ST 3: Artificial Intelligence in Medical Physics

Time: Tuesday 14:00–15:15 Location: STa

ST 3.1 Tue 14:00 STa

Optimierung der Bildregistrierung mit maschinellem Lernen für die Strahlentherapie — •Alexander Ratke und Bernhard Spaan — Experimentelle Physik 5, TU Dortmund

Die präzise Lokalisierung des Tumors und der Risikostrukturen ist ein wichtiger Bestandteil der Therapieplanung. Die eingesetzten medizinischen Bildgebungsverfahren wie Computertomografie (CT) und Magnetresonanztomografie (MRT) bieten bedingt durch die jeweiligen physikalischen Prozesse unterschiedliche Vorteile, welche mithilfe von Bildfusionen kombiniert werden können. In diesem Projekt werden CT- und MRT-Aufnahmen aus der Strahlentherapie verwendet. Dabei liegen die MRT-Aufnahmen in der T_1- und T_2-Gewichtung vor, die der longitudinalen beziehungsweise transversalen Relaxationszeit entsprechen.

Für eine optimale Registrierung werden die Aufnahmen zuerst durch eine affine Transformation bearbeitet, sodass anschließend Algorithmen des maschinellen Lernens verwendet werden können. Die *Deep-Learning*-Methode wird genutzt, um Strukturen eines Bildes durch mehrere Schichten zu filtern und an ein zweites Bild anzupassen. In diesem Vortrag werden die Ergebnisse der Bildregistrierung von dreidimensionalen CT- und MRT-Aufnahmen des Schädels vorgestellt, die mit Verfahren der Bildbearbeitung und maschinellem Lernen erzeugt werden.

ST 3.2 Tue 14:15 STa

Development of fast dose distribution calculations with generative adversarial networks — Susanna Guatelli[2], Markus Hagenbuchner[2], Kevin Kröninger[1], Michael Lerch[2], •Florian Mentzel[1], Olaf Nackenhorst[1], Jason Paino[2], Anatoly Rosenfeld[2], Ayu Saraswati[2], Ah Chung Tsoi[2], and Jens Weingarten[1] — [1]TU Dortmund, Germany — [2]Centre for Medical Radiation Physics, University of Wollongong, Australia

Radiotherapy targets tumor tissue with radiation to kill cancerous cells. To ensure delivery of the planned dose to the tumor cells while sparing the surrounding healthy tissue, a treatment plan is created before the therapy that defines irradiation angles and durations. The required computation of dose distribution is in many cases accelerated using approximations. For novel irradiation techniques like microbeam radiation therapy (MRT), such approximations have yet to be developed. Therefore, treatment planning is done using time consuming Monte Carlo simulations. A way to create fast dose distribution simulations for novel irradiation modes is the use of generative adversarial networks (GANs). GANs are a class of neural networks that can be trained to generate data points that match the distribution of the training data samples.

We present a study on the development of an algorithm based on 3D-UNet GANs to calculate the dose deriving from minibeam irradiations as simplified case of microbeams irradiation. The dose distributions in different simple target geometries used for the trainings of the GANs were obtained by means of Geant4 simulations.

ST 3.3 Tue 14:30 STa

A neural network for event identification in a Compton camera for imaging prompt gamma rays in proton therapy — •Pascal Wirtz, Ronja Hetzel, Jonas Kasper, and Achim Stahl — RWTH Aachen University - Physics Institute III B, Aachen, Germany

The utilization of proton beams for cancer treatments has gained popularity because it allows a more precise deposition of energy due to the Bragg peak. One big challenge is the live monitoring of the beam. The SiFi-CC project develops a Compton camera based on scintillating fibres which detects the prompt gamma rays in order to determine the penetration depth of the beam. A neural network is developed to reconstruct the direction of the prompt gamma rays. This network consists of three parts. One classifies whether the detected data represents a Compton event, while the other parts identify the locations and energies of the electron and photon of the Compton event. The classification of the event type already works quite well. Therefore the aim is to improve the reconstruction of the energies and locations of the particles in the Compton event in order to get better in determining the direction of the prompt gamma ray. With the directions of those an image reconstruction can be done to identify whether the position of the Bragg peak is inside the tumor.

ST 3.4 Tue 14:45 STa

Tracking of low-energy protons in a proton CT system using machine learning methods — •Miriam Schwarze, Marius Hötting, Kevin Kröninger, Florian Mentzel, Olaf Nackenhorst, and Jens Weingarten — Technische Universität Dortmund, Lehrstuhl für Experimentelle Physik IV

An essential component of a proton CT system is the tracking system for estimating the proton trajectory. Algorithms for reconstructing the proton path through a test object are based on knowledge of the position and flight direction of the proton in front of and behind the object. This information is obtained by detecting the protons in multiple layers of pixel sensors. Using the simulation software Allpix^2, the interactions of the protons with the materials and the processes in the pixel sensor are simulated in detail and a data set is created.

The sensors provide an accumulation of hits in each detector layer, which have to be combined to individual tracks. Deep neural networks represent a possible form of pattern recognition. The geometric information of the hits is processed into a three-dimensional image, which serves as input for a Convolutional Neural Network. It is investigated to what extent the Convolutional Neural Network is able to predict the track parameters based on the geometric information and what influence the track density has on the result.

ST 3.5 Tue 15:00 STa

Improving information extracted from glow curves of thermoluminescent personal dosemeters using CNNs — •Evelin Derugin[1], Florian Mentzel[1], Jens Weingarten[1], Jörg Walbersloh[2], and Kevin Kröninger[1] — [1]TU Dortmund, Lehrstuhl für Experimentelle Physik IV — [2]Materialprüfungsamt NRW

Personal dose monitoring is essential for a successful radiation protection program for occupationally exposed persons. Thermoluminescence detectors are among the most frequently used dosimeters. The *Lehrstuhl für Experimentelle Physik IV* at TU Dortmund, in cooperation with the *Materialprüfungsamt NRW*, is developing multivariate techniques for glow curve analysis using convolutional neural networks (CNNs), to gain additional information about the irradiation scenario, i.e. the number of irradiation fractions or the time of irradiation. These can help to better track the reason for radiation exposure and thereby improve the existing radiation protection concept. Before a convolutional neural network can be used to predict parameters of a new measurement, large data sets are required for training. Our investigations are based on several thousand measured LiF:Mg,Ti glow curves, which are used for the training of the CNNs.
In this talk, we will present results obtained using the CNNs for a multivariate analysis of the glow curves including information about the performance and the optimization of the neural network.