Workflow Model Gerneration for Video Augmentation for Neural Networks

Andreas Wachter, Institute of Biomedical Engineering (Karlsruhe Institute of Technology), Karlsruhe, Germany, Andreas.Wachter@kit.edu
Werner Nahm, Institute of Biomedical Engineering (Karlsruhe Institute of Technology), Karlsruhe, Germany Werner.Nahm@kit.edu

Neural networks are becoming increasingly popular in medicine for diagnostic support and decision support. For a high accuracy and sensitivity of the application an extensive and annotated data set consisting of a large number of dissimilar training data is required. Such training data is often not available for various reasons. A reason could be that the medical data is not annotated because of effort or it is legally not possible to use the data because of data protection reglementations. A neural network which is trained with less training data leads to overfitting and it can no longer generalize well. To overcome this problem the data set would be in the most cases artificially enlarged by geometric or colored transformations like rotation, translation, color reversal etc. However, it can be insufficient for data that also contains information in time domain, because only the images would be modified not the sequence and not symbolic information is available.
In this publication we present an approach how to generate a workflow model for the workflow-based augmentation of time-sensitive data using the example of cataract surgery. The workflow model would be extraced automatically out of the present annotated videos of the cataract surgeries and can be extended by expert interview or observation of caterarct surgeries. With that model the annotated videos was be cutted and sorted by the new symbolic information from the workflow model. In the future it will now be possible to extend the training data with the symbolic information database using the workflow model for better accuracy and sensitivity of neural networks even in time sensitive cases.

Intraoperative Registration of 2D C-arm Images with Preoperative CT Data in Computer Assisted Spine Surgery: Motivation to Use Convolutional Neural Networks for Initial Pose Generator

Alvarez-Gomez Julio*, julio.agomez@uni-siegen.de
Prof. Dr.-Ing. Roth Hubert*, hubert.roth@uni-siegen.de
Dr.-Ing. Wahrburg Jürgen*, wahrburg@zess.uni-siegen.de

*Center for Sensor Systems (ZESS), Univerisity of Siegen, Siegen, Germany

2D to 3D registration algorithms have been studied intensively based on intensity-base and stochastic-base methods. We use preoperative CT-Scans taken for planning and register them using intraoperative C-arm images in our research on spine surgery and implantation of pedicle screws. Previous works using multimodality images have found that the initial guess used for the registration has a high impact on the outcome. We experience the same phenomena when carrying out some tests using two different lumbar spine phantoms from whom we took CT-Scans and X-ray images. Using measurement methods and optimizing cost functions, we have achieved registrations that result in errors within ±2mm when the initial pose was no more than ±5° and ±10mm away in each axis respecting to the actual pose. At this point in our study, the initial pose is chosen manually, but it is necessary to remove user intervention to the minimum extent. Consequently, using an image processing method, that gives a pose within our critical range, is our next step to support intraoperative navigation based on CT-based planning. For automating this process, we gathered a set of 2500 X-ray images of both phantoms from whom we know the C-arm poses. Starting for predicting the rotation, we used 2000 images for training a fully connected neural network (FCNN) and testing the result with the remaining 500. The inputs of the FCNN were the x-ray image, CT-Scan's lateral and anteroposterior projection. We got in the prediction average errors of ±4.536°, but some peak errors up to ±26.8°. In order to improve the prediction rate, and making a better generalization, we propose an approach using CNNs within the Pytorch framework as a mean for obtaining the initial pose for our registration procedure. Later we plan to migrate the trained CNN to C++ and CUDA to make it compatible with our current development.

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Combination of sensor-embedded and secure server-distributed artificial intelligence for healthcare applications

Pierre Gembaczka, Duisburg, Fraunhofer Institute for Microelectronic Circuits and Systems (IMS), Germany, pierre.gembaczka@ims.fraunhofer.de
Burkhard Heidemann, Fraunhofer Institute for Microelectronic Circuits and Systems (IMS), Duisburg, Germany, burkhard.heidemann@ims.fraunhofer.de
Wolfgang Groeting, Fraunhofer Institute for Microelectronic Circuits and Systems (IMS), Duisburg, Germany, wolfgang.groeting@ims.fraunhofer.de
Thomas Norgall, Fraunhofer Institute for Integrated Circuits (IIS), Erlangen, Germany, thomas.norgall@iis.fraunhofer.de
Karsten Seidl, Department of Electronic Components and Circuits, University of Duisburg-Essen, Duisburg, Germany, karsten.seidl@uni-due.de

The application of artificial intelligence (AI) in the areas of health, care and social participation offers great opportunities but also involves great challenges and risks. To counter them, extensive regulatory, ethical and data-security related requirements exist for data recording, storage and processing of respective personalized and patient-related data. “Artificial Intelligence as a Service” (AIaaS) is pushed for consumer applications by big companies which implies data storage on external database server. However, the available solutions do not meet the above mentioned requirements. Moreover, small and medium-sized enterprises (SMEs) in the field of healthcare fear the loss of data sovereignty and information outflow. In this paper, we propose a secure and resource-efficient approach by embedding AI directly close to the sensor in combination with secure and distributed data processing on local server or certified “Trusted Data Center”. For this puropose, we have developed the Artificial Intelligence for Embedded Systems (AIfES) platform-independent machine learning library in C programming language. It contains a fully configurable deep artificial neuronal network with feedforward structure. The library can be run directly on a microcontrollers and even allows to train the AI network on the microcontroller. Possible healthcare application include direct (pre-)processing of sensor data, calibration of sensors, pattern recognition and classification. Furthermore, virtual sensors can be developed by extracting a dependence of different measured variables (e.g., pulse and blood oxygen saturation using a pulse oximeter) to a new target variable (e.g., respiratory frequency). The work is part of the German Federal Ministry for Economic Affairs and Energy (BMWi) funded project Care[Ful]KI – Responsible AI platform for health, care and social participation. It aimes an integrated, on open standards based, legally certain and highly available AI data platform with competence and data pool. It shall allow innovative products and services applying anonymized or pseudonymized healthcare data.

Hyperthermia Efficiency Impact of Magnetic Nanoparticle Immobilization inside Hybrid Stents

Benedikt Mues, Institue of Applied Medical Engineering, Helmholtz Institue, Medical Faculty, RWTH Aachen University, Aachen, Germany, mues@ame.rwth-aachen.de
Benedict Bauer, Institut für Textiltechnik, RWTH Aachen University, Aachen, Germany, benedict.bauer@ita.rwth-aachen.de
Jeanette Ortega, Institut für Textiltechnik, RWTH Aachen University, Aachen, Germany, jeanette.ortega@ita.rwth-aachen.de
Andreas Blaeser, Institut für Textiltechnik, RWTH Aachen University, Aachen, Germany, andreas.blaeser@ita.rwth-aachen.de
Thomas Gries, Institut für Textiltechnik, RWTH Aachen University, Aachen, Germany, thomas.gries@ita.rwth-aachen.de
Thomas Schmitz-Rode, Institue of Applied Medical Engineering, Helmholtz Institue, Medical Faculty, RWTH Aachen University, Aachen, Germany, smiro@ame.rwth-aachen.de
Ioana Slabu Institue of Applied Medical Engineering, Helmholtz Institue, Medical Faculty, RWTH Aachen University, Aachen, Germany, slabu@ame.rwth-aachen.de

Inductive heatable hybrid stents with incorporated magnetic nanoparticles (MNP) are developed for local hyperthermia treatment of endoluminal tumors. By application of an alternating magnetic field (AMF) a temperature of ca. 43 °C is generated at which tumor cell death via apoptosis is induced. In this way, tumor tissue in close vicinity to the stent can be destroyed.

In this study, we investigate the effects of MNP immobilization, concentration and agglomeration inside polypropylene (PP) matrices on hyperthermia efficiency. Two different PP matrices with incorporated MNP, compounds and fibers, are analyzed and compared to dispersed MNP and MNP immobilized in hydrogels. The compounds were produced by melt spinning PP pellets mixed with freeze-dried MNP and the fibers by melt spinning of these compounds. The synthesized MNP were stabilized with lauric acid and consist of iron oxide cores with a diameter of (10.2 ± 2.4) nm and a saturation magnetization of (99.4 ± 0.8) Am2/kg(Fe). All samples were exposed to an AMF at H = 14 kA/m and f = 100 kHz and the intrinsic loss power (ILP) was determined.

We analyzed the ILP values for dispersed MNP in water compared to MNP immobilized in polyacrylamide hydrogel as well as for incorporated MNP in PP compounds and PP fibers with various MNP concentrations. The results show an ILP decrease of approx. 20 % for the immobilized MNP in hydrogel, of approx. 65 % for the compounds and of approx. 73 % for the fibers. This can be explained by partial blocking of Brownian relaxation of MNP for the hydrogels and a full blocking for the PP matrices. Further, larger agglomerates formed during the freeze-drying and melt spinning process may have an influence on the heating efficiency.