ZEN Intellesis: Machine Learning Based Image Segmentation

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1. Introduction

Image segmentation is usually the biggest challenge in image analysis as segmentation lays the foundation for subsequent image analysis steps, i.e., data extraction and quantification. Besides, conventional threshold-based image-segmentation methods frequently require a specialized segmentation workflow using a combination of digital filters and tools. Moreover, there are datasets where threshold-based methods struggle or fail to generate meaningful results (e.g., images with low signal to noise ratio).

Machine learning, on the other hand, offers even non-experts the possibility to create robust and reproducible segmentation results easily. Also, machine-learning methods often yield good results with challenging images.

2. ZEN Intellesis

The software module ZEN Intellesis enables easy and precise segmentation of multidimensional images and supports images from a wide variety of different imaging modalities. ZEN Intellesis uses supervised machine learning and can be trained to automatically identify objects within an image according to a predefined set of rules (the model). In supervised learning, some features are manually labeled by the user, which forms the so-called "ground truth." ZEN Intellesis uses pixel-based classification and offers an extremely easy to use, GUI based training interface. This enables non-experts to easily segment complex data sets without needing knowledge of machine learning. The result – a correctly classified image – can then be seamlessly integrated into the image analysis workflows to extract meaningful data. In this talk, I will describe Intellesis as a method and illustrate several examples of its applications. Figure 1 shows an example of Intellesis at work.
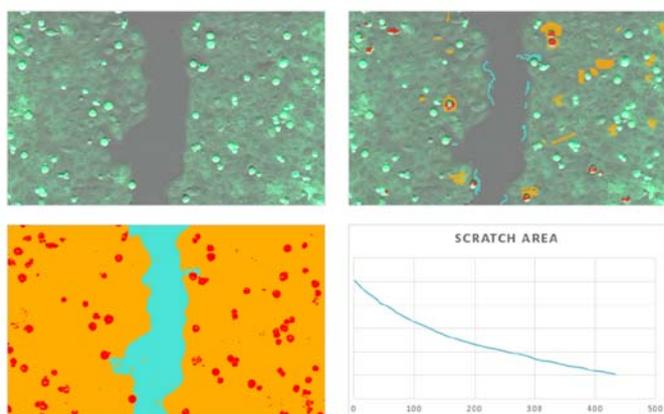

Figure 1: Scratch Assay of GFP expressing HeLa cells. Top left: One frame of a recorded time-lapse movie. Top right: Labeled pixels used for training of ZEN Intellesis. Bottom left: Segmentation result of the trained model – scratch area (turquoise), cell layer (orange) and mitotic cells (red). Bottom right: Based on ZEN Intellesis segmentation results, the size of the scratch area was measured over time using the ZEN Image Analysis module.