Structure and Synthesis of Robot Motion
Homework Assignment 2 (Semester 2 - 2011/12)

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Instructions:

1. This homework assignment is to be done *individually*, without help from your classmates or others. Plaigarism will be dealt with strictly as per University policy.

2. Solve all problems and provide your **complete** solutions (with adequate reasoning behind each step) in a computer-printed or *legibly* handwritten form.

3. For computational questions, include your code (e.g., Matlab commands) and all major numerical parameters involved.

4. This assignment will count for 10% of your final course mark. It is due at 4 pm on 1^{st} March 2012.

Questions:

1. This assignment is concerned with the learning and structuring of controllers, in a navigation example. This assignment is to be completed in Matlab.

   Consider the following setup: an office environment is represented by a 100x100 matrix (which will be provided as a binary map, where a 0 corresponds to free space, and a 1 to an obstacle). A robot occupies a single block of this gridworld and can move deterministically in one of the four cardinal directions (N, S, E, W) at any point in time, provided that destination block is unoccupied. The robot can sense everything in a 7x7 grid centred on the position of the robot. A predefined start and goal location is provided, and the robot is tasked with moving from the start to the goal in the shortest time possible.

   (a) Construct a breadth-first A^* solution to reach the goal (ref: Chapter 2, *Planning Algorithms*, LaValle). Comment on the assumptions needed by the robot to use this solution.

(b) Now construct a single global potential function (possibly as a sum of attractive and repulsive functions) to reach the goal. Comment on the knowledge needed by the robot to use this solution.

(c) Construct a set L of local potential functions, where each is a vector field, for this domain using the approach of Conner, et. al (as discussed in lectures). Use a backchaining algorithm to perform a search over the local controllers in L to find a sequence which the robot can follow to reach the goal (see also Burridge, et. al. as discussed in lectures). What assumptions are needed for the use of this method?

(d) You will be provided with three other maps. Solve these three problems together using each of the three approaches you have developed: A^*, a global potential function, building and sequencing of local potential functions. Compare the total time required for each method. What are the strengths and weaknesses of each approach?

[100 marks points (20 + 20 + 30 + 30)]