University of Basel

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Automated detection of cardiac and neurological causes of death in post mortem CT data

Master Thesis by Andrea Zirn (Department of Biomedical Engineering, University Basel) performed at the Research Group Forensic Medicine & Imaging, Institute of Forensic Science.

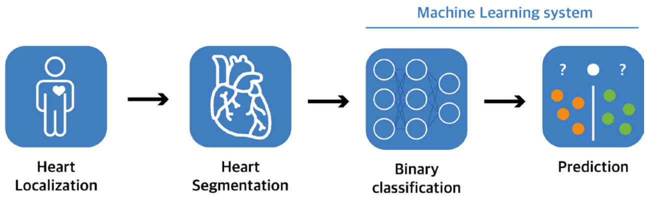

Figure 1: Cardiac pathologhy detection pipeline. The first step of the pipeline is to define the region of interest (ROI) of the heart. The second step is the semi-automatic segmentation with seed growing within the 3D slicer software. The third and last step consist of the predicting the binary classification into the pathologocal or healthy category with different machine and deep learning algorithms. (picture: A. Zirn)

During the last years, the detection of different causes of death based on post mortem imaging findings became more and more relevant. Especially post mortem computed tomography (PMCT) as a non-invasive, relatively cheap and fast technique is progressively used as an important imaging tool for supporting autopsies. Additionally, previous works showed that deep learning applications have yielded robust results for medical imaging interpretation. In this work, we propose and implement two pipelines to identify cerebral and cardiac causes of death on three-dimensional PMCT data.

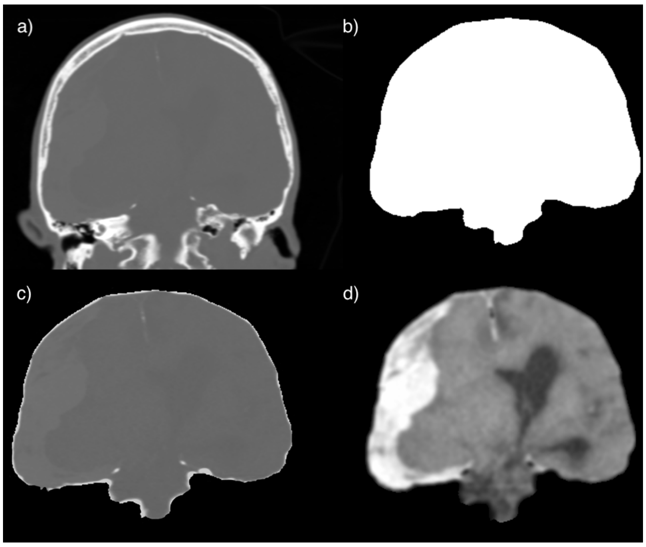

Figure 2: Cerebral segmentation process. The segmentation process consisted of 3D CT datasets. a) Original CT image in the coronal plane, b) 2D view of the created binary mask with the FSL library, c) segmented CT image in the coronal plane, d) contrast enhanced CT image in the coronal plane. (picture: A. Zirn)

For this study, we retrospectively selected 129 PMCT cases from the database of the Institute of Forensic Medicine Basel. This data contained 13 cases with cerebral hemorrhage, 24 cases with cardiac infarction, eight cases with cardiac pump failure, seven cases with left-sided cardiac failure, five cases with right-sided cardiac failure, three cases with cardiac tamponade and 69 consecutive healthy cases. Based on these datasets, six machine learning classifiers (k-nearest neighbors, Gaussian naive Bayes, logistic regression, decision tree, linear discriminant analysis and support vector machine) were executed and two different artificial neural networks (CNN, DenseNet) were trained. For the machine learning algorithms, CNN and DenseNet, 80% of the data was randomly selected for training and 20% for validation purposes. The best performing classification networks for cranial hemorrhage were Gaussian naive Bayes, CNN and DenseNet with an accuracy of 90.91%. This thesis further shows that deep learning algorithms show promising results for the automated classification in the area of right-sided cardiac failure, where both deep learning algorithms achieved an accuracy of 85.71%. Additionally, DenseNet was able to obtain an accuracy of 90.91% for the classification of cardiac infarction.

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Institut für Rechtsmedizin der Universität Basel

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