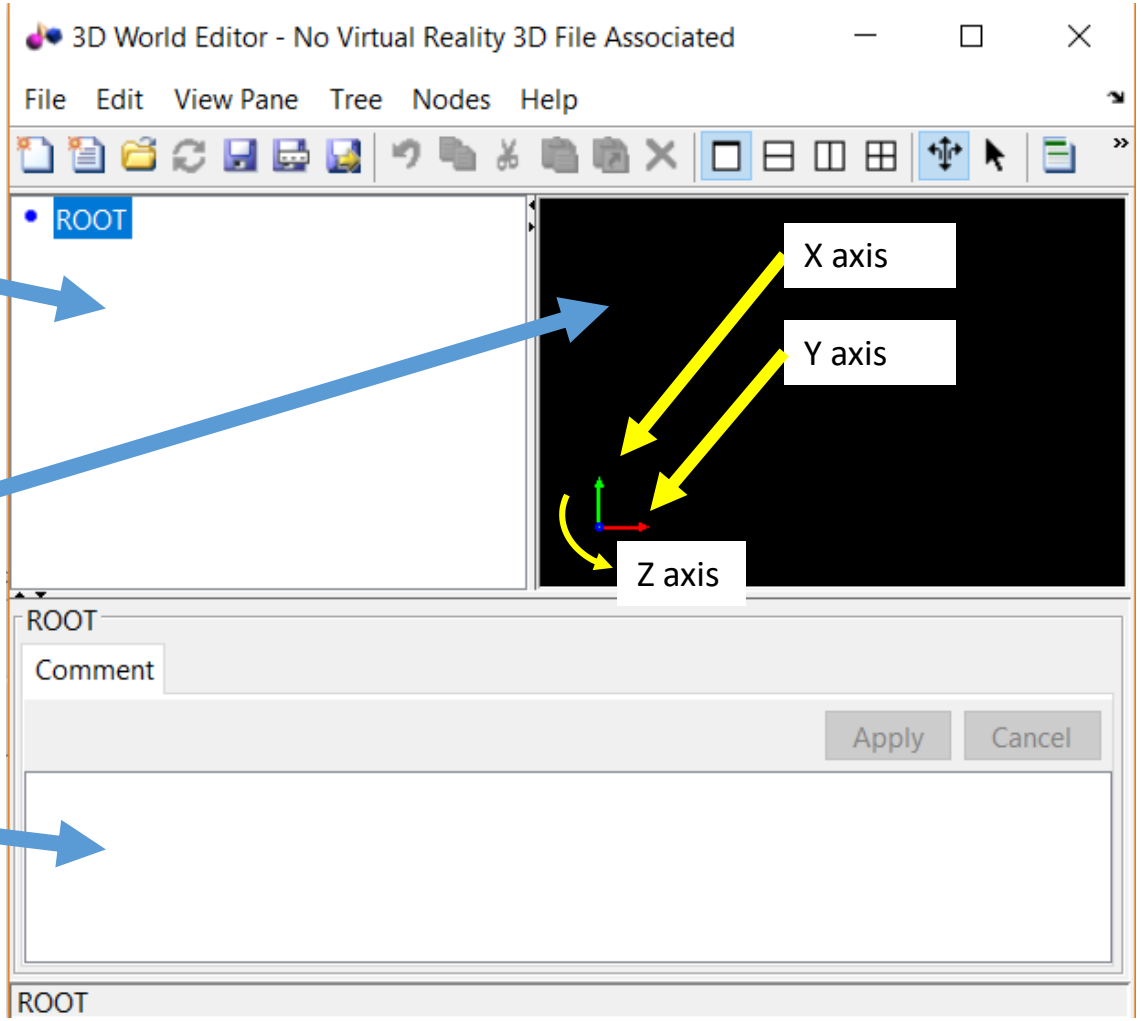
Basic knowledge to take into account

Inertial and fixed reference frames

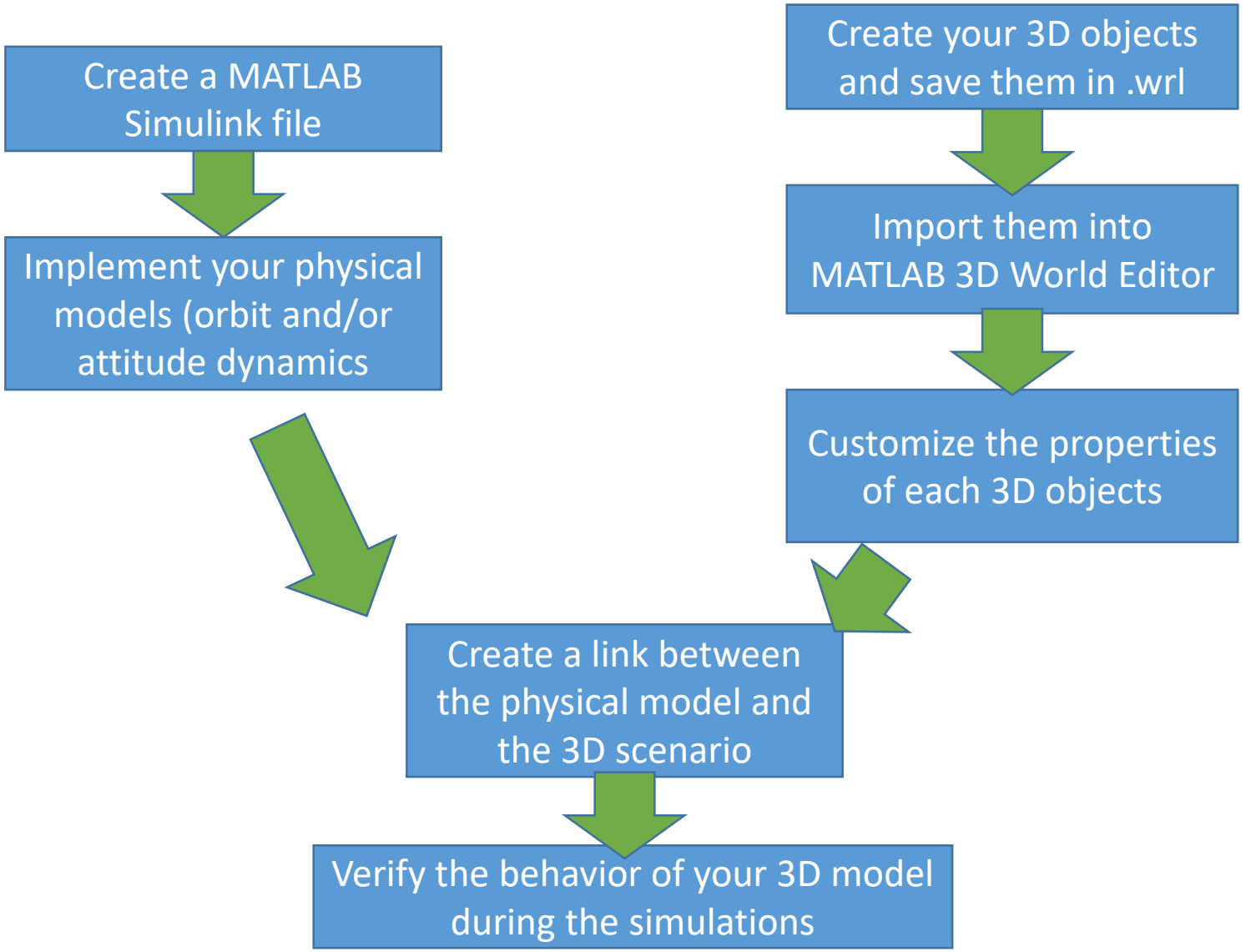
Objects placed in a tree diagram

Preview of the virtual scenario

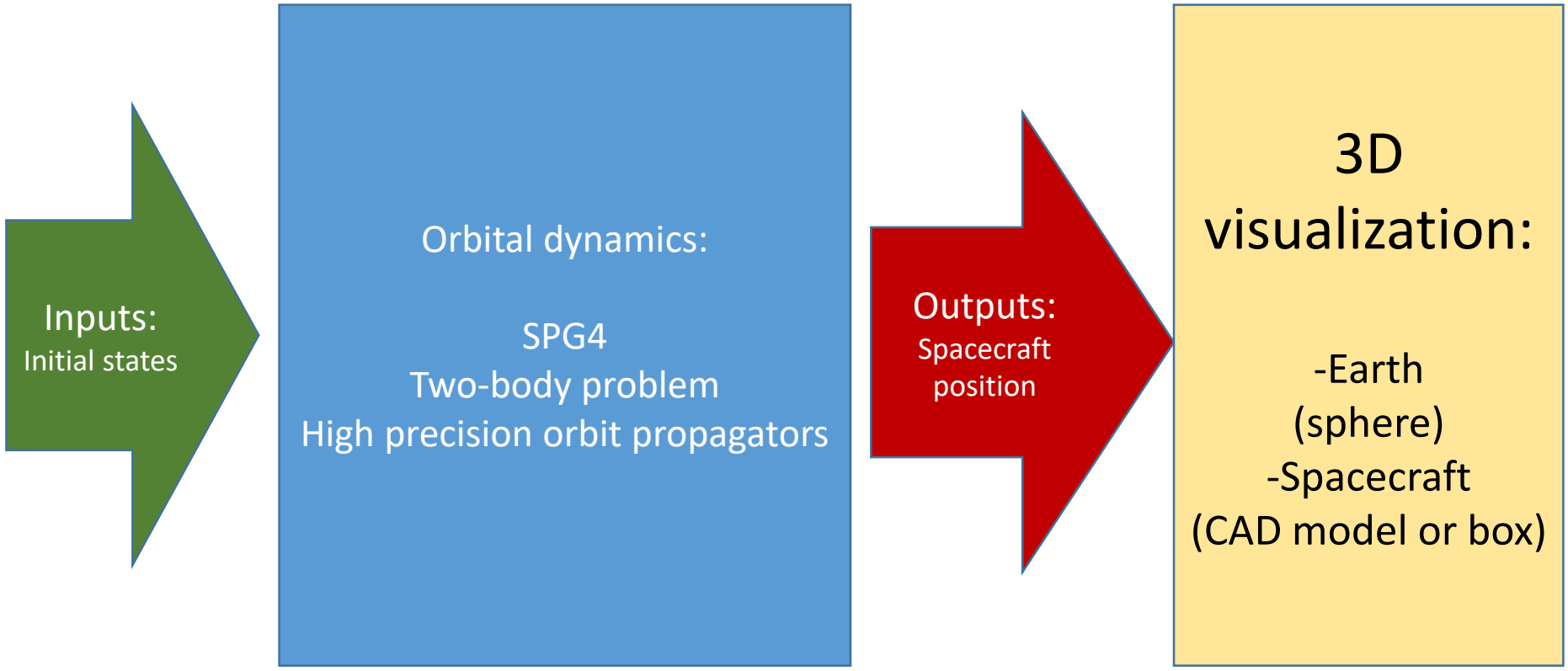
Parameters or comments from each object



Flowchart for the development of a virtual simulator



Simulation of orbital dynamics



Simulation of attitude dynamics