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Kinematics-based tracking of cells and fluorescent beads using feature vectors

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ABSTRACT

Tracking of cells or fluorescent beads from images of deforming or developing biological systems is a central challenge in biomechanics. In the former case, the objective is often to find the same cell in a tissue or on a Petri dish that has been imaged before and after time in an incubator. In the latter case, the objective is often to estimate mechanical tractions based upon displacement of fluorescent beads embedded in a defined extracellular matrix. A great number of techniques exist for this purpose, and all face challenges in matching cells and beads from one image to the next and in identifying mismatches. Here, we present a simple, fast, and effective technique for matching cells and beads using “feature vectors” that connect a cell or bead to a set of its nearest neighbors. A generalized feature vector deformation gradient tensor is defined that enables the use of standard kinematics to estimate the maximum likelihood matches between cells or beads in image pairs. We describe the strengths and limitations of the approach and present examples of its application.