Numerical Modelling of Temperature-based Time of Death Estimation

Julia Ullrich[1] Martin Weiser[2] Sebastian Schenkl[3] Holger Muggenthaler[4] Michael Hubig[5] Gita Mall[6]

In forensic medicine, up to now the time of death is estimated based on a single measurement in the body core. To yield higher accuracy than established phenomenological models and take all relevant cooling mechanisms into account, we can simulate the thermodynamic heat transfer on a meshed corpse by a finite element (FE) based method. We then solve a regularized inverse problem to identify parameters by a gradient-based method to minimize the model-data mismatch. For this, besides the availability of human phantoms, highly detailed anatomical models with organs and tissue types have been segmented and reconstructed form CT scans of corpses. Implementation of this model is carried out within the FE toolbox Kaskade 7. Here, the body is represented by a spatial grid of tetrahedra and the temperature distribution at each time point is approximated by the temperature values at the grid nodes. The calculation of the cooling curves is then carried out by an implicit time-stepping method. We investigate the influence of heat transfer mechanisms like convection and radiation on the boundary and the impact of parameter variations and different measurement positions to get a qualitative understanding of relevance of thermal processes and modelling options for a sufficient accuracy of time of death estimation.

References:

[1] https://doi.org/10.1007/s00231-018-2324-4

[2] https://doi.org/10.1088/1361-6420/aae7a5

[1]Zuse Institute Berlin (ZIB), Modelling and Simulation of Complex Processes
ullrich@zib.de

[2]Zuse Institute Berlin (ZIB), Modelling and Simulation of Complex Processes
weiser@zib.de

[3]Institute of Forensic Medicine, Jena University Hospital – Friedrich Schiller University
Sebastian.Schenkl@med.uni-jena.de

[4]Institute of Forensic Medicine, Jena University Hospital – Friedrich Schiller University
Holger.Muggenthaler@med.uni-jena.de

[5]Institute of Forensic Medicine, Jena University Hospital – Friedrich Schiller University
Michael.Hubig@med.uni-jena.de

[6]Institute of Forensic Medicine, Jena University Hospital – Friedrich Schiller University
Gita.Mall@med.uni-jena.de