FIELD AND SERVICE ROBOTICS (FSR) – a.y. 2023/2024
University of Naples Federico II
Department of Electrical Engineering and Information Technology

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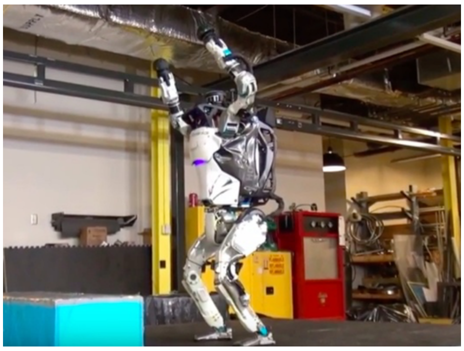
HOMEWORK n. 1




1. Consider the ATLAS robot from Boston Dynamics in the pictures above. On the left, ATLAS is standing. On the right, ATLAS is performing a backflip. If ATLAS actuators can produce unbounded torques, establish whether each of the following statements is true or not, and briefly justify your answer.

- ***a.*** While standing, ATLAS is fully actuated. SI
- ***b.*** While doing backflip, ATLAS is fully actuated. NO

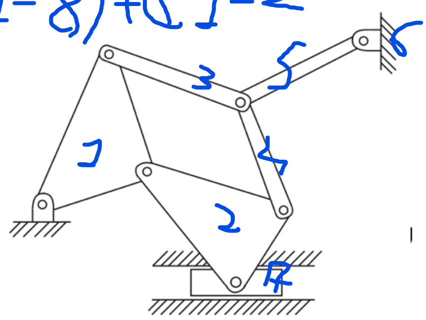
$= -12 + 18 = 6$

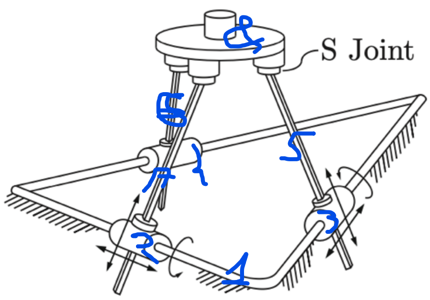
$6(8-1-9)+3+6+9$

$3(7-1-8)+8\cdot 1 = 2$

$m = 7$

$J = 8$





$m = 8$

$J = 12$

2. Consider the planar mechanism on the above-left and the spatial mechanism on the above-right. Determine the number of the degrees of freedom for each mechanism, comparing the result with your intuition about the possible motions of these mechanisms. For each mechanism, write its configuration space topology. $\mathbb{R}^2 \times T^7 \rightarrow I^7$ $\quad \mathbb{R}^3 \times E^3 \times T^3 \times S^2 \times S^2 \times S^2$

chiedere degli intervalli

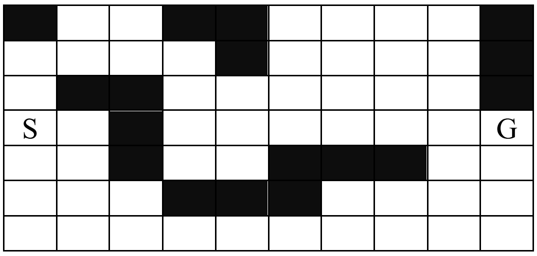
3. State whether the following sentences regarding underactuation or fully actuation are true or false. Briefly justify your answers.

- **a.** A car with inputs the steering angle and the throttle is underactuated. YES
- **b.** The KUKA youBot system on the slides is fully actuated. — YES/NO → Lezioni
- **c.** The hexarotor system with co-planar propellers is fully actuated. NO
- **d.** The 7-DoF KUKA iiwa robot is redundant. YES

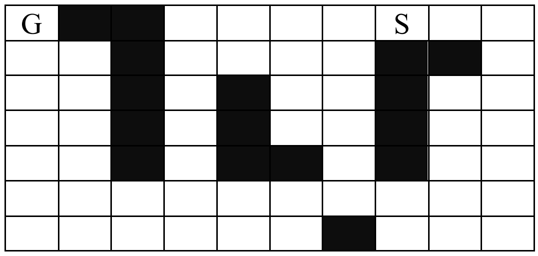
4. Consider the map attached as *image_map.mat*. The 0 value represents an obstacle, the 1 value is a free point in the partitioned map. To show the map, use the command *imshow(image_map)*. Implement yourself in a software program the RRT method for a point robot moving in the above map from $q_i =$

$[30 \quad 125]$ to $q_f = [135 \quad 400]$. Select a suitable maximum number of iterations and show the obtained graph is a solution has been found. Otherwise, report a failure and increase the maximum number of iterations. Repeat the procedure for a finite number of times at your choice. [Hint: the robot is a point; therefore, the collision check algorithm is very simple: for a given point, you must just check whether the associated value of the map is 0 or 1.]

5. Given the map below (select the one based on your matriculation number), implement a software program for the motion planning method based on the numerical navigation function. The black cells are obstacles, the cell with S is the starting one, the goal cell is denoted by G. If the algorithm is successful, provide the sequence of cells from the start to the goal. First choose 4 adjacent cells, then 8 and comment on the comparison.



Odd matriculation numbers



Even matriculation numbers

<u>NOTE:</u> It is worth recalling not to report theory in the report. Put all the plots you think are the most important to understand the performance of the code you implemented, and critically comment on the results. Attach the code with your submission in a ZIP file. If you overcome the submission limit on Moodle, you may link in the report a GitHub, Dropbox, or Google Drive link (make these links public, if possible, to avoid waiting for permission to download the files). The software is left free. Matlab is anyway suggested to save time.