Kidnapped Robot Recovery Using Natural Landmarks

rUNSWift 2012 Open Challenge Entry
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I. Motivation

In the 2012 SPL competition the goal-posts at either end of the field have been made the same colour for the first time. This development poses a challenge for robots that are unintentionally 'kidnapped', for example after a complicated fall. One way to resolve this ambiguity is by using a team-wide ball model, enabling a kidnapped robot to recover by fusing their own ball observations with those of their team-mates. However, this approach can fail if the robot is alone, unaware that it has been kidnapped, or if the team-wide ball model is incorrect. A better method would be to extract unique natural landmarks from the unspecified background around the field, and use these to resolve the field-end ambiguity.

II. Implementation

To find natural landmarks in images of the background around the field, we use a modified one dimensional SURF algorithm (1D SURF), applied to a single row of grey-scale pixels captured at the robot's horizon, as illustrated in Figure 1. This method dramatically reduces the computational expense of SURF feature extraction (to around 2ms on a Nao V4), while exploiting the planar nature of the robot's movement and still providing acceptable repeatability of the features.

A simple method to perform landmark recognition is to match features in an observed image to their nearest neighbours in a stored image, based on the Euclidean distance between feature descriptors. A horizon recognition score can be calculated by summing the inverse distance between matching feature descriptors. Recognition can be improved by using RANSAC to perform geometric verification of the feature matches.

Figures 2 and 3 illustrate the performance of the algorithm when attempting to match horizon areas to a single image of the right hand goal taken from the middle of the field. Figure 2 shows that when looking at the wrong goal area, the algorithm recognition response is very low, but in Figure 3 there is a strong response when looking at the correct goal area, particularly in the centre where the 1D SURF features were learned. The performance then degrades as the robot moves away from this position.

III. Demonstration

For the RoboCup 2012 Open Challenge we plan to demonstrate that a robot can recover from kidnapping by using natural landmarks around the field.

Fig. 1. Image showing the horizon band. The single row of grey-scale pixels taken from the horizon band for landmark extraction is shown at top of image.

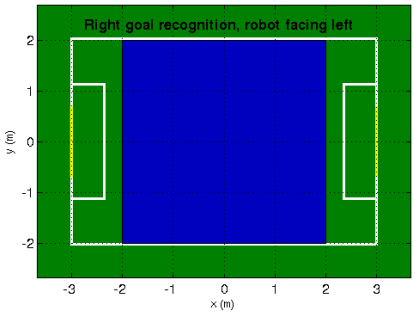

Fig. 2. Low recognition when facing the incorrect goal area.

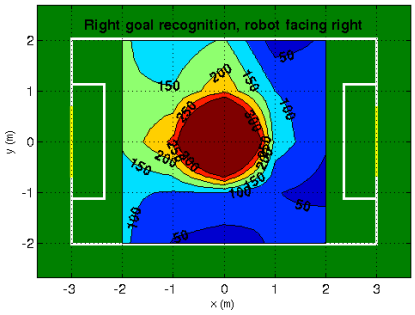

Fig. 3. High recognition when facing the correct goal area, particularly from the centre of the field where the stored image was captured.

References

[1] P. Anderson, Y. Yusmanthia, B. Hengst and A. Sowmya, *Robot Localisation Using Natural Landmarks*, Proceedings of the RoboCup International Symposium 2012.