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Single Molecule Imaging Apparatus and Method for Noise and Interference Reduction

Interest in visualizing and analyzing individual biomolecules has increased significantly in the past twenty years or so, especially for DNA. Single molecule DNA imaging is critical for studying the biophysical and biochemical properties of DNA and for developing new applications. Typically DNA is imaged using fluorescence which has limited contrast and suffers from blinking and photobleaching, making it difficult to quantify the image intensity and study single molecules over a long time. Moreover fluorescent tags may interfere with binding sites on DNA.

Prof. Nongjian Tao at the Biodesign Institute of Arizona State University has developed a novel label-free technique and apparatus for imaging single molecules, including DNA. This system produces high contrast images and removes background noises and interference, allowing for quantitative analysis of individual molecules. A novel deconvolution algorithm was further developed to accurately measure the length of stretched DNA molecules. Optical mapping, a technique for obtaining high-resolution genome wide restriction maps of single DNA molecules, is also enabled with this system.

Removing all the noises and interference patterns of the entire optical system allows for superior image contrast, making this method and apparatus a potentially very valuable tool in single molecule imaging and analysis.

Potential Applications

- Single molecule imaging (DNA, proteins, peptides, RNA, carbohydrates, enzymes, lipids, etc.)
- Quantitative analysis of individual DNA molecules
  - Measuring the length of stretched DNA
  - Measuring the intrinsic mass density distribution of DNA
- Optical mapping of DNA molecules

Benefits and Advantages

- Background noises and unwanted interference patterns are removed
- The image has a highly stable contrast many orders of magnitude greater than conventional bright field optical microscopy imaging
- Intrinsic physical characteristics of DNA are measured instead of the label
- Higher signal to noise ratios than fluorescent imaging
- The image contrast measures the intrinsic mass density distribution of DNA molecules - providing quantitative information about the sample molecule
- Imaging is fast and compatible with micro- and nano-fluidic devices

For more information about the inventor(s) and their research, please see Dr. Tao's directory webpageDr. Tao's laboratory webpage Dr. Tao's Biodesign directory webpage