Intelligent Acquisition and Learning of Fluorescence Microscope Data Models

Charles Jackson

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This thesis presents a new acquisition framework that models fluorescence microscope data during acquisition, and uses these learned models to intelligently guide future acquisitions. This framework results in significant time savings, as well as in reducing the photobleaching and phototoxicity incurred during acquisition. Fluorescence microscopy is a popular tool for live-cell imaging, and in recent years, there has been an explosion in the amount of data acquired with this technique. Visual inspection of this data is time-consuming and not reproducible, motivating the goal of automated image analysis. Furthermore, we would ideally like to acquire all types of cells under all conditions, but standard acquisition methods are too time-consuming to achieve this feat. This work proposes to address these problems with a new acquisition framework that builds models of the data while it is being acquired, and uses these models to carry out intelligent acquisition. The goal is to reduce total acquisition time by identifying and acquiring only the data that is necessary for building the model, as well as to acquire in a way that reduces photobleaching and phototoxicity - two fundamental limitations associated with fluorescence microscopy. We evaluate the framework experimentally on synthetic and real data. First, we present a possible method to build models of a single object within a cell, of multiple objects in a cell, and of a population of cells. Then, we present intelligent acquisition algorithms to determine where to acquire in a cell, when to acquire in a cell, when to stop acquiring from a cell, and how many cells to acquire from a population. We show that the combination of model building and intelligent acquisition results in time savings, reduced photobleaching, and reduced phototoxicity, without loss of accuracy.

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