A Scanning Probe Nanomanipulator

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Scanning probe microscopy (SPM) provides 3D images at the nanoscale with unprecedented resolution, enabling the manipulation of nanometer-scale objects in a variety of ways with the tip of the SPM. The forces required to manipulate objects at the nanoscale are so foreign to researchers that little or no intuition is available to aid in the design and implementation of novel experiments. To address this problem, a collaborative research initiative is underway at Purdue that combines a haptic interface with an ambient Nanotec scanning probe microscope. The haptic interface transduces the nanonewton forces acting on the SPM tip into forces that are felt by the user in real time. At present, we are using a three degree-of-freedom PHANToM force-feedback interface to control SPM tip position. In the future, we will incorporate a six degree-of-freedom DELTA haptic interface that has the additional capability of torque feedback. This research is developing a state-of-the-art nanomanipulation instrument combined with a versatile haptic interface to produce a nanoworkbench that provides the user with real time manipulation of nano-scale objects. While manipulation is underway, a data acquisition module accumulates frictional, compressive and electrostatic properties of matter at the nanoscale. This capability will enable not only the measurement and feel of relevant forces influencing objects at the nanoscale, but it will also lead to a better understanding of the properties of different classes of materials in the nanoworld.