UNIVERSIDAD DE LAS PALMAS DE GRAN CANARIA
Instituto Universitario de Microelectrónica Aplicada

Master of Science in Telecommunication Technologies

Master Thesis

Evaluation of band selection techniques in the classification of hyperspectral images of brain tumors

Beatriz Martínez Vega

Gustavo Marrero Callicó, Himar Fabelo Gómez, Samuel Ortega Sarmiento

July 2019

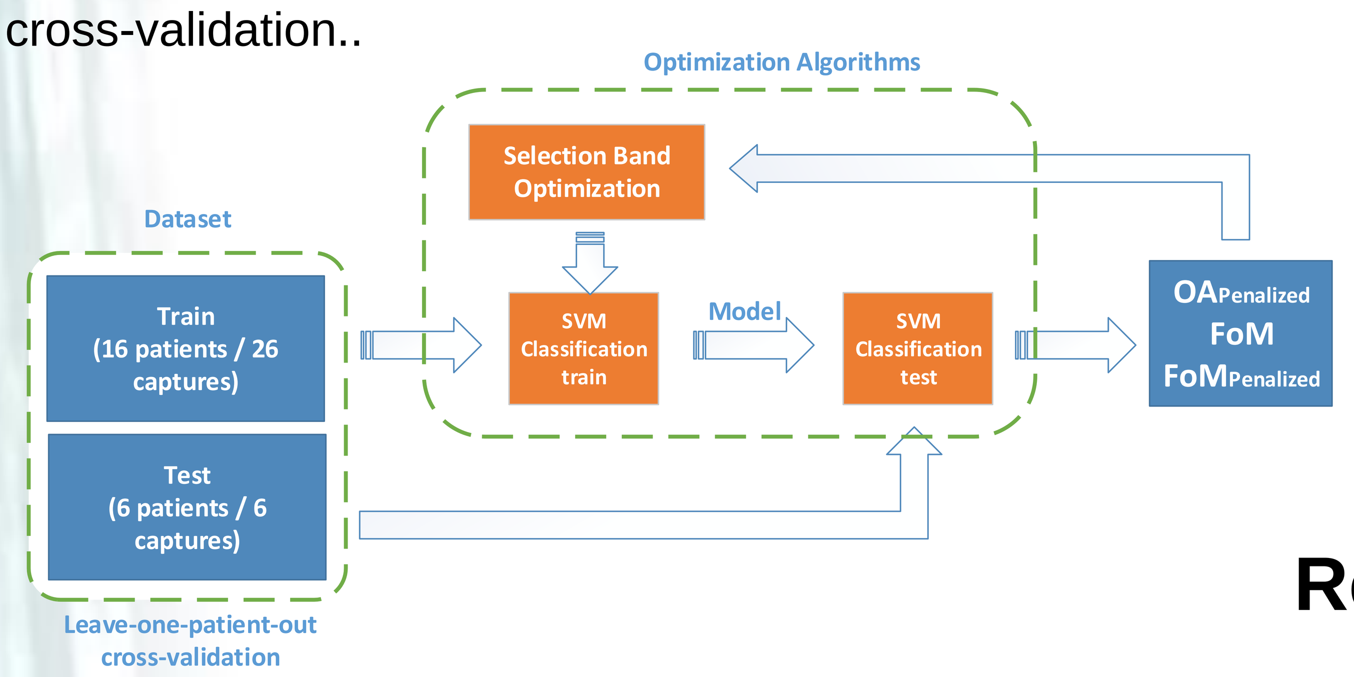
Abstract:

- Hyperspectral imaging (HSI) is an emerging technology in the medical area. HSI is a non-contact, non-ionizing, and label-free imaging modality that can assist surgeons during this challenging task without using any contrast agent. This paper describes different methodologies to identify the most representative bands that are part of the HSI used in brain tumor detection. This selection process is carried out through different optimization algorithms, specifically *Genetic Algorithm* (GA), *Particle Swarm Optimization* (PSO). For the evaluation of the selected bands, the supervised *Support Vector Machine* (SVM) is used.

Methodology

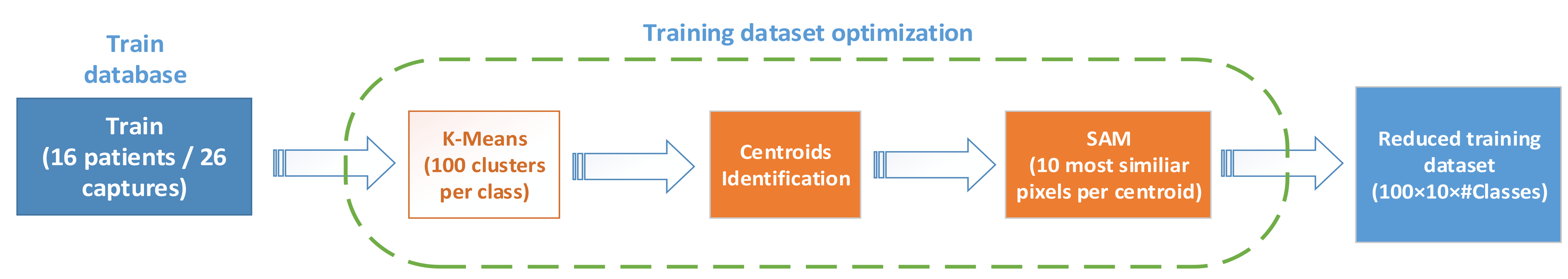
Basic Processing Framework (BPF)

- The first proposed processing framework has the goal to evaluate the results obtained with the band selection algorithm (GA and PSO) when employing the entire labeled dataset for the training of the SVM classifier. The labeled database was divided into training and test data performing a leave-one-patient-out cross-validation..



Optimized Processing Framework (OPF)

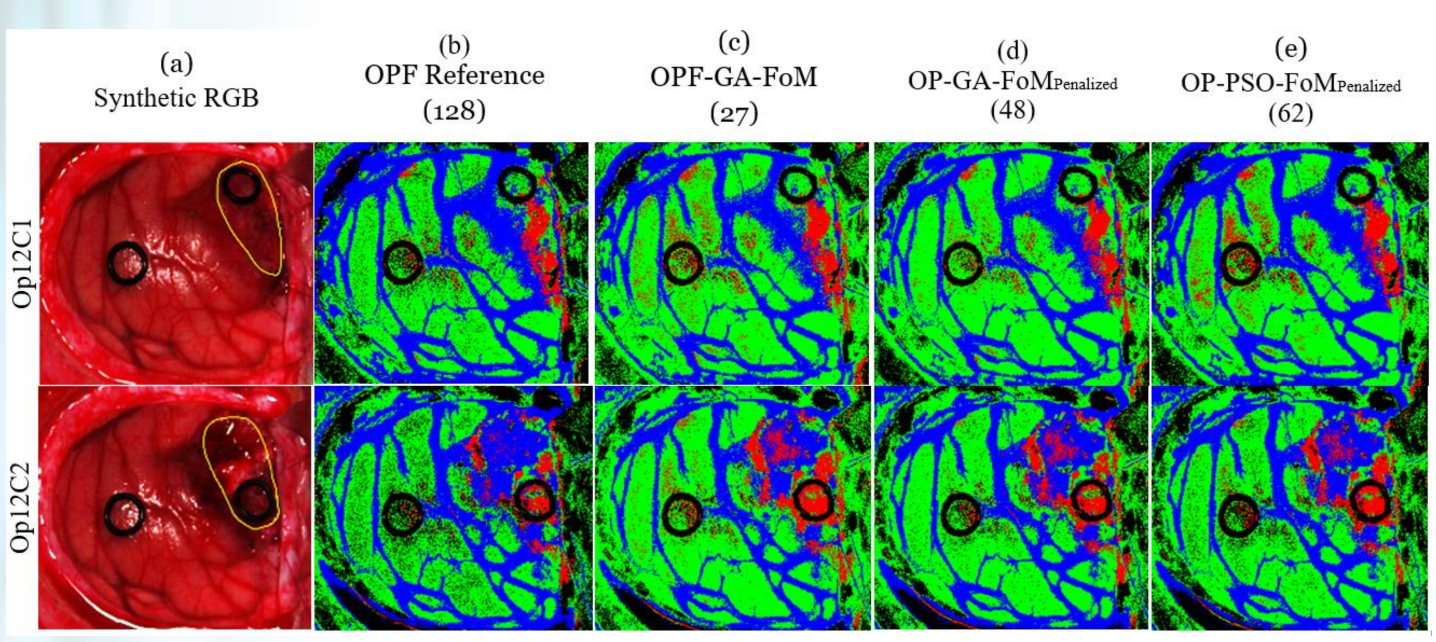
- After performing some experiments with the BPF, it was observed that the execution time was really high. Taking into account that the number of generations performed was repeated per each test image, it was necessary to find some techniques that allow reducing the execution time. In order to solve these problems, it was decided to use only 4,000 pixels (1,000 pixels per class) for training the SVM classifier, thus, balancing all classes and dramatically reducing the size of the training database (from ~200,000 to 4,000 pixels).



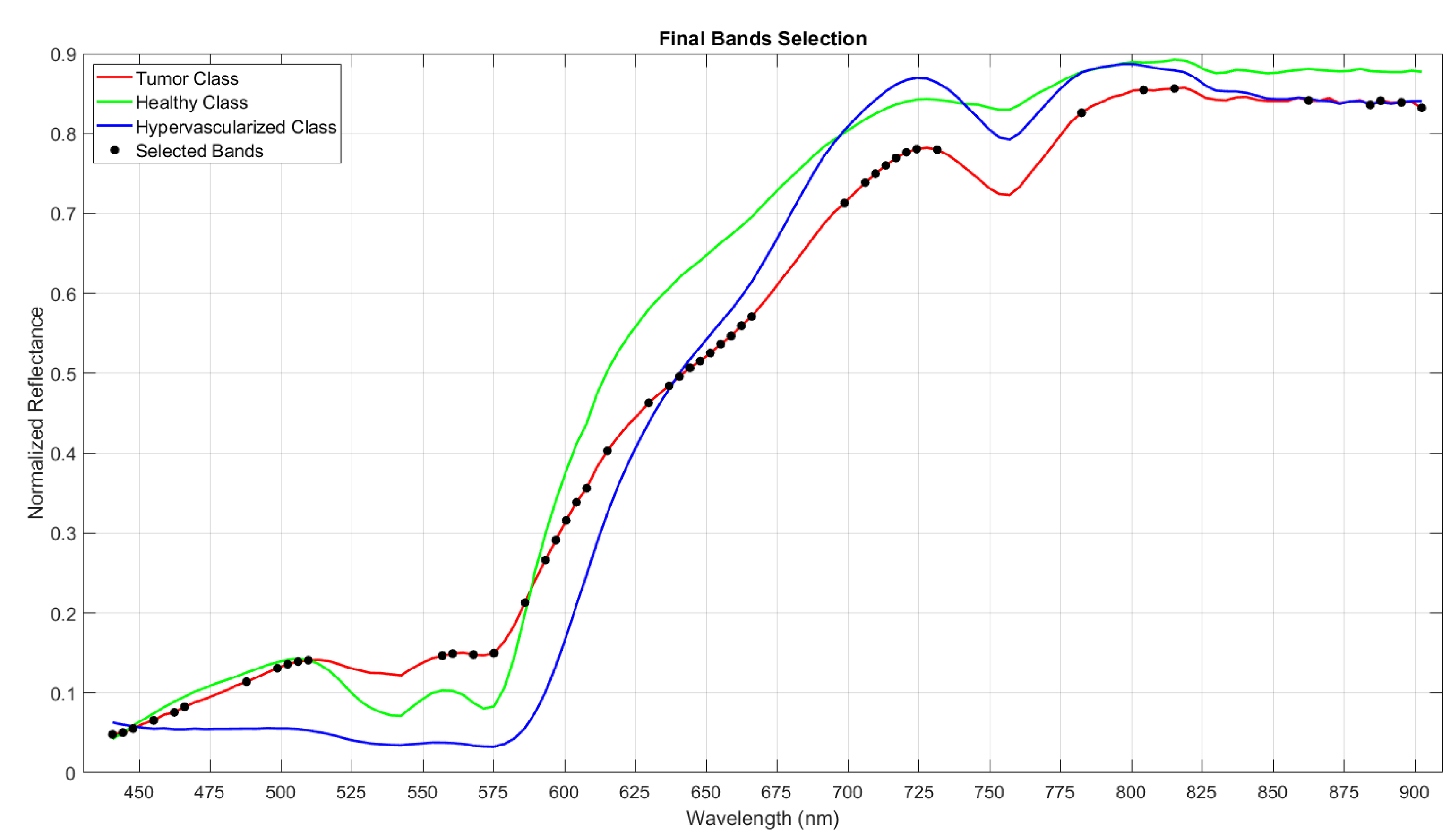
Results

- The best cases were: OPF-GA-FoM, OPF-GA-FoM$_{Penalized}$ and OPF-PSO-FoM$_{Penalized}$.

Technique (#bands)	OA AVG (STD) %	Sensitivity AVG (STD)%				Specificity AVG (STD)%				MCC AVG (STD)%			
		NT	TT	HT	BG	NT	TT	HT	BG	NT	TT	HT	BG
GA-FoM (27)	77.3 (16.5)	84.4 (15.2)	52.9 (31.1)	83.4 (21.7)	89.8 (21.1)	87.4 (10.4)	93.4 (8.2)	96.9 (5.0)	85.7 (20.7)	69.1 (19.1)	41.5 (30.9)	82.9 (16.6)	71.3 (22.1)
GA-FoM$_P$ (48)	77.9 (17.0)	85.1 (17.6)	52.7 (29.8)	83.5 (20.9)	92.5 (14.2)	87.3 (12.2)	94.6 (8.3)	96.7 (5.1)	85.3 (18.0)	69.0 (21.0)	44.4 (30.9)	82.4 (16.7)	72.7 (20.2)
PSO-FoM$_P$ (62)	75.9 (17.3)	77.8 (22.2)	47.1 (30.6)	84.5 (20.1)	93.1 (13.0)	87.0 (13.3)	92.9 (11.5)	95.9 (5.7)	84.6 (17.2)	62.5 (19.5)	38.4 (27.7)	82.1 (17.4)	72.2 (19.9)



- The obtained results demonstrate that using only 48 bands the classifier is able to improve the classification results.
- The graph shows the spectral signatures of the healthy tissue (green color), the tumor tissue (red color), the hypervascularized tissue (blue color) and the final bands that were selected (black spots). It can be seen that the selected bands are grouped into small regions throughout the spectral signature. The most important regions are 440.5-465.96 nm, 498.71-509.62 nm, 556.91-575.1 nm, 593.29-615.12 nm, 636.94-666.05 nm, 698.79-731.53 nm and 884.32-902.51 nm.



Conclusions

- The results demonstrate that the proposed methodology based on the Genetic Algorithm optimization method improved the accuracy results in identifying the different classes for the brain cancer detection application, employing only 48 bands.
- It was observed that by reducing the dataset and selecting the most relevant bands, the results improved with respect to the reference ones (128 bands).

IUMA
Universidad de Las Palmas de Gran Canaria
Campus Universitario de Tafira
Las Palmas de Gran Canaria, SPAIN
t: +34 928 451 150
+34 928 451 286
f: +34 928 451 083
e: iuma@iuma.ulpgc.es **w:** www.iuma.ulpgc.es