Final Project Assignment:
Orbital Robotics & Distributed Space Systems:
"Analysis of the gravitational effects on a Free-flyer"

Due Date: Friday, 2023-06-09, 17:00.
Deliverable:
Software simulator utilizing as a basis Orolab: max 7 points
Report, max 5 pages: max 5 points

OBJECTIVE

Analysis S/W Tool for the planar orbital and attitude/configuration motion of a Satellite-Robotic Manipulator System orbiting Earth

Instruction
Use `pure' matlab for the numerical simulations.

Modeling Assumptions

1) Consider motion in the plane of orbit
2) Consider the target (chief) moving along a circular orbit, at 500 Km of altitude, according to the KR2BP model
3) The mass of the entire manipulator and the mass of the (ungrounded) base body for the free-flyer need to be chosen similar in value
4) The free-flyer has a square body with a protruding 5 revolute DOF robotic manipulator.

REQUIREMENTS

1) Identify and list all of the mathematical quantities necessary for analyzing the modeled scenario. Decide geometry and numerical values. Prepare a drawing of the geometry of the scenario illustrating the quantity involved. Prepare a project plan and schedule.

2) ***PART 1: Analysis of the translational motion*** by considering the free-flyer to be a point mass:
   1.1: Perform the two numerical lab exercises in Part 4/unit 2. (to check your SW: but do not include in report)
   1.2: Implement a script file named `HCW_IC_MakeFigs' that, when executed, reproduces all figures in the section "Analysis of the spontaneous motion of deputy relative to target for different I.C." of the slides
   1.3: Implement a function that, given initial conditions of relative position/velocity of Deputy w.r.t. target (in physical Cartesian coordinates) compute the minimum total V two-impulse maneuvers (with maximum final time equal to half orbital period)
   1.4: (OPTIONAL) implement a game-like simulation and visualization in matlab, during which in real-time or, as an option that need to be set, in accelerated time, the HCW equations are propagated, while impulsive Delta v control inputs are impressed to the chaser (deputy) through keyboard. The objective of the game is to have the deputy reach the target (chief). The delta V used is computed and visualized.

3) ***PART 2: Analysis of the rotational-internal motion*** The free-flyer equations of motion are developed and numerically integrated by using the recursive approach, and including the gravitational effect. The evolution of the motion, while no torques are acting on the revolute joints is studied (e.g., the free-flyer is at rest at the beginning of the simulation, with the manipulator aligned at a Pi/4 angle w.r.t. local vertical).

NOTES:
-This project assignment is on-purpose not completely specified to leave room to your initiative and creativity!
-TEAMS: are assigned

GRADE Breakdown

SOFTWARE

1) **[point: 0 to 1]** a readme file is included that explains very synthetically how to run the S/W and the main structure of it. The script and function developed have a help section, describing clearly inputs and outputs, and their unit of measurement. The two `main simulations' script file have a user input section which is clearly organized.

2) **[point: 0 to 1]** *Analysis of the translational motion: task 1.2 and 1.3*

3) **[bonus point: 0 to 2] For the optional task 1.4**

4) **[point: 0 to 2]** *Analysis of the rotational-internal motion.* For the analysis of the rotational-internal motion, when running the `main simulation' script, the following figures are produced: figures of the most important quantities for one quarter of an orbit, and figures showing the conservation of momentum and angular momentum up to numerical accuracy.

   [bonus point: 0 to 1] Furthermore, the `main simulation' script file generates an animation (in post-processing) of the motion of the system.

REPORT
<u>REQUIRED FORMAT: the project has to be written in LaTeX, by using the template provided.</u>

5) **[point: 0 to 1]** 20% illustrates the systems (with a figure).

6) [point 0 to 2] 40% clearly explains the choices made, the developed software, the project plan and milestones. It highlights the main challenges and problems, and each team-member's role and contribution.

7) [point 0 to 2] 40% reports your conclusions and comments pertaining the results obtained.