# **Live-Cell Tracking using Phase Stretch Transform (PST)**

ECE 274

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Continuous long-term live-cell imaging is essential to advance the understanding of cellular dynamics that influence cell fate. Recent studies highlight the importance of continuous live-cell analysis [1,2], but lack of automated software tools for live-cell detection, tracking and quantification suitable for long-term time-lapse microscopy experiments still impedes their analysis [3]. Although long-term imaging is possible, it involves numerous technical challenges such as photoxicity, varying levels of illumination.

Phase stretch transform (PST) is a physics inspired edge and feature detection algorithm that came out of Jalali-lab in 2015 [4,5]. It emulates group velocity dispersion followed by coherent (phase) detection of the dispersed input, but it does so in 2D discrete domain, instead of 1D time domain. PST has received extraordinary response from the image and signal processing community. The transform has inherent equalization ability that is useful for feature detection in visually impaired images [6]. The source code for PST can be found here [7]. CytoLive [8], is the name of live cell tracking tool that was developed in Jalali Lab for tracking 2D live cell.

In this project, you will:

1. Download the Matlab PST 2D code from Github Jalali Lab repository [7]. Extend the algorithm to 3D (x,y,z) – Write the code for operation of PST on a 3D.
2. Analyze the 3D+T (3D plus time; vidoes) live-cell dataset available here [9]. Select at least two types (and not more than four types) of datasets from this challenge dataset collection.
3. Visualize the input and the PST output (edge maps)
4. Use the PST edge maps to detect cells.

Hint: find center of each cell then track them cells in time. Show x,y,z coordinates vs. time.

3D+Time data structure in [9]: Each frame is a .tif file. Each .tif has N (e.g. 28) slices in z direction. There are multiple frames that make up the video.

References:

1. Schroeder T. Imaging stem-cell-driven regeneration in mammals. Nature. 2008 May;453(7193):345-51.
2. Etzrodt M, Endele M, Schroeder T. Quantitative single-cell approaches to stem cell research. Cell stem cell. 2014 Nov 6;15(5):546-58.
3. Schroeder T. Long-term single-cell imaging of mammalian stem cells. Nature methods. 2011 Apr;8(4):S30-5.
4. Asghari MH, Jalali B. Edge detection in digital images using dispersive phase stretch transform. International journal of biomedical imaging. 2015 Jan 1;2015.
5. https://en.wikipedia.org/wiki/Phase\_stretch\_transform
6. Suthar M, Asghari H, Jalali B. Feature enhancement in visually impaired images. IEEE Access. 2017 Dec 6;6:1407-15.
7. <https://github.com/JalaliLabUCLA/Image-feature-detection-using-Phase-Stretch-Transform>
8. <https://www.youtube.com/watch?v=MbaKqm5KXv8>
9. http://celltrackingchallenge.net/3d-datasets/