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Application of Computer Vision to Quantify Cell Behavioral Responses on Growth Factor Patterns

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Abstract

Biological discovery is moving toward high-throughput, combinatorial experimental approaches for applications in genomics, proteomics, drug development, and regenerative medicine. Bioprinting technologies are helping to enable these approaches by creating complex patterns of extracellular components, including hormones and extracellular matrix (ECM) molecules, in order to study how such patterns regulate cell behaviors using bioimaging techniques to quantify cellular responses. However, automated measurements have focused on either intracellular events or on individual cell responses, but not on cell population behaviors, which is more biologically relevant and the next logical step. Observing and tracking entire cell populations, including temporal-spatial quantification of proliferation, migration, differentiation and cell death, is challenging for bioimaging due to image complexity and extremely large datasets. New image analysis approaches are needed to efficiently quantify and report on cell population behavioral responses. Significant challenges are registration of cell population features between image sequences, integration of individual cell behavior with population behavior, and evaluation of multiple behavioral responses simultaneously. We propose to develop a multi-target tracking algorithm that simultaneously tracks a very large number of cells based on a topology-constrained, level-set method and Markov-chain Monte Carlo particle filtering. We will apply our methodology to *in vitro* tissue cell tracking under phase-contrast microscopy and demonstrate that the cells proliferate and migrate in alignment with spatial hormone patterns.