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Sidescan Sonar Imagery Segmentation with a Combination of Texture and Spectral Analysis

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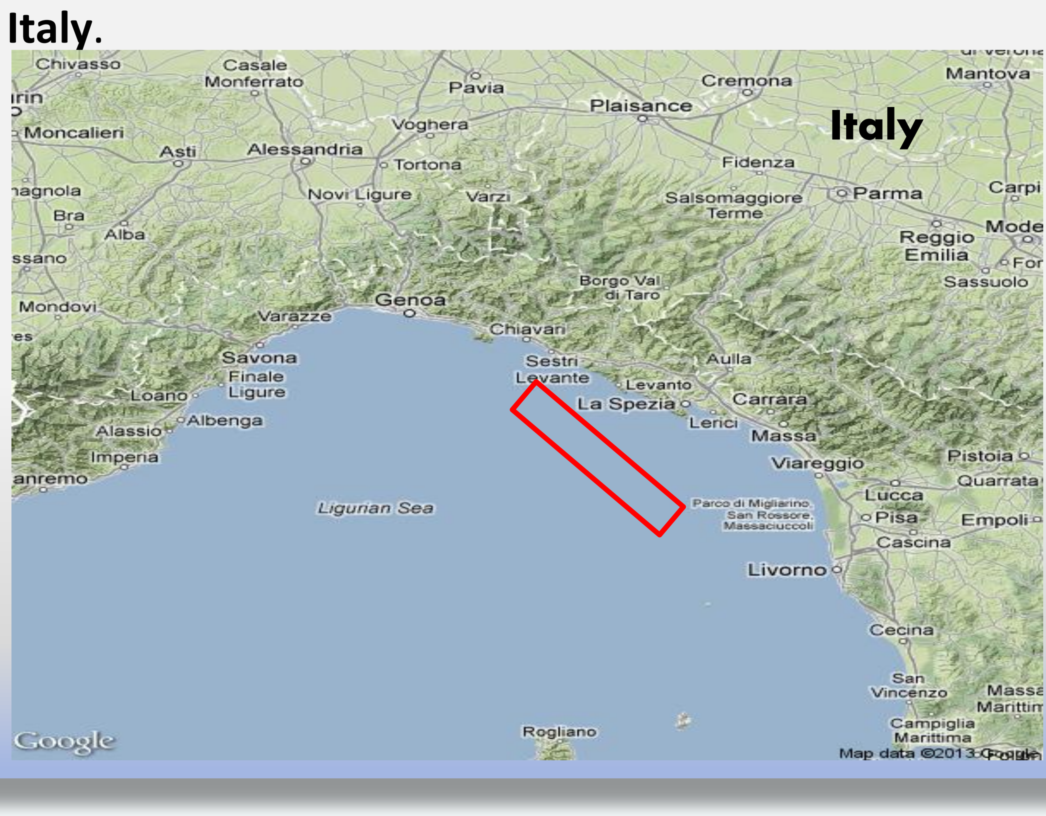
Abstract

In this work, we investigate a non classical **sonar imagery segmentation** approach based on the Directional Filter Bank (**DFB**). The approach uses a decomposition of the Fourier spectrum into three spectral bands: low, medium and high frequencies. A subsequent analysis of the pattern isotropy is conducted by dividing the medium spectral band into small, overlapped, angular sectors. The features extracted from this process are assessed so as to determine their potential on the classification performances. First, a comparison with classification performances result given by texture features derived from grey level co-occurrences matrices (**GLCM**) is made. Finally the global performance of the segmentation is assessed using the spectral features, the features extracted from GLCM and the grazing angle. The Klein 5000 experimental data used in this study have been acquired by DGA/GESMA during BP 02 experiment conducted by NURC.

Experiment Data

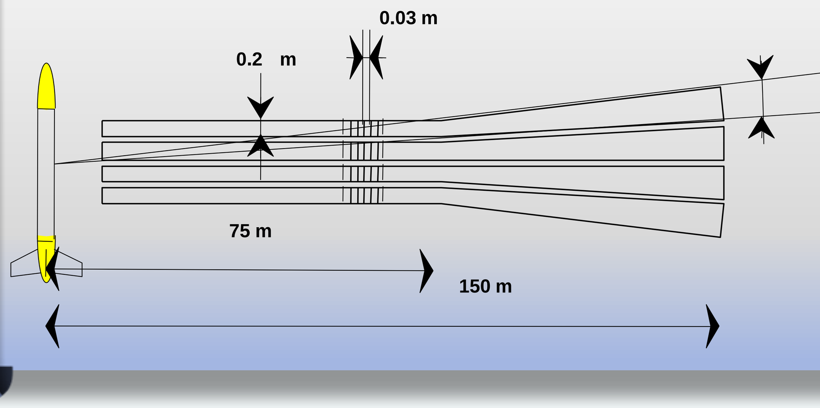
The data used for our study were obtained during the BP'02 (Battlespace Preparation) experiments carried out by the SACLANT Undersea Research Centre in **La Spezia, Italy**.



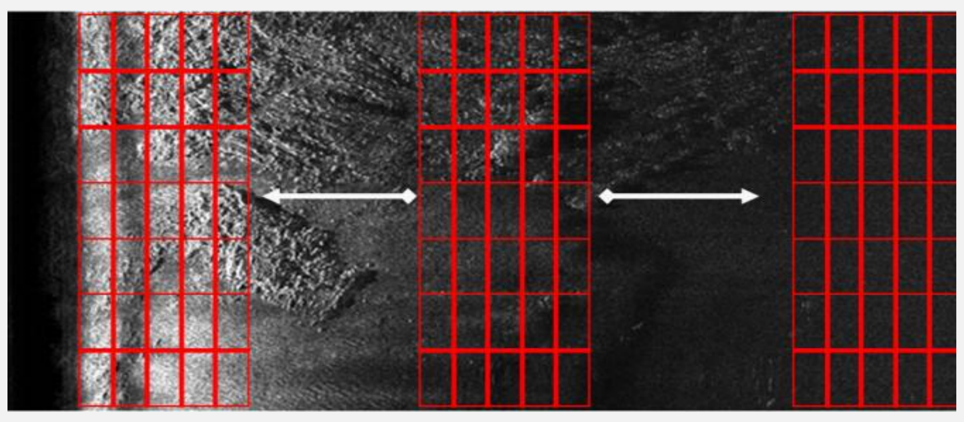
Sonar Characteristics

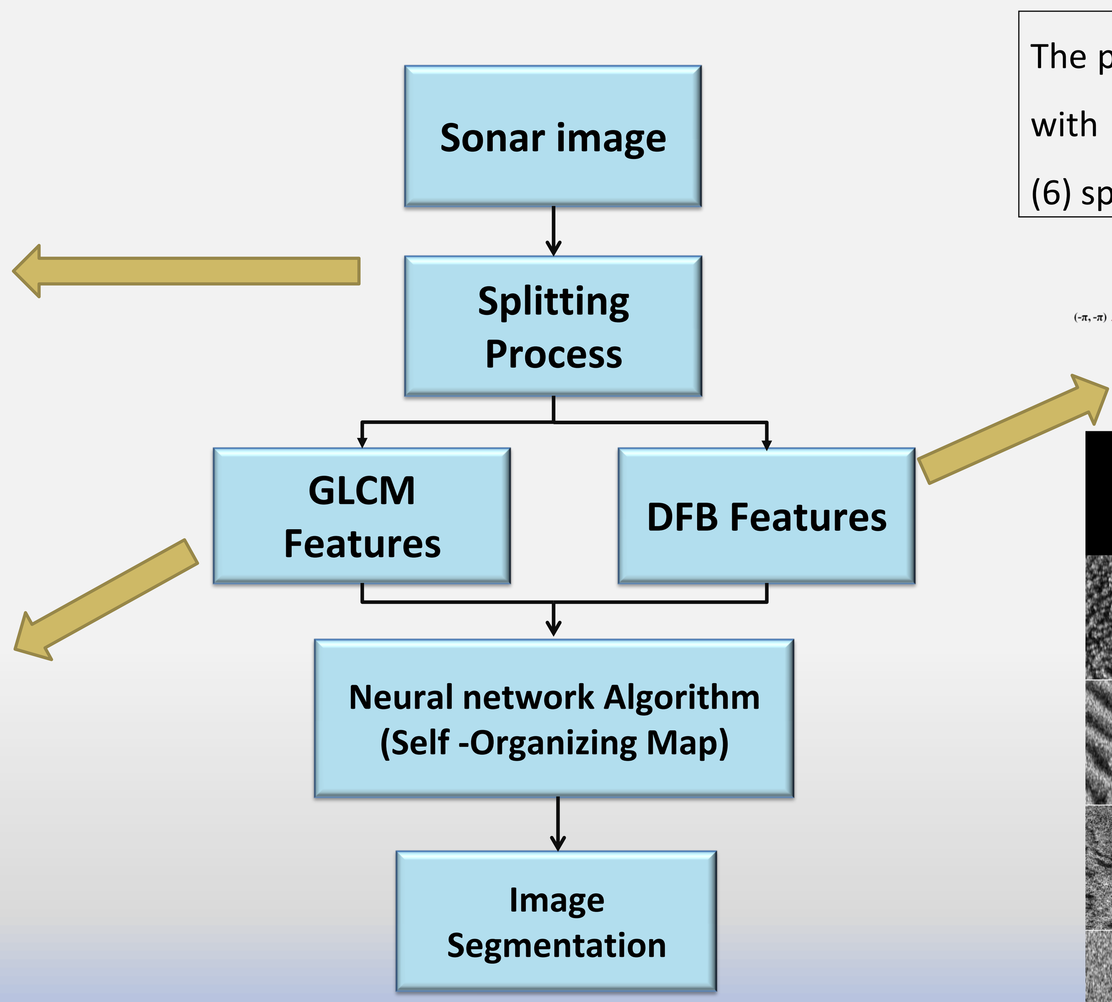
Sonar Klein 5000

Frequency : 455 kHz
Swath: 150m-300m
Range Resolution :~3 cm
Azimuth Resolution: 10cm-20cm



Methodology

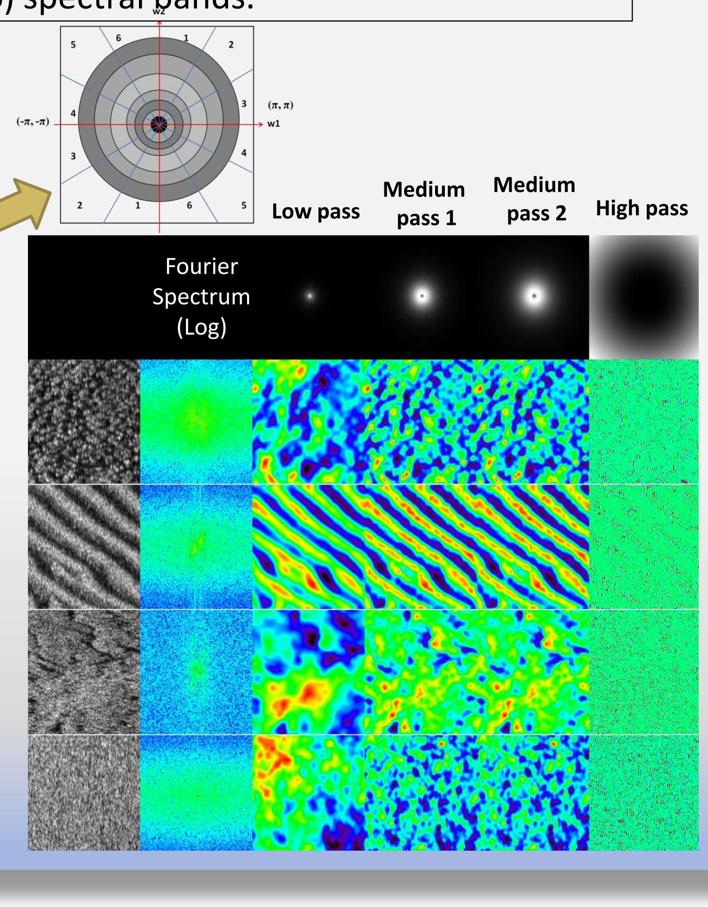




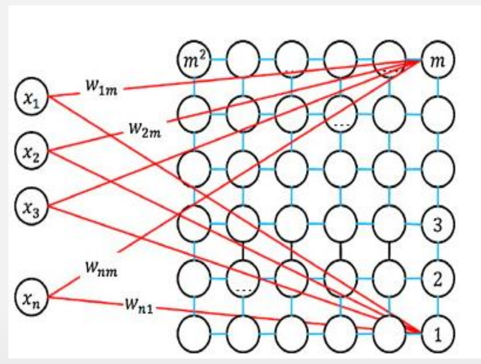
Gray-Level Co-occurrence Matrices-GLCM describes the intensity changes over various distances in the images. Statistics are derived from the GLCM matrices. The features computed from GLCM in this work are:

Kurtosis	Heterogeneity
Homogeneity	Correlation
Max. of probability	Elongation Factor
Entropy	Contrast

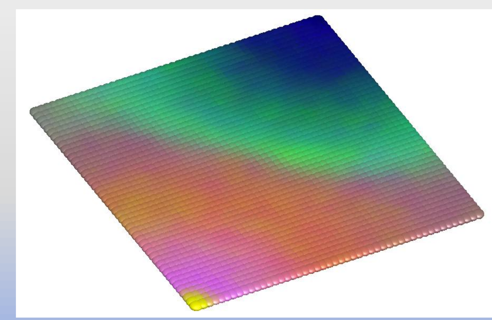
The proposed directional filter Bank (DFB) with twelve (12) angular sectors and six (6) spectral bands.



Competitive Neural network based on **S**elf-**O**rganizing **F**eatures **M**aps **(SOFM)** algorithm, is adapted in this work to segment sonar images.



SOMF Learning Process



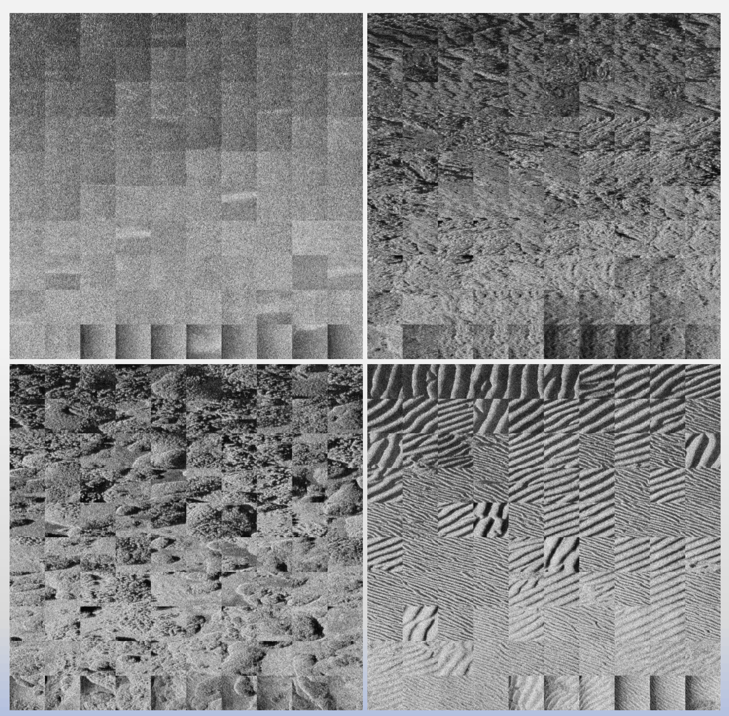
2D SOFM projection table- 48x48 neurons-

Results

Data base used for tests

- **400 images 128X128 size**
- **4 types of sediment**

(Rock -Sand -Posidonia-Ripples)

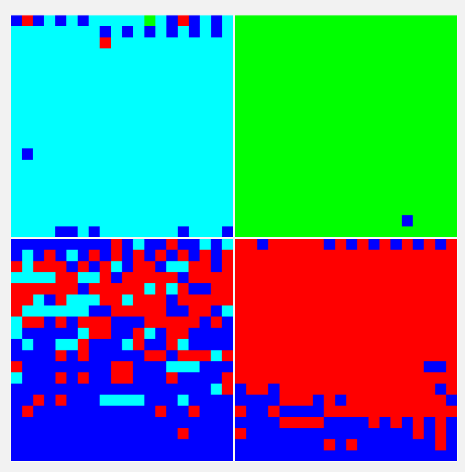


Supervised Classification tests

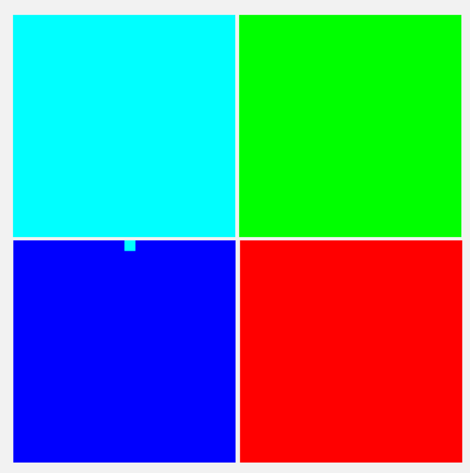
Method of classification	Features used	Correctly Classified Instances (%)
Naïve Bayes	**Case1**: GLCM	76.06
	Case 2: DFB	78.18
	Case 3: GLCM+ DFB+ Grazing angle	**82.31**
Multilayer Perceptron	**Case1**: Haralick features	95.43
	Case 2: Spectral features	93.18
	Case 3: GLCM+ DFB+ Grazing angle	**99.06**

Unsupervised Classification tests

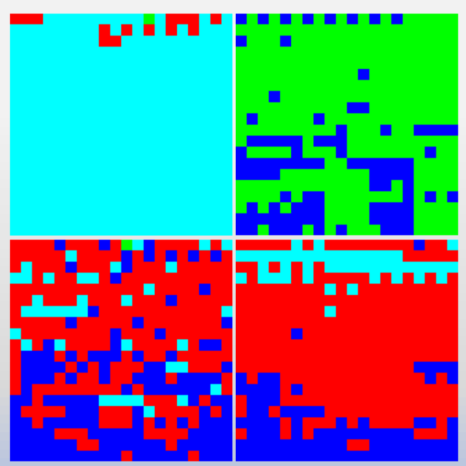
Method of classification	Features used	Correctly Classified Instances (%)
K-means	**Case1**: GLCM	63.06
	Case 2: DFB	44.00
	Case 3: GLCM+ DFB+ Grazing angle	**65.25**
SOFM (Self Organizing feature Maps)	**Case1**: Haralick features	59.00
	Case 2: Spectral features	51.75
	Case 3: GLCM+ DFB+ Grazing angle	**65.5**



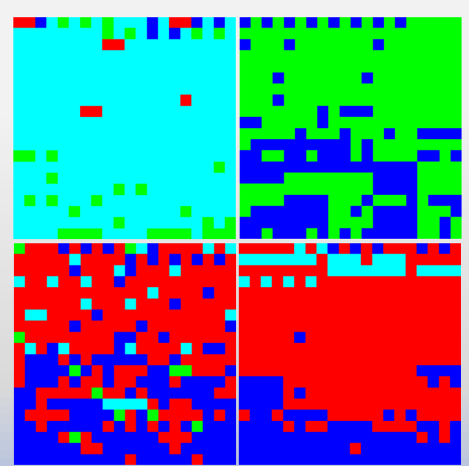
Naïve Bayes



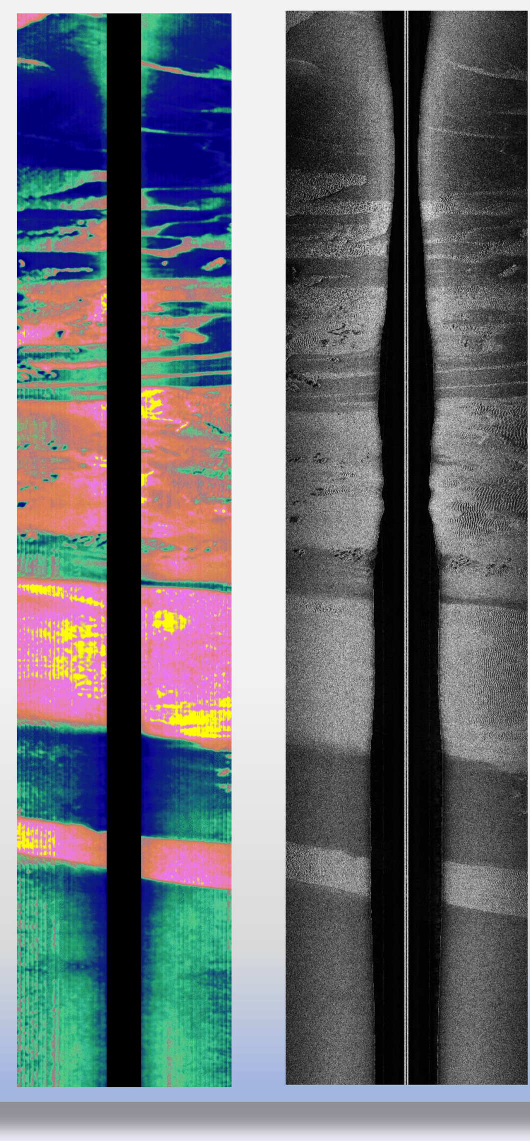
Multilayer Perceptron



K-means



SOFM



Conclusion

In this paper, we propose directional filter bank DFB for spectral features analysis. A combination of the proposed spectral features with the Haralick features derived from GLCM gives better classification results.

Both, supervised and unsupervised algorithms tested on the created sonar data base confirm the ability of DFB features to discriminate of seabed textures.

We also note that the grazing angle feature improves the classification accuracy.

The splitting process of sonar images and SOFM algorithm allows a good segmentation by reducing the dependency to the grazing angle of features computed.

The improvement of classification results on combined features show that GLCM and spectral features provide complementary descriptions of seabed textures. Further study will be conducted to analyze more deeply this complementarity.

Acknowledgements

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