Development of machine vision algorithms for radiomics

Abstract

The proposal aims to develop innovative methods for the recognition of medical images in the field of dosimetry and radiomics using Machine Learning algorithms. First aim is to simulate the entirely neutron field of an Accelerated-based BNCT. Then I will study the dose released in the tumor area treated with Boron Neutron Capture Therapy (BNCT). BNCT is a highly selective hadron radiotherapy, based on the 10B(n, α)7Li capture reaction. 10B is deposited in the cancer cell via a drug. Subsequently, the patient is irradiated with thermal neutrons producing an unstable 11B nucleus which decays into an α particle and an excited recoil nucleus of 7Li, which de-excites by emitting 478 keV gamma rays. The reaction has a positive Q-value of 2.78 MeV and the products have high linear energy transfer (LET) which drives the deposition of the emitted energy within a range <10 μm, making it possible to transfer most of the energy into the cell tumor. The starting dataset consists of images simulated with Monte Carlo methods of the dose released in a phantom and detected by a CdZnTe sensor. The images will be analyzed to reconstruct the dose deposition area. This will be made with a tomographic algorithm used for pin-hole SPECT diagnosis. Single Photon Emission Computed Tomography (SPECT) is the method used to detect gamma and reconstruct 3D-images of dose in patient. After successful reconstruction, a Machine Learning (CNN) method will be used for the identification of gamma ray source. This algorithm exploits a CNN network that will be trained and tested on the dosimetric image database. The second phase consists in applying these methods to the analysis of cancer medical images for radiomics purpose, obtaining information on dosimetry and tumors features. I will use existing database of medical images of tumor lesions and I will build a Deep Learning algorithm able to segment images and distinguish lesions from healty tissue. The method will be benchmarked with the most up-to-date medical image recognition methods. During the final part of the project, I will classify tumor images by combining segmentation methods with radiomics extraction methods, in order to extract feature like “energy” and “grey-level”. In this way, a BNCT-SPECT-CT hybrid system could take profit from a full reconstruction method able to measure on-line dose to patient.

Index:

Cap.1: Particle and Neutron Capture Therapy

1. Boron neutron capture therapy
2. Neutron production

Cap.2: Offline and online dose monitoring

Cap.3: Tomography methods

1. Reconstruction

Cap.4: SPOC project

Cap.5: Image segmentation for SPECT-CT