Place Recognition and Homing Using the Snapshot Model

In the paper “How honey bees use landmarks to guide their return to a food source“, Cartwright and Collett have proposed a computational model for place recognition. The model is based on the principle of matching the current retina image with a snapshot captured beforehand at the home position. After matching, a vector can be calculated for reaching home. As demonstrated in the paper, the proposed model can guide a robot bee back to the home position.

Your task is to implement and verify the snapshot-based visual homing algorithm. As suggested by the authors, a grid of 14 x 14 units is used for the discrete representation of different starting positions of the robot bee. The home position is located at (0,0). The four outmost corner points of the grid are located at (-7, -7), (-7, 7), (7, 7), and (7, -7), respectively. In the paper the authors use three cylinder landmarks. For simplicity, we use three circles whose centers are located at (3.5, 2), (3.5, -2), (0, -4) respectively as landmarks. Each of the circles has a diameter of one unit. Fig. 1 gives the schematic representation of the grid with three landmarks.

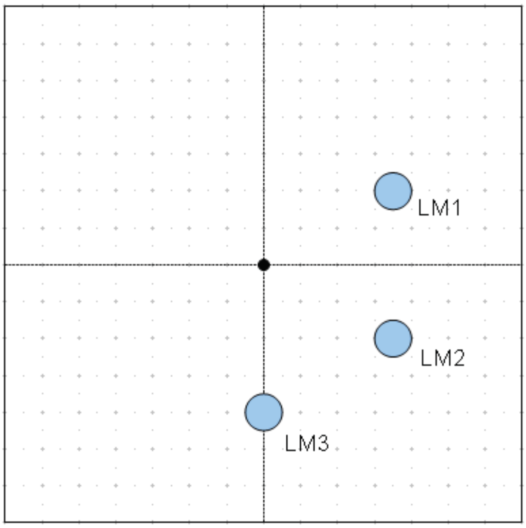

Fig. 1. The grid with three landmarks.

You should carry out both manual and automatic verification of the proposed model as follows:

1. Manual Verification

Through this manual verification step, one will get a deep understanding of the algorithms described in the paper. Please select a few locations on the grid (e.g. three to four), calculate the corresponding homing vectors and finally show them on the grid. To accomplish this, one needs to map the landmarks onto the circular retina and match retina features to the corresponding features located in the snapshot. You may use paper and pencil to perform the mapping, matching and home-vector calculation process. Alternatively, you can use a graphic program for drawing purpose.

2. Automatic Verification

In this part, a computer program has to be implemented for the determination of homing vectors. The main task lies in the implementation of the visual mapping, matching and homing vector calculation.

The central part of you program works as follows: It accepts as input the location of an arbitrary starting point on the grid and outputs a vector representing the homing direction. Here one has to first initialize the positions of the three landmarks and extract all the necessary features in the snapshot. Next one should map each of the landmarks onto the retina and extract corresponding retina features. Later, matching of individual pairs of features needs to be implemented. Once matches are found, the final homing vector can be calculated and visualized accordingly.

You need to write a test program which calculates and outputs all the homing vectors. This means, the test program uses all the positions on the grid as starting points and outputs a grid map with all the homing vectors visualized. Your result should be similar to Fig. 4e of the paper, as is shown in the following graph.

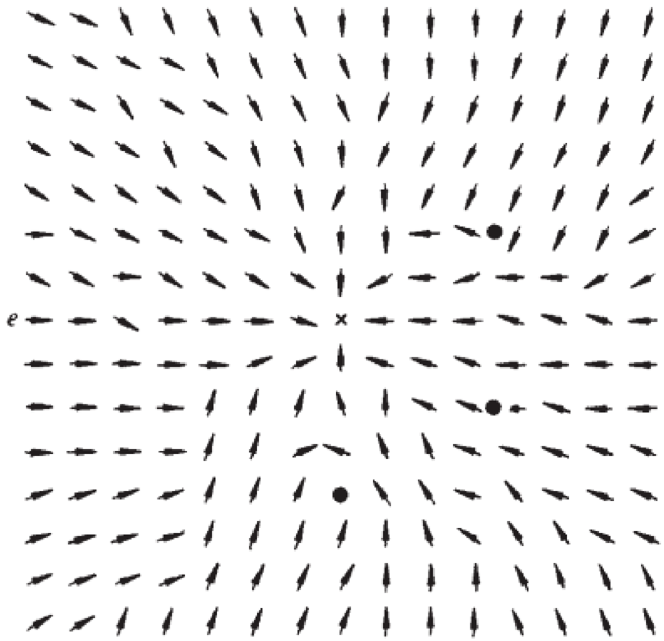

Fig. 2. A map with homing vectors from all grid points.

A further task is to calculate the achieved homing precision by calculating the average difference between the desired homing directions and the calculated ones.

You are required to perform both of the tasks (i.e., manual as well as automatic verification) and upload in Ilias the results you achieved together with proper documentation of your code by May 7th. Appointments for demonstration will be made individually. Please note that your submission should include all the parts listed below.

a) The results of your manual verification as drawings or images
b) Your implementation of the algorithm (i.e. documented code)
c) A readme file giving specific information on how to run your code
d) A graph showing your achieved map with homing vectors together with the information about the obtained homing precision