Project Details

Nikos Tsiknakis

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1 Projects in CBML FORTH

1.1 3D Medical Image Registration

During my internship (summer 2018) as well as the past few months that I have been working in CBML, ICS FORTH I am involved in the H2020 InSilc project (`https://insilc.eu/`), in which my main responsibilities relate to the implementation and testing of a number of algorithmic approaches for the registration of IVUS image sequences before and after stent procedure.

IVUS image sequences suffer from various artifacts that are caused by the cardiac pulse, which can complicate their analysis. One major artifact is that the longitudinal movement of the transducer is affected by an oscillatory movement due to the heart beats [1]. Moreover, because the catheter is withdrawn through the blood vessel, its position with respect to the vessel is not fixed but freely to move inside it. As a result, the acquired image sections might not be orthogonal to the vessel walls [2] as well as subsequent frames might be misaligned [1]. To address these problems, a gating technique is applied in order to sample the frames which correspond to the end-diastolic phase of the heart cycle. Then we apply a DTW based method in order to temporally align the IVUS image sequences. Finally, we apply rigid registration between each image pair of the temporally registered sequences.

1.2 Deep Learning for Retina Diseases

I am also working on the H2020 SeeFar project (`https://www.see-far.eu/`) on the development and evaluation of methods for the detection and the progression of retina diseases (diabetic retinopathy and age-related macular degeneration), as well as diseases that are not related with the eyes health, but signs of the diseases can be detected by the analysis of retina images (e.g. cardiovascular risk). Both traditional (featured based) machine learning approaches as well as deep learning methods will be explored and evaluated with respect to accuracy, sensitivity and specificity in diagnosis and prediction.

In particular, we are focusing on the detection and classification (Grade 1-4) of diabetic retinopathy from fundus-like images. We are using a CNN architecture which is trained on publicly available fundus retina datasets for the detection and classification of the disease. Subsequently, we apply transfer learning in order to fine-tune the model to our dataset.

Furthermore, we are also focusing on the segmentation of lesions (i.e. drusen, exudate, hemorrhage, scar, and others). We are comparing CNN and U-Net approaches.

2 Projects in University of Patras

2.1 ECE Thesis

This thesis was conducted in the Digital Signal and Image Processing Laboratory of the Electrical and Computer Engineering Department, University of Patras under the supervision of Prof. Athanassios Skodras in collaboration with the Vrije Universiteit Brussel (VUB) and the Royal Meteorological Institute of Brussels (KMI).

Its central objective was the application of advanced stereo vision techniques for the estimation of cloud height based on images from the MSG-3 and MSG-1 satellites.

In the context of the thesis I have specifically focused on the following:

1. Extensive review of prior work regarding image registration methods.
2. Implementation of several state-of-the-art image registration methods. Specifically, I have compared two major algorithmic family of methods, i.e.
   (a) One operating on the pixel domain, which is based on the maximization of the Mutual Information of the image pair and
   (b) One operating on the low-level features of the images. In this approach, the features were extracted using the SIFT and SURF algorithms. The transformation model for registering the images was estimated using these features and the RANSAC algorithm.
3. Review and application of Graph Cut algorithms based on the Markov Random Fields theory to extract the disparity map.

2.2 IEEE Signal Processing Society SPCup2018

During the fourth year of my studies I was part of a 5-members team that participated in the IEEE Signal Processing Cup 2018 (`https://piazza.com/ieee_sps/other/spcup2018/home`). The specific challenge focused on the topic: A forensic camera model identification challenge. The goal of this competition was to build a system capable of determining the type of camera (manufacturer and model) that captured a digital image without relying on metadata. We developed a system based on machine learning techniques that could identify the camera type with an accuracy of 71%.

References

[1] Marina Alberti, Simone Balocco, Xavier Carrillo, Josepa Mauri, and Petia Radeva. Automatic non-rigid temporal alignment of ivus sequences. In *International Conference on Medical Image Computing and Computer-Assisted Intervention*, pages 642–650. Springer, 2012.

[2] Carlo Gatta, Oriol Pujol, Oriol Rodriguez Leor, Josepa Mauri Ferre, and Petia Radeva. Robust image-based ivus pullbacks gating. In *International Conference on Medical Image Computing and Computer-Assisted Intervention*, pages 518–525. Springer, 2008.