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SIGNATURE

A Particle Analysis System for Molecular Electron Microscopy

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Topics

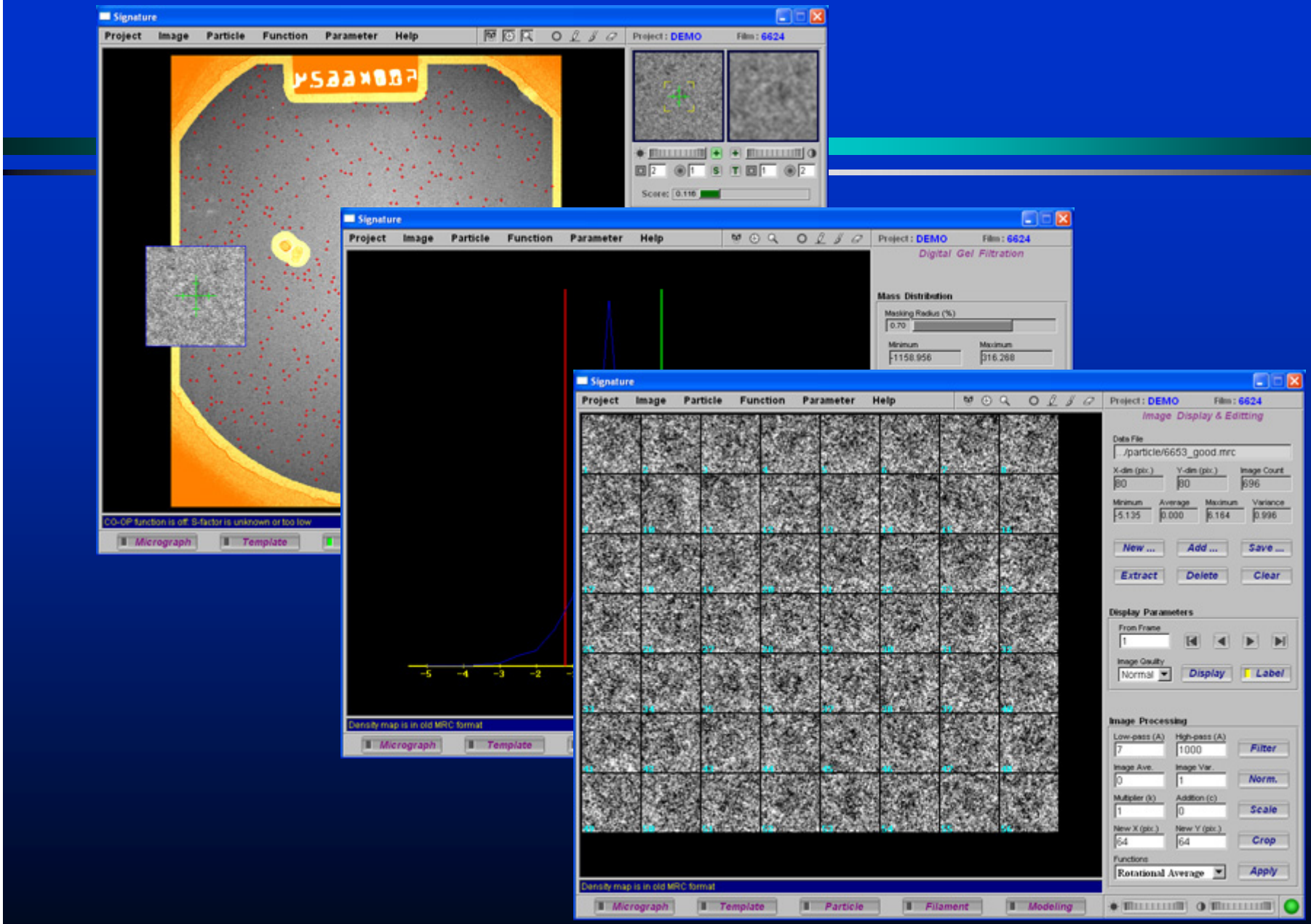
- *System Overview*
- *Algorithm & Implementation*
- *Application Demo*

System Overview

Signature is a particle analysis system for molecular EM :

- ✓ **A friendly GUI for interactive data analysis**
- ✓ **Batch processing & distributed computing**
- ✓ **Compatible data I/O with major EM packages**
- ✓ **Multi-platform application: Linux, Mac OS X, MS-Win**

Program website: www.brandeis.edu/~jzchen/Signature


Signature
Project Image Particle Function Parameter Help
Project : DEMO Film : 6624
Micrograph Template
Digital Gel Filtration
Mass Distribution
Density map is in old MRC format
Image Display & Editting
Data File
../particle/6653_good.mrc
New ... Add ... Save ...
Extract Delete Clear
Display Parameters
Display Label
Image Processing
Filter Norm. Scale Crop Apply
Rotational Average
Micrograph Template Particle Filament Modeling

Particle Selection

Signature supports algorithmic & manual particle selection:

Algorithmic selection

Hierarchical screening, high-throughput distributed computing,

reproducible and less susceptible to subjective bias.

Manual selection / inspection

Utilizing human users' unrivalled pattern recognition ability for quality control and decision making.

Template-Matching

Local Correlation Function (LCF) for image intensity matching

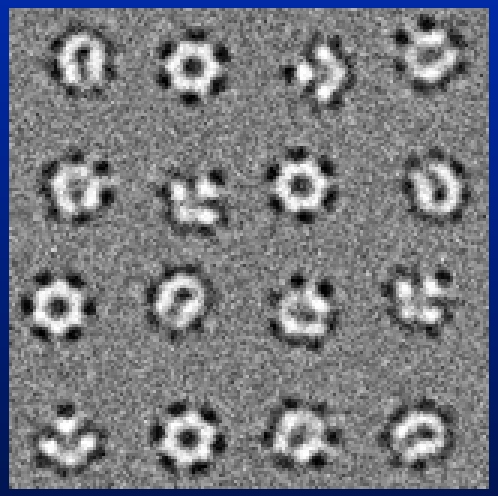
$$LCF(x) = \frac{1}{N_T \sigma(I_x)} \langle M_T \otimes T, I \rangle_x$$

Spectra Correlation Function (SCF) for overall shape matching

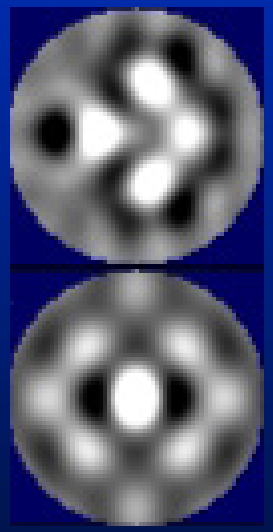
$$SCF(x) = \frac{1}{N_S \sigma(LCF_x)} \langle M_S \otimes ACF, LCF \rangle_x$$

I is a template image, M_T and M_S are template masks, N_T and N_S are pixels under the respective masks. **ACF** is the auto-correlation function of ***I***, and $\sigma(\ )$ is the square-root of variance.

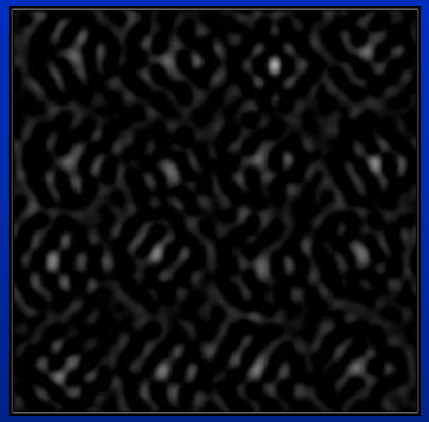
LCF & SCF Functions



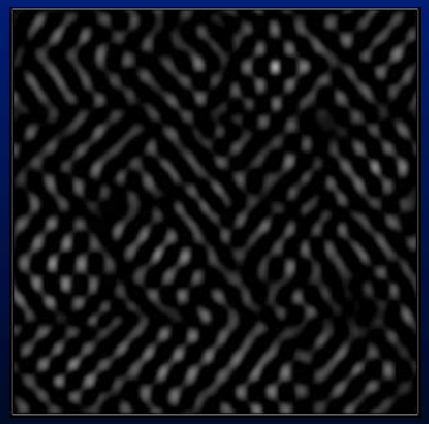
Micrograph



Template



LCF



SCF

Source of Templates

Depending on the stage of development, template images may come from

- ✓ **Particle images cropped directly from a micrograph**
- ✓ **Class averages from a sizable particle dataset**
- ✓ **2D projections from a 3D density model**

Data Processing Protocol

Image pre-processing

Micrograph quality inspection, image filtering, background removal …

Hierarchical particle screening

Image correlation, spectrum correlation, multi-layer template masking …

Particle post-processing

Informative display for user inspection, editing, and decision making …

Data Processing Toolbox

Data visualization

1D data plotting, 2D image displaying

Image processing functions

2D/3D images: normalization, filtering, re-sampling …

Image Stack Editor

Particle display and editing, synchronized with micrograph

Application Demo

1. **On a synthetic micrograph**
2. **On a cryo-EM micrograph**

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