ROBOTICS (06/07/2022)

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The exam will be graded IFF the following recommendations have been taken into account:

- Use only the space provided, you can use scratch paper
- Write clearly so that the teacher can easily understand your answers
- Write your name, surname, and student id on scratch paper if you turn it in
- You are not allowed to use any programmable device (e.g., smartphone, calculator, etc.)
- You can use pen or pencil, paper will be provided, you cannot use notes or books

NAME: _____

SURNAME: _____

Student Id: _____ Laureando/ERASMUS? _____

Exercise 1 – Sensors and Actuators [2+2 points]

Consider a single RGB camera used in a mobile robot for localization.

- 1.1: Which sensor model would you use? Why?

- 1.2: Which localization algorithm would you use? Why

Exercise 2 – Robot Odometry [1+1+2 poinst]

With reference to the agricultural robot in the picture on the right answer the following questions.

Make assumptions about the information you do not know by looking at the picture and providing their motivation.

It is very important I understand your reasoning while grading! I suggest you make notes on the picture to help us in understanding your answers when grading.

- 2.1: Enumerate all the sensors you see in the picture and make a hypothesis of their use(put a reference in the picture, e.g., a number or a letter)

- 2.2: Which sensors you do not see in the picture but you are quite sure they are installed on the robot? (Continue the enumeration and add the numbers/letters to the picture)

- 2.3: Describe the actuators of the robot and provide its direct kinematics (with a picture, not just formulas)

Exercise 3 – Robot Motion Control [2+2+2+2 points]

With reference to obstacle avoidance and trajectory tracking, answer the following questions

- 3.1: In VHF (and VHF+) how do you select which is the best direction to take among the possible ones?

- 3.2: In DWA, how do you select which is the best (v, w) pair to choose among the possible ones?

- 3.3: What is the navigation function proposed with the global approach? How does it improve on the criteria described in the previous points?

- 3.4: How do you set the weights of the navigation function described in the previous question?

Exercise 4 – Robot Operating System [1+3 points]

Answer the following questions:

- 4.1: What are ROS nodes and what are they used for?

- 4.2: What are topic, services and actions? Provide definitions and highlight differences.

Exercise 5 – Simultaneous Localization and Mapping [1+1+1]

Let's consider the Simultaneous Localization and Mapping problem; answer the following questions:

- 5.1: What is full SLAM?

- 5.2: How can full SLAM be solved using an EKF-SLAM algorithm?

- 5.3 Can you spot a problem in implementing full SLAM with and EKF?

Exercise 6 – Planning [3]

Apply the A* planning algorithm to the following problem reporting the open list at each step, and for each state in the open list its f value. Use the 4-cell connectivity (vertical and horizontal) and the Manhattan distance heuristic, i.e., the sum of the absolute values of the differences between the current cell coordinates and the goal cell coordinates (ignoring the presence of obstacles). Break ties with low numbers.