Hyperspectral Image Analysis Using Machine Learning and Adaptive Data-Driven Filtering

2020—2022: Scientific-Technological Cooperation with Slovenia

Project Leaders : Doc. dr. sc. Jonatan Lerga[1], Doc. dr. sc. Matija Milanič[2]

[1] University of Rijeka, Faculty of Engineering, Department of Computer Engineering (Croatia)

[2] University of Ljubljana, Faculty of Mathematics and Physics (Slovenia)

RESEARCH TEAM

CROATIA

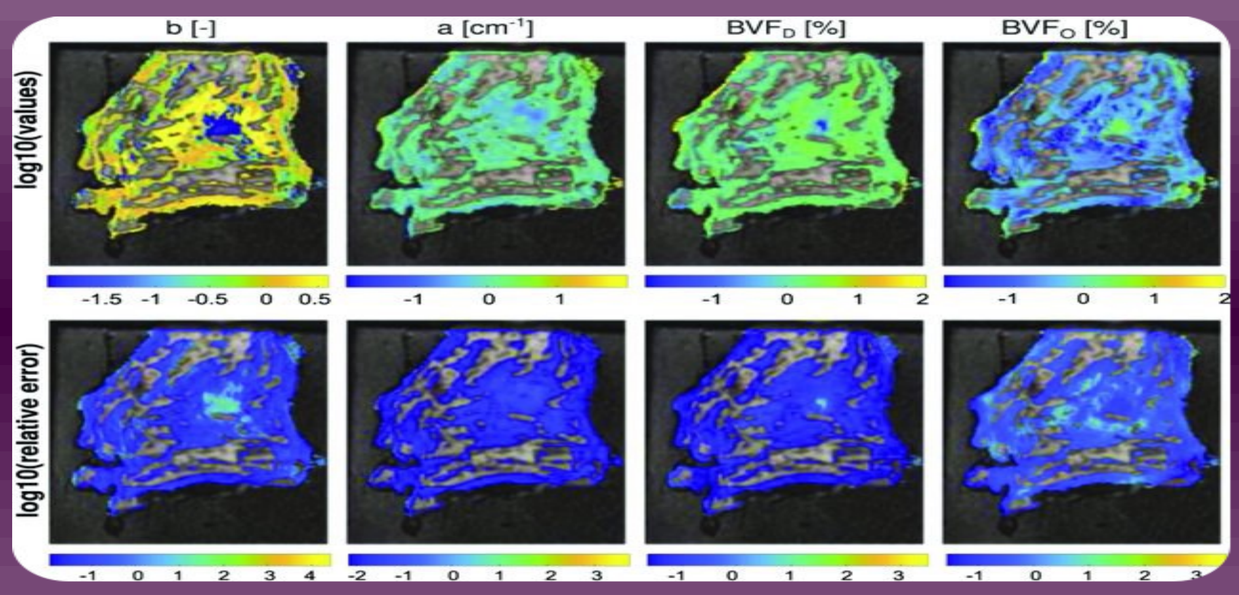
Doc. Dr.. Sc. Jonatan Lerga
Izv. Prof. Dr. Sc. Ivan Štajduhar
Doc. Dr. Sc. Nicoletta Saulig
Teo Majnolović (PhD student)
Franko Hržić (PhD student)
Ana Vranković (PhD student)
Luka Batistić (PhD student)

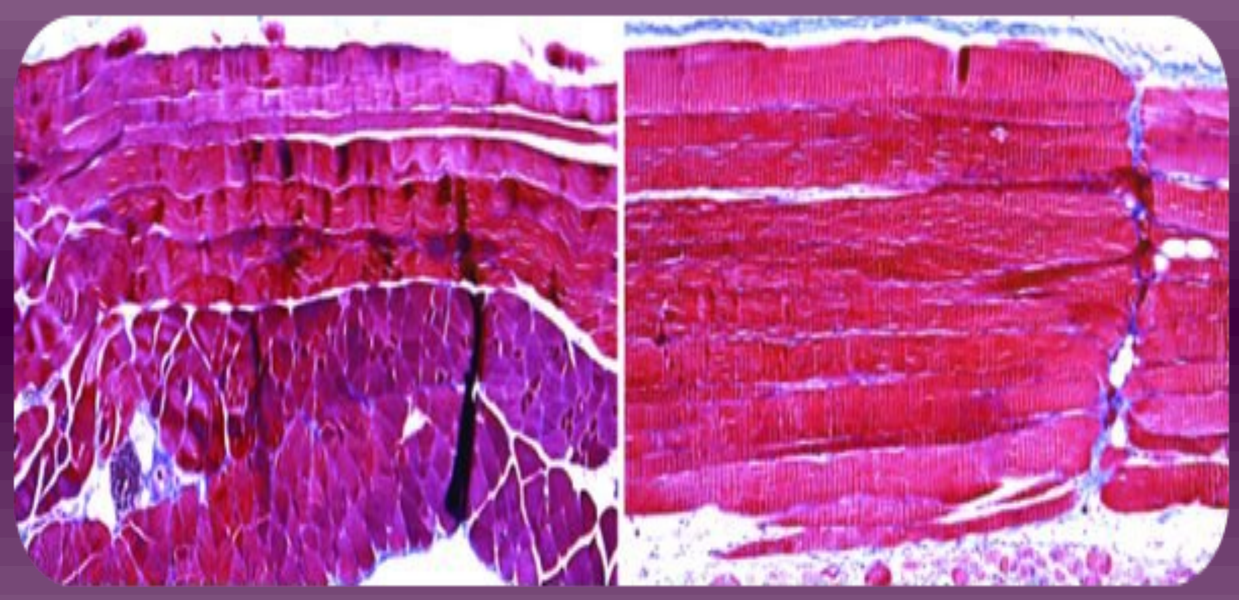
SLOVENIA

Doc. dr. sc. Matija Milanič
Prof.. dr. sc. Robert Jeraj
Jošt Stergar (PhD student)
Luka Rogelj (PhD student)

PROJECT DESCRIPTION

- Hyperspectral imaging (HSI), as a non-contact and non-invasive technique, enables the collection of very informative spectral (at different wavelengths) and spatial data on the observed sample
- For the results of the analysis to be usable, the analysis has to occur in almost real-time
- Machine learning (ML) methods allow us to train models on an extensive amount of data (once the model is trained, the results are obtained instantaneously)
- ML methods are sensitive to outlier values and noise - so, it is crucial to denoise the data as much as possible, so that the learned models are as accurate as possible
- Implementation of different noise removal algorithms would significantly

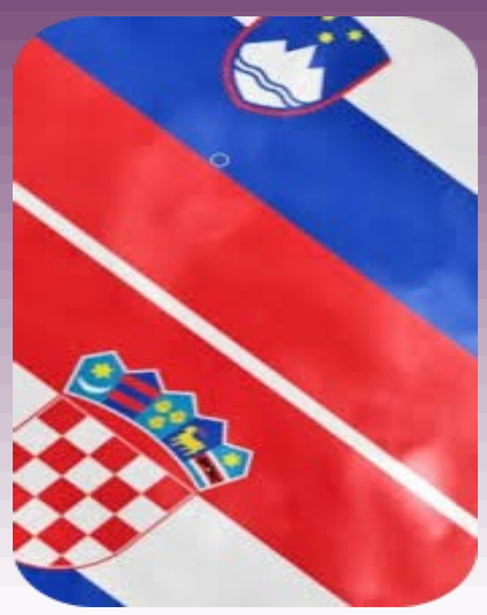




PROJECT GOALS

The project's main goal is to develop algorithms based on ML and adaptive filtering for the analysis of HSI. The specific objectives of the research are focused on:

1. Study of mathematical background and design of theoretical procedures (improved/modified/hybrid) based on ML and digital signal processing for noise removal, classification, and analysis of HSI
2. Collection of real-world data with a focus on medical images (skin scars, skin examinations, animal tissues, etc.), and art paintings (wallpaper patterns, films, etc.)
3. Simulation of real-world objects recorded by HSI technique with different noise levels using the Monte Carlo model of light transmission
4. Regression and classification based on ML: basic representations of ML and their corresponding optimization techniques (maximum delimitation, perceptron, partitioning, and probabilistic modeling techniques); model communities (sampling with return and model strengthening), deep learning (CNN, AE, RNN, LSTM, GAN)
5. Development of adaptive filtering procedures with an optimal trade-off between estimation bias and variance, time-frequency noise removal
6. Applying entropy information measures: local entropy measures for HSI analysis, extraction of useful information from noisy data
7. Validation of proposed classifiers on real-world data



CONTACT

Doc. dr. sc. Jonatan Lerga

Head of Department of Computer Engineering

EMAIL

jlerga@riteh.hr

WEBSITE

https://portal.uniri.hr/portfelj/961