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Optogenetics-Biofluid Model for Engineered Beating Cardiomyocytes using Meshfree Method YASSER ABOELKASSEM, University of California San Diego — Optogenetic techniques make use of genetically encoded, light sensitive ion channels to manipulate cellular function with light. More recently, microbial opsins such as the light-gated ion channel channelrhodopsin-2 (ChR2) have been transfected into cardiomyocytes, allowing cardiac muscle contractions to be initiated by pulses of light. Cardiac optogenetics raises numerous interesting possibilities, including optical pacemakers, defibrillators, and flow pumping assistant devices accomplished through the precise spatiotemporal application of light excitations. In this study, an optogenetics-fluid mathematical model is proposed to study the flow motions induced by a single engineered cardiac cell. The optogenetics module is based on Monte Carlo type of simulations to control light stimulus events, which are then used to probe the cellular wall contractions. The fluid module is derived based on a two-dimensional meshfree-Stokeslets computational framework. The results show that, cells with a slightly different beating profile can induce different flow field that is characterized by coherent vortices with different strengths and core sizes. This implies that, each cell induces unique flow biomarker "signature", which can be used to better understand the intrinsic sub-cellular excitation-contraction processes of cardiac cells.

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