

Robot Localisation Using Natural Landmarks

Peter Anderson, Yongki Yusmanthia, Bernhard Hengst, and Arcot Sowmya



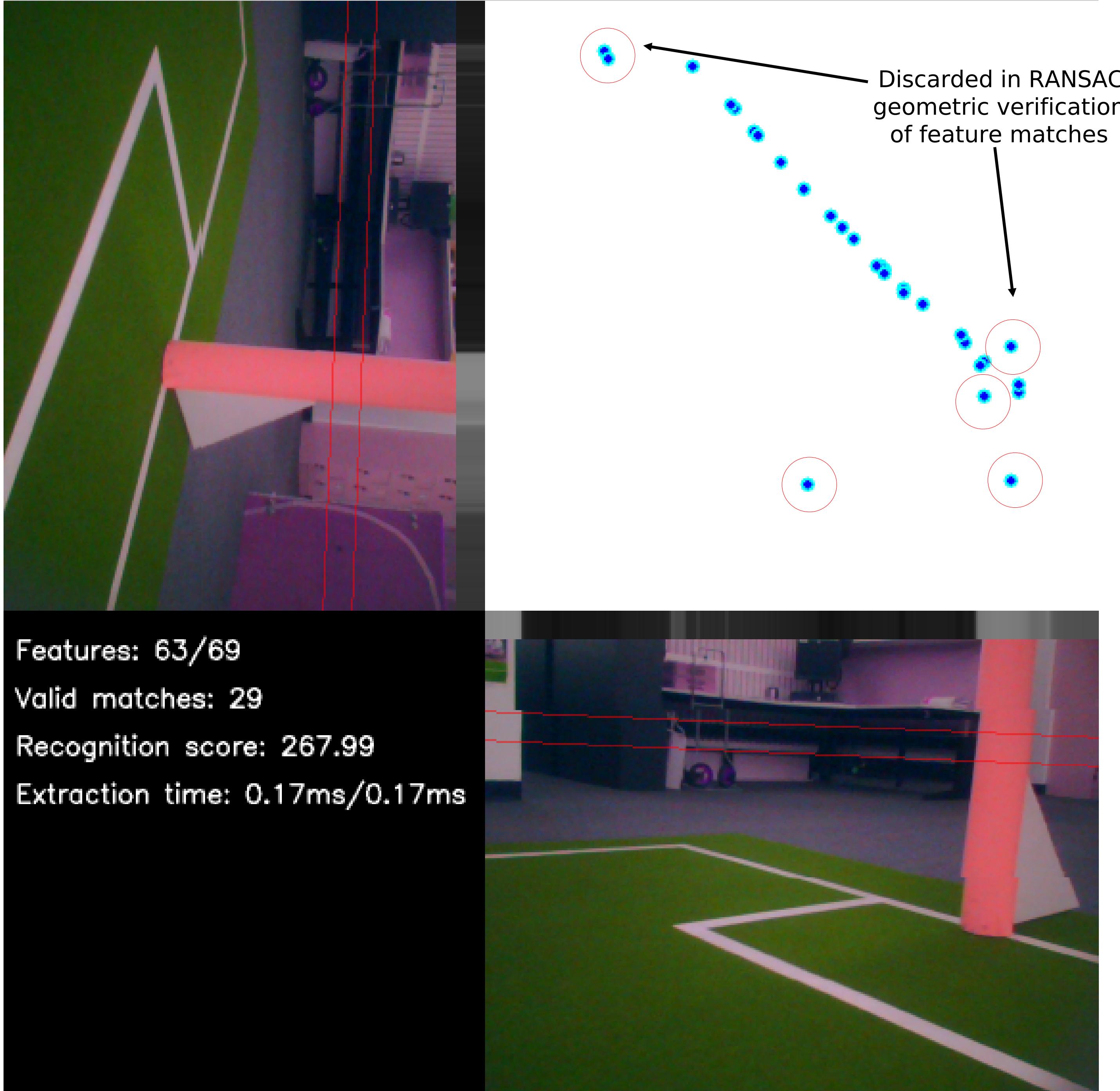
Motivation and Background

- In the 2012 SPL competition, for the first time both goals are yellow. Kidnapped robots need to resolve this field-end ambiguity.
- Team-wide ball filters require localised, functioning team-mates and a ball. Natural landmark localisation might be a better method.
- This paper contributes a fast 1 dimensional variant of the SURF [1] algorithm (1D SURF) suitable for mobile robot navigation.

1D SURF

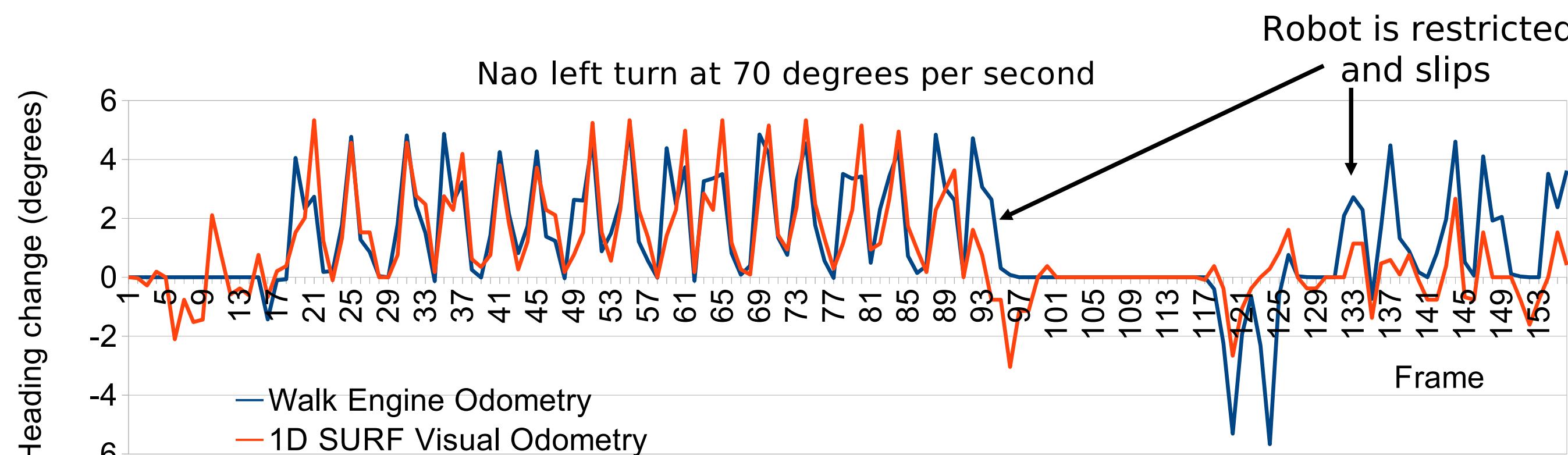
- Exploits the robot's planar movement by sub-sampling the horizon to extract one row of grey pixels.
- Searches for blob response extrema in a 2D scale-space, using the integral image and box filters.
- Applies a weaker neighbourhood test than SURF, and discards the orientation assignment and 3D quadratic curve fitting steps.
- Reduces the SURF 64 dimension feature descriptor to 6 dimensions.
- Dramatically reduces the computational expense of SURF, while still providing repeatable features.

Landmark Matching



Application to Visual Odometry

- Bipedal robots slip and get pushed while playing soccer.
- By matching 1D SURF features in subsequent frames, we can accurately measure heading changes, to improve robot localisation and behaviour.



Classification Experiment

- 88 images captured at 4 degree increments from a single location using the Nao robot camera.
- No changes in scale or viewing angle.
- SURF and 1D SURF features extracted from images.
- Pairs of images classified as overlapping or non-overlapping, based on the sum over matching features of the inverse distance between feature descriptors.

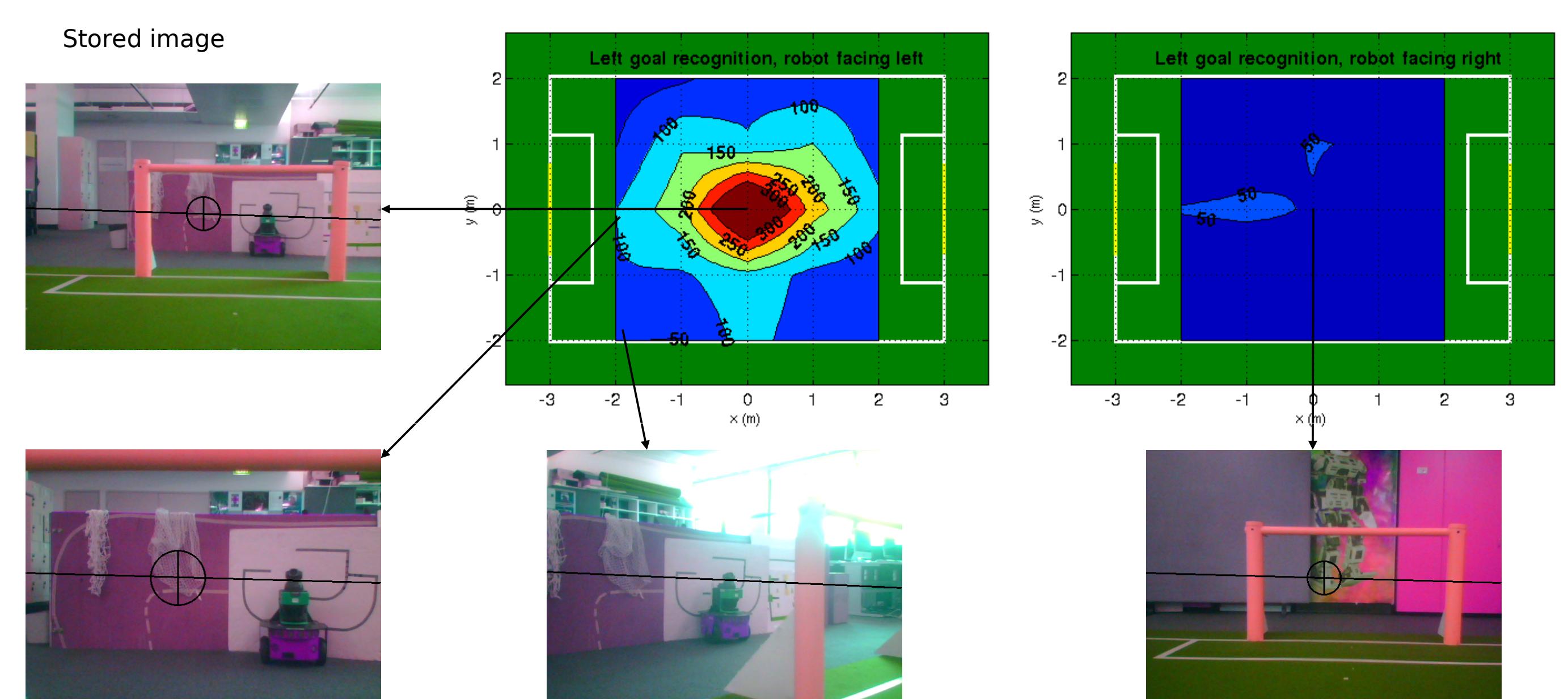
Feature extraction technique	Feature matching technique	Mean number of features	Mean extraction time (ms)	Mean matching time (ms)	Area under ROC curve
SURF	Nearest Neighbours	429	222.3	19.1	98.8%
1D SURF	Nearest Neighbours	59.2	0.158	0.069	88.0%
1D SURF	Nearest Neighbours with RANSAC	59.2	0.158	0.076	89.6%

Execution times evaluated on a 2.4GHz laptop

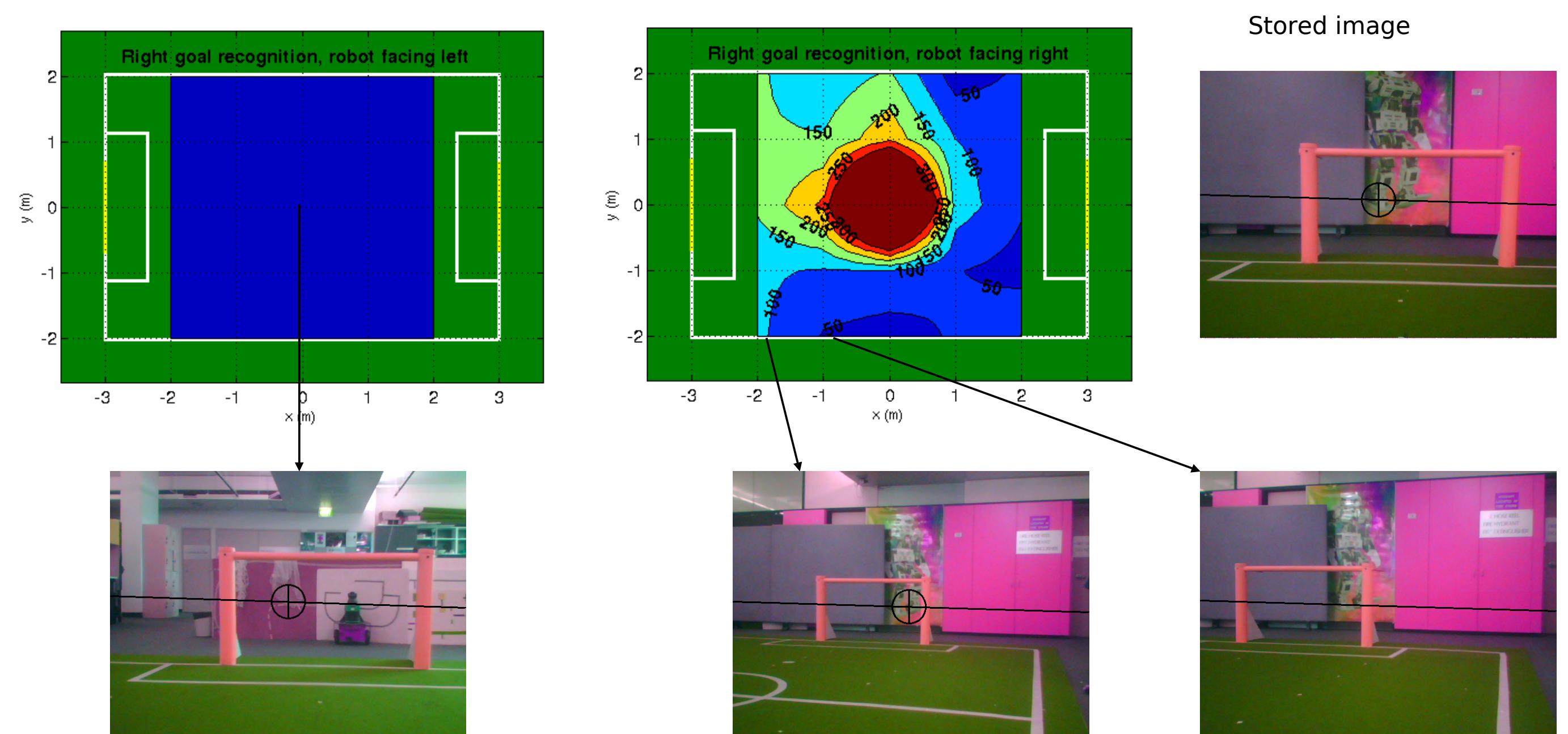
Application to Robot Localisation

- A single image of each goal area captured from the centre of the SPL field.
- Recognition measured over a 4m x 4m area (including scale and viewing angle changes).
- Mean feature extraction time: 12ms (Nao V3), 2ms (Nao V4).

Left Goal Recognition



Right Goal Recognition



References

- [1] H. Bay, T. Tuytelaars, and L. Van Gool. Surf: Speeded up robust features. Computer Vision-ECCV 2006, pages 404-417, 2006.