Title: Tracking contractile movement in engineered heart tissue with virtual particles

Authors:
Annika Ahvenjärvi, Ivo Ihrke, Jari Hyttinen, Antti Ahola

Keywords:
Engineered heart tissue
Movement tracking
Opical flow estimation

Abstract
Engineered heart tissue (EHT) is a novel platform for studying cardiac diseases and drug responses *in vitro* using induced pluripotent stem cell derived cardiomyocytes. The platform models the functionalities of cardiac tissue in 3D. EHTs are cultured around bending pillars, enabling the measurement of force generated by the tissue. However, apart from the generated force, there are limited tools for analyzing the EHTs at the moment. For greater understanding of the EHT structure-function-relation, there is a need for new methods and tools. This study uses contractile movement as a way to characterize EHTs using virtual particles, digital flow estimation tools suited for tracking the progression of contractile motion within the tissue. Using this method, we obtain particle trajectories, which can further be used to visualize and characterize the motion occurring in different parts of the EHT during contraction. We analyzed brightfield microscopy videos, revealing differences in contraction timings and particle trajectories in EHTs. The trajectories and their divergence from uniaxial motion provide valuable information for understanding the tissue biomechanics. Further, they enable the characterization of force measurement results, and could also be mapped with structural staining of the EHT, to provide more insight into the structure-function relation of the EHT. Together, this enables the clustering of EHTs regarding their contractile characteristics, enabling more detailed drug studies.