Optimum path: tracking fluorescent nanoparticles using laser

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(Phys.org)—NIST Center for Nanoscale Science and Technology researchers Gregg Gallatin and Andrew Berglund (now at Quantifind in Palo Alto, CA) have determined the optimum path in which to scan a laser beam in order to track a fluorescing nanoparticle as the particle moves inside a fluid or gas in two or three dimensions.

The ability to accurately track nanoparticles is extremely useful in biology, in fluid dynamics at the nanoscale, and in nanotechnology generally. In biology, for example, if one or more fluorescing nanoparticles are attached to a protein inside a cell then the position and orientation of that protein can be tracked as it performs its functions inside the cell. In nanofabrication, many techniques involve nanoparticles or nanostructures coalescing to form useful materials or devices and optimizing these processes requires accurate data on how these nanostructures move. The path derived by the researchers is considered optimal because it yields the most accurate possible data on the nanoparticle's position as a function of time.

The researchers developed a simple formula for determining the overall positional accuracy as a function of various standard laser beam parameters such as beam intensity and beam size. The formula for the optimum path was derived using a classical mathematical technique, the calculus of variations, and the resulting solution was verified by showing that it satisfies the conditions of global optimality (i.e. it is the best solution among all possible solutions) using the theory of optimal experimental design. The positional accuracy was determined using

classical statistical methods. Interestingly, although the path can be smooth in two dimensions, in three dimensions the beam needs to hop to achieve optimality.

While the accuracy formula was derived for the most common laser beam shape, a Gaussian, the researchers are expanding the work to show how changing the laser beam's shape can further improve the tracking accuracy.

More information: Optimal laser scan path for localizing a fluorescent particle in two or three dimensions, G. M. Gallatin and A. J. Berglund, *Optics Express* 20, 16381–16393 (2012). www.opticsinfobase.org/abstrac … m?uri=oe-20-15-16381

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