Autonomus Mobile Robots
Spring 2022
Exam 1
2022-04-13
Time Limit: 180 Minutes

This exam contains 1 page and 6 questions. Total of points is 36.

Instructions:

1. It is a **CLOSED BOOK EXAM**. No additional materials are allowed during the exam.
2. Answer all the questions (the points for each question are indicated in brackets at the beginning of each question).
3. Write the answers to the questions in **ORDER**.
4. Start the answer for each question on a **FRESH** page of the answer sheet.
5. Sign **EACH** answer sheet.

Good luck!

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1. One of the mobile robots' most popular kinematic configurations is differential drive (DD) (i.e., Pionier robot you have been using in the practical assignment).
   (a) (3 points) Explain and contrast holonomic and non-holonomic constraints. Provide examples of holonomic and non-holonomic constraing using real-world robotic platform.
   (b) (3 points) Using DD as an example describe and explain closed-loop control.
2. Perception plays a fundamental role in robotic autonomy.
   (a) (3 points) Provide an example of a range sensor you have learned about during this course. Describe the principle of its operation. Describe the sources and effects of distortion for this sensor.
   (b) (3 points) Provide an example of an internal sensor you have learned about during this course. Describe the principle of its operation. Describe the sources and effects of distortion for this sensor.
3. Robotic Localisation can be solved in multiple ways. One of them is to use the robot's observations and sensor readings.
   (a) (3 points) Describe and compare two types of Kalman Filter you have learned about during this course.
   (b) (3 points) Explain how EKF can be used for robot localisation.
4. In the previous question, you have described robotic localisation using a map. In this question, we will focus on the map building problem. Currently, the majority of robotic maps are built using SLAM.
   (a) (3 points) Describe the frontend in SLAM. Provide examples and describe algorithms that are used in the frontend.
   (b) (3 points) Describe the backend in SLAM. Provide an example and describe an algorithm that is used in the backend.
5. Map-based localisation is not the only way to solve the robot positioning problem. Another one is the use of GNSS.
   (a) (3 points) Describe and expalin the architecture of GNSS system.
   (b) (3 points) Describe and explain the sources of errors of GNSS system.
6. For robots to successfully execute their tasks, they have to be able to move in the environment. Before the robot moves, it is necessary to plan the robot's path.
   (a) (3 points) Describe and explain the Forward Search Algorithm. How this algorithm relates to the motion planning problem?
   (b) (3 points) Describe and explain a graph-based motion planning algorithm of your choice.