PhD Thesis: 2024-2027

Development of an intraoperative tool in neurosurgery to assist in biopsy site selection based on fluorescence spectroscopy and machine learning to improve diagnostic accuracy in oncology.

Scientific Context:

Early and accurate diagnosis of cancer is crucial for improving outcomes for patients and optimizing the use of clinical resources. Biopsy is an essential medical procedure in this process, but the selection of biopsy sites remains a critical and complex step, often based on visual criteria or general clinical indications. The proposed research project aims to develop an innovative biopsy site selection assistance tool, based on the combination of fluorescence spectroscopy and machine learning, to improve diagnostic accuracy in oncology.

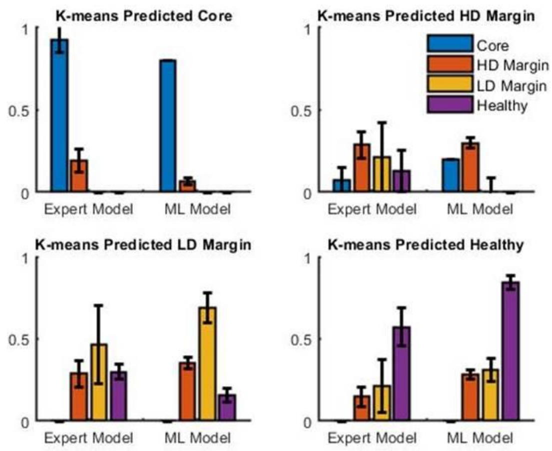
The candidate selected for this thesis will work closely with experts in fluorescence spectroscopy, machine learning, neurosurgery, and clinical oncology. The specific objectives of the thesis will include:

1. Collection and analysis of fluorescence spectroscopy data from biological tissues obtained during clinical biopsies. We aim to use endogenous fluorophores (e.g., NADH, flavin, PPIX, ...) to obtain even more precise biological information than in our previous work.

2. Development and validation of machine learning models capable of recognizing morphological and molecular characteristics associated with specific lesions. In detail, we aim to evaluate different machine learning and deep learning models for the comprehensive analysis and classification of optical spectra obtained from glioblastoma tissues.

3. Integration of these models into a user-friendly computer tool that can be used by clinicians to guide biopsy site selection.

4. Evaluation of the effectiveness and accuracy of the tool using independent clinical data and prospective tests in the operating room.



In vivo experiments during a surgery "Machine Learning model" vs "Expert model"

In vivo experiences during an operation Comparison "Machine Learning model" vs "Expert model"
The candidate will have the opportunity to work on an innovative and interdisciplinary research

project, with potentially significant practical applications for clinical practice. The results of the thesis could contribute to improving diagnostic accuracy, reducing complications associated with unnecessary biopsies, and optimizing outcomes for cancer patients. The candidate will gain valuable skills in fluorescence spectroscopy, machine learning, and clinical oncology, as well as practical experience in the design, implementation, and evaluation of innovative medical assistance tools.

Candidate Profile:

The ideal candidate for this thesis should have a master's degree/engineering degree with skills in data analysis, data processing, and machine learning, an interest in instrumentation. The candidate must have strong programming skills, an ability to work in a team, and a strong motivation to conduct interdisciplinary research in the field of health. Proficiency in written and spoken English is required.

Supervision and Funding:

The candidate will be supervised by an interdisciplinary team of experts in fluorescence spectroscopy, machine learning in neurosurgery, and clinical oncology. In detail, the supervision will be provided by:

- Cédric RAY-GARREAU (CREATIS),
- Thiebaud Picart (Neurosurgeon at Hospices Civils de Lyon)
- Arthur Gautheron (CREATIS)

The thesis project will be funded by a doctoral allocation from the Graduate School Medical Device and is part of the European project EIC Pathfinder Hyperprobe.

Perspectives:

The perspectives for this thesis include exploring new imaging and detection techniques, such as in vivo fluorescence imaging. By integrating multimodal data and leveraging more advanced artificial intelligence approaches, it is possible to develop even more sophisticated tools for clinical decision-making. The candidate will also could pursue an academic or industrial career in the rapidly expanding field of personalized medicine and digital health.

Contacts

Cédric RAY-GARREAU cedric.ray@univ-lyon1.fr , www.creatis.insa-lyon.fr

References

1. B. Montcel, L. Mahieu-Williame, X. Armoiry, D. Meyronet, and J. Guyotat, "Two-peaked 5-ALA-induced PpIX fluorescence emission spectrum distinguishes glioblastomas from low-grade gliomas and the infiltrative component of glioblastomas," Biomedical Optics Express 4, 548 (2013).https://doi.org/10.1364/BOE.4.000548.
2. Gautheron, M. Sdika, M. Hébert, et B. Montcel, "An explicit Estimated Baseline Model for Robust Estimation of Fluorophores using Multiple-Wavelength Excitation Fluorescence Spectroscopy," IEEE Transactions on Biomedical Engineering (2023). https://doi.org/10.1109/TBME.2023.3299689.
3. P. Leclerc, C. Ray, L. Mahieu-Williame et al. "Machine learning-based prediction of glioma margin from 5-ALA induced PpIX fluorescence spectroscopy". Sci Rep 10, 1462 (2020). https://doi.org/10.1038/s41598-020-58299-7.
4. The HyperProbe project receives funding from the European Union's Horizon Europe research and innovation program under grant agreement No 101071040. https://hyperprobe.eu/
5. Graduate school for medical devices : https://graduate-plus.fr/en/medical-device-engineering-2/