EVALUATION OF FEATURE EXTRACTION TECHNIQUES ON AQUACULTURE PLACE RECOGNITION PROBLEM

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PROBLEM STATEMENT

Aquaculture industry is one of the most sustainable way of satisfying the world's increasing food demand. However, fish escape still remains a critical challenge that is not only a financial loss but badly effects the biodiversity as well. SLAM(simultaneous localization and mapping) remains the state of the art technique to solve this problem. Selection of feature extraction technique is a very important choice in SLAM process and plays a key role in the accuracy of place recognition and loop closures.

OBJECTIVE AND STATE OF THE ART

The study revolves around the impact of choosing different feature extraction technique on the place recognition effectiveness in SLAM underwater. Every feature extraction technique has their own pros and cons. The aim of thesis is to evaluate the performance of most commonly used descriptors such as SIFT, SURF, ORB, AKAZE and BRISK on the fish net cage imagery.

METHODOLOGY

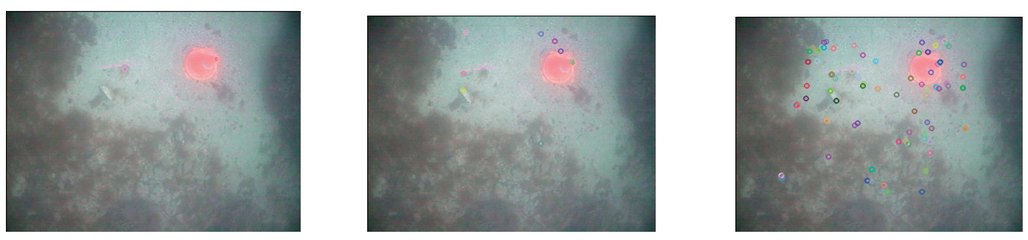
Following key steps were performed

- An extractor model is created based on the choice of descriptors
- Key points are extracted from the image and the regions of interest were obtained in pixel coordinates
- Key points are evaluated by descriptor specific criteria and then transformed into vector representation
- Bag of words (BOW) technique is used to create simplified vectored representation of feature space
- A vocabulary and database is created based on the extracted features
- A testing scenario is defined e.g. to test short term tracking, maximum feature extraction etc
- Feature space of images is compared, matching probabilities computed and results registered in .csv files
- Results are then visualized by a separate program

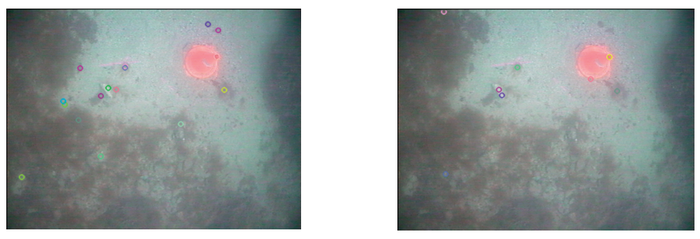
The tests were performed on both the NET CAGE and the general seabed environment to compare the results.

EXPERIMENTAL RESULTS ON UNDERWATER CAVE

AKAZE BRISK ORB



Showing key points on actual image



SURF SIFT

RESULTS/FINDINGS

- SIFT was able to extract maximum amount of features in the image followed by SURF
- Even though ORB is a standard on land based SLAM but it failed to produce convincing results underwater and detected very few features
- In short term tracking SIFT and SURF was able to track for the longest when there are some overlaps between the images and tolerated the blur better. Though a different threshold is suitable for each. SIFT allows a higher threshold and is more consistent. Both of them performed good under changing luminosity and scale
- The results were quite different when applied on Girona underwater cave dataset. ORB was able to detect the most number of key points and thus much better in loop closure conditions

ANALYISIS

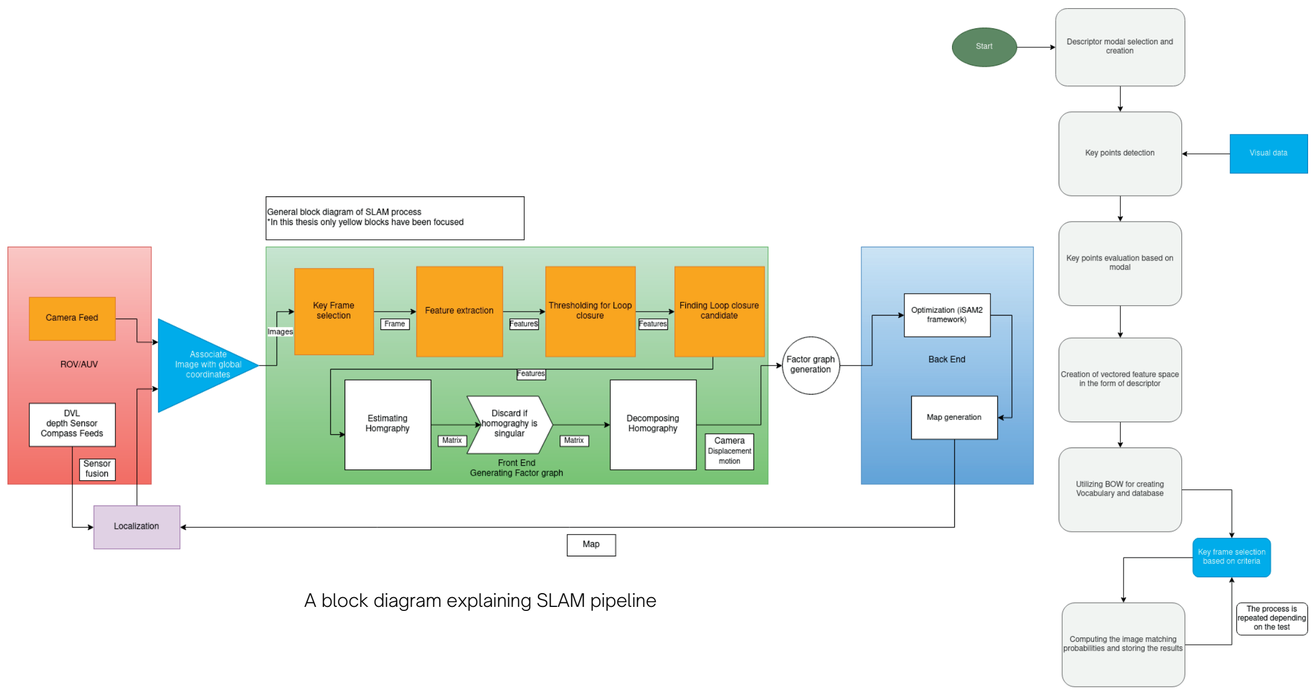
Short term tracking results again shows a split between SIFT and SURF.

- SIFT performed better when the visual was clear and sharp, it was able to detect a very small overlap as well
- SURF handled the blur condition very effectively and continued tracking
- SURF is a much faster algorithm, even though we can increase the speed of SIFT as well by selecting top features only
- The fish cage data was not suitable to perform the long term tracking test but when applied on the underwater cave dataset, ORB perfrmed the best.

CONCLUSION

It is safe to say that SIFT and SURF are two of the most effective methods for aquaculture. ORB, AKAZE and BRISK are not suitable for net cage environment. SIFT is recommended if the visual data is better while SURF is recommended if the quality is not very good. On the other hand ORB is recommended if the sea bed and the rocks make most of the scenery.

BLOCK DIAGRAM

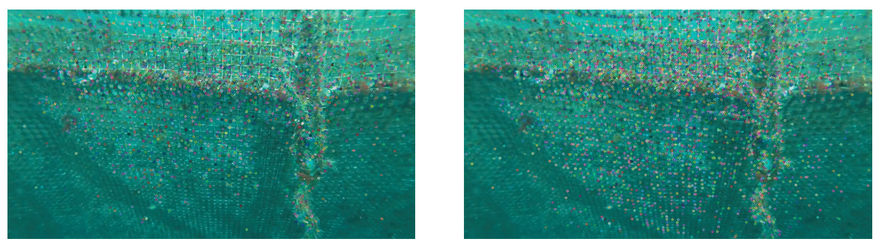


A block diagram explaining SLAM pipeline

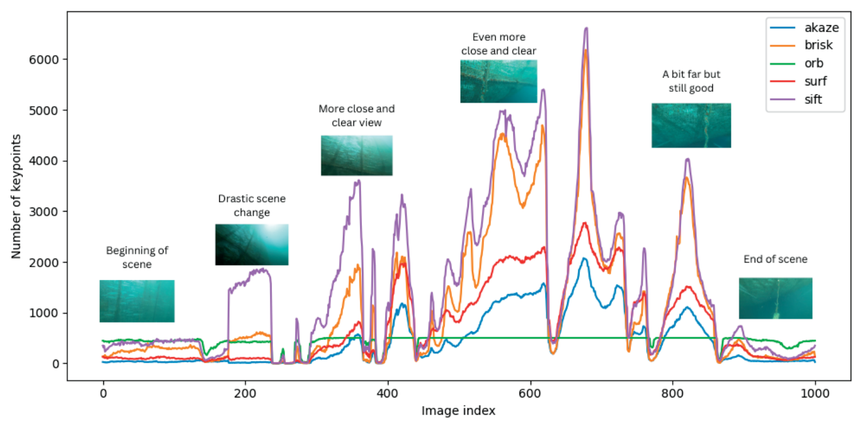
EXPERIMENTAL RESULTS ON NET CAGE

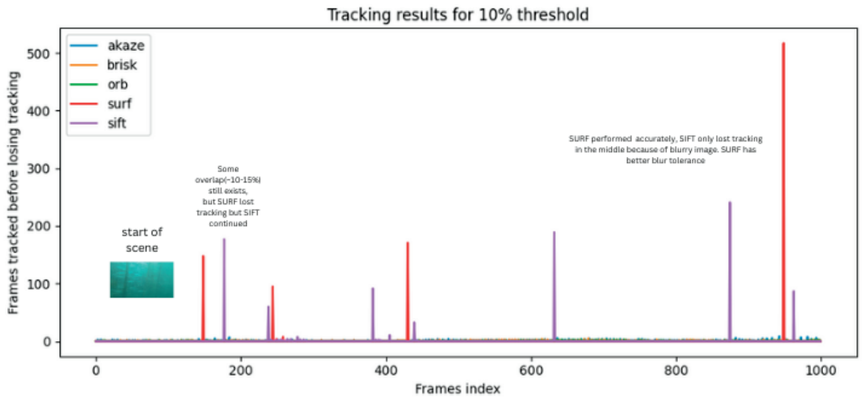
AKAZE BRISK ORB

Showing key points on actual image



SURF SIFT





REFERENCE

[1] Straume Haugland, Kyrre (2021). 'Underwater Pose Graph SLAM with DVL-Enhanced Visual Loop Closure for Future Aquaculture'. MA thesis. NTNU.