Control Mechanism for Maintaining an Optical Antenna in a Laser Focus

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The goal of this project is to develop a control mechanism for maintaining a nanoscale object inside a tightly focused laser beam. This control mechanism will be used in scanning near-field optical microscopy (SNOM).

In SNOM, an optical antenna is positioned into a laser focus in order to generate a localized near-field interaction with a sample surface (figure a). Optical imaging with nanoscale resolution is achieved by raster scanning the sample underneath the stationary antenna [1].

Over time, due to thermal fluctuations and unfavorable material properties, the optical antenna tends to drift out of the focus, degrading the quality of the near-field image. Therefore, a feedback mechanism is required to actively control the position of the optical antenna within the laser focus. Due to the high degree of symmetry with both the optical focus and antenna, the symmetry of the reflected focal spot, distorted by the optical antenna, forms an ideal feedback signal (figure b).

In this project an image-processing algorithm will be developed that is capable of tracking the location of the tip and applying the appropriate voltages to an X-Y piezoelectric transducer to insure that the optical antenna remains in the laser focus. The feedback will be programmed and simulated using NI LabVIEW prior to being experimentally implemented.

(a) Illustration of a SNOM setup. (b) Optical image of the reflected optical focus with a properly positioned antenna.


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Prerequisites: Basic knowledge of computer programming and image processing.