PURDUE INNOVATES | Office of Technology Commercialization

SPTnet: a deep learning framework for end-to-end single particle tracking and motion dynamics analysis

End-to-end deep model (SPTnet) extracts single-particle trajectories/dynamics directly from videos under noisy, blurred conditions.

Researchers at Purdue University have developed a deep learning framework to overcome existing challenges in Single Particle Tracking (SPT). Their model, called SPTnet, utilizes deep learning to bypass traditional SPT processes, which are limited by localization inaccuracies, limited track lengths, heterogeneous fluorescence backgrounds, and molecular motion blur. All of these issues hinder the accurate extraction of movement trajectories and their underlying motion behavior, which can be essential for improving understanding of dynamic biological systems. Unlike conventional SPT pipeline, SPTnet directly infers molecular trajectories and motion parameters from fluorescence microscopy videos with precision approaching the statistical information limit. With SPTnet, researchers in biological or related fields will be able to expand existing knowledge of complex, dynamic systems with unprecedented accuracy.

Technology Validation:

Testing results demonstrate that SPTnet outperforms conventional methods under commonly encountered but challenging conditions such as short trajectories, low signal-to-noise ratio (SNR), heterogeneous backgrounds, motion blur, and especially when molecules exhibit non-Brownian behaviors.

Advantages:

-Leverages deep learning and Transformer-based architecture

-Optimized trajectory and motion parameter estimations

-Directly infers motion parameters and trajectories from fluorescence microscopy videos

-Extreme accuracy

Technology ID
2025-HUAN-70970

Category
Artificial Intelligence & Machine Learning/Computer Vision & Image Recognition
Artificial Intelligence & Machine Learning/AI Model Optimization & Acceleration Tools
Energy & Power Systems/Grid Modernization & Smart Grids

Authors
Cheng Bi
Fang Huang

Further information
Parag Vasekar
psvasekar@prf.org

View online

-Outperforms existing technology under common but challenging conditions

Applications:

-Tracking the motion of single particles, such as protein, RNA and small molecules

-Constructing 2D or 3D maps/models of dynamic biological systems

TRL: 4

Intellectual Property:

Provisional-Gov. Funding, 2024-11-25, United States

Keywords: Biomedical Engineering, Computer Technology, deep learning, single particle tracking, SPT