**Research Proposal:**

Our project deals with the complex mission of segmenting brain tumors from multimodal imaging data. Due to the verity of tumor structures in terms of size, extension, and localization this is one of the most challenging tasks in medical image analysis today.

Neuroimaging is used today for detecting tumors and for evolution of the disease before and after treatment. Present neuroimaging solutions are based only on two-dimensional tumor measurements and actually analyzes only the enhancing component of the tumor, this is a very limited and inefficient solution. A fully-automated, multimodal segmentation algorithm will be helpful and efficient tool for tumor detection and treatment procedure. [1]

Our goal is to segment tumors and tissue components in multimodal brain MR images automatically and reliably. We will explore the current state of the art algorithms, choose the superior ones and modulate them to an optimized solution. We will use “classical” image processing tools and current machine learning and neural networks in order to implement the optimized solution.

Our product will be an algorithm implemented in Python which will be able to process and analyze multimodal MR images with high accuracy. The algorithm will be trained on BARTS image dataset and will be tested and measured on an unseen data. The output of the algorithm is a segmentation map of the input image (with the ability to label 4 different tissue areas).

The algorithm performance on the test data will be evaluated with an online evaluation tool by BARTS. The online tool compares the algorithm results to the ground true and evaluates the quality of the segmentation.

Three tumor regions segmentation will be evaluated: the “whole” tumor, the tumor “core” and the “active” tumor (the enhancing core). We will follow those evaluation metrics:

Dice – the number of true positives divided by the average size of the true prediction area and the ground true area, measured in %). Hausdorff distance – a method for calculating distance between segmentation boundaries (measured in mm).

A realistic success rate will be:

|  |  |  |  |
| --- | --- | --- | --- |
|  | Hole tumor | Tumor’s core | Active tumor |
| Dice score | 80% | 70% | 60% |

Our algorithm will consist the following components:

* Preprocessing of the input data for a ma homogenous dataset, for example: intensity correction and images registration.
* Features extraction, for example: voxel-wise features, textural and spatial features and

intensity distribution.

* Classification for distinguish between different classes, for example SVM network or decision trees. [2] [3]

In order to achieve our goals, we will follow the following working methodology:

1. Information gathering stage:
   1. Extensive research of relevant segmentation algorithms from BARTS challenge and beyond.
   2. Learning “classical” image processing and MR imaging.
   3. Experiencing with implementation of neural networks.
2. Evaluation stage:
   1. Designing a leading algorithm with 3 possible modifications to implement.
3. Implementation stage:
   1. Implement the leading algorithm and his modifications.
   2. Evaluating and comparing the different algorithms.
   3. Changing and optimizing the leading algorithm.

*Checkpoints, working environment, collaboration with the image processing lab*

**Task management:**

|  |  |
| --- | --- |
| **Weeks** | **Tasks** |
| 1-4 | * Articles and algorithms research. * Learning TensorFlow. * Submit preliminary report (11/2017) |
| 5-8 | * Articles and algorithms research. * Implementation of basic image processing procedures as part of image processing course. * Implementation of neural network with TensorFlow. |
| 9-12 | * Evaluating the leading algorithms. * Designing a leading algorithm with 3 possible modifications to implement. * Executing a classical MR image processing project. |
| 13-16 | * Implementation of the algorithms. |
| 17-20 | * Implementation of the algorithms. * Evaluation of the algorithms on the test data. * Comparing the algorithms results using the evaluations metrics. |
| 20-24 | * Further modifications for optimizing the leading algorithm. * Re-evaluation of the modified algorithm. * Summery and reports. |
| 24-28 | Summery and reports |

References:

B. H. Menze, A. Jakab״, The Multimodal Brain Tumor Image Segmentation Benchmark (BRATS)״, Med. Im. vol:34 issue: 10

1. P. Y. Wen, "Updated response assessment criteria for high-grade gliomas: Response assessment in neuro-oncology working group", J. Clin. Oncol., vol. 28, pp. 1963-1972, 2010.
2. C. Cortes, V. Vapnik, "Support-vector networks", Mach. Learn., vol. 20, no. 3, pp. 273-297, 1995.
3. A. Criminisi, J. Shotton, Decision Forests for Computer Vision and Medical Image Analysis, Germany, Heidelberg:Springer, 2013.