Tracking of Migrating and Proliferating Cells in Phase-Contrast Microscopy Imagery for Tissue Engineering

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Abstract. Tissue Engineering is an interdisciplinary field that applies the principles of biology and engineering to develop tissue substitutes to restore, maintain, or improve the function of diseased or damaged human tissues. One approach for engineering tissue involves seeding biodegradable scaffolds with hormones, then culturing and implanting the scaffolds by means of a printing technology to induce and direct the growth of new, healthy tissue cells. Precise and quantitative tracking of the migrating and proliferating cells by non-invasive phase-contrast video microscopy is a vital component to studying and understanding how the concentration-modulated patterns of hormones direct the migration and proliferation of tissue cells. The varying density of the cell culture and the complexity of the cell behavior (shape deformation, division/mitosis, close contact and partial occlusion) pose many challenges to existing tracking techniques. We propose 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 apply our methodology to *in vitro* tissue cell tracking under phase-contrast microscopy and demonstrate that the cells proliferate and migrate in alignment with the printed hormone patterns.

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