Structure and Synthesis of Robot Motion
Homework Assignment 1 (Semester 2 - 2011/12)

Subramanian Ramamoorthy
Benjamin Rosman

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 9^{th} Feb. 2012.

Questions:

1. Consider a circular mobile robot, 0.5 m in diameter, with 25 distance sensors equally spaced along its perimeter. The motor apparatus is modelled as two 'treads' a_0 and a_1, $\in [-1, 1]$ (when both are moved together, the robot goes forward subject to a maximum speed of 0.25 m/s; when they are moved in opposite directions, the robot rotates subject to a maximum angular speed of 100 deg/s). Build a simple simulated version of this robot in Webots and perform the following experiments with the robot, following the procedure of the Pierce and Kuipers paper discussed in lectures:

   (a) It is initially placed in a room of dimensions 6 m by 4 m. Generate a random trace of the distance sensors by walking the robot around this room. Using this trace, perform the unsupervised learning procedure of the paper in order to reconstruct the structure of your sensor array. Show *all of the intermediate steps and results*, including code.

In particular, show your inter-sensor distances for the full array, initial groupings, complete groupings over the array, metric scaling results and your final summary results.

(b) Now, change the room to 6 m by 1.25 m. Repeat the exact same procedure, provide all of the same results and comment on observed differences.

(c) Again use the 6 m by 4 m room. For this experiment, add a small amount of Gaussian noise (mean 0m, variance 0.03m) to all sensor readings. Repeat the procedure, and comment on any differences to the results in (a).

(d) Again use the 6 m by 4 m room, but do not use the noisy sensors. For this experiment, add a second circular mobile robot. This is to act as a dynamic obstacle, using some simple Braitenberg-style rules to 'bounce' off walls and the learning robot. The obstacle should 'bounce' such that the angle of reflection equals the angle of incidence plus some noise (normally distributed, with 0 mean and 5% of the angle variance). Repeat the learning procedure for the first robot in the presence of this dynamic obstacle, and comment on differences to (a) and (c).

[100 marks points (25 + 25 + 25 + 25)]