Digital Control of a Near-Field Scanning Optical Microscope

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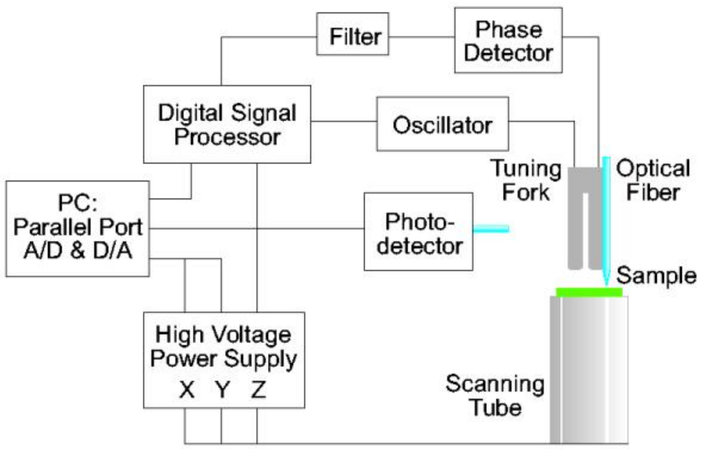
Concept

A digital control scheme for keeping a constant separation between the tip of an optical fiber probe and the sample surface in a near-field scanning optical microscope.

The forces of interaction change the resonance frequency of a piezoelectric tuning fork as it approaches the sample surface.

The frequency and distance control systems are realized by DSP algorithms

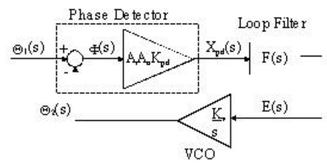
Using a high Q resonator as distance sensor gives improved sensitivity, accuracy, and scanning speed.

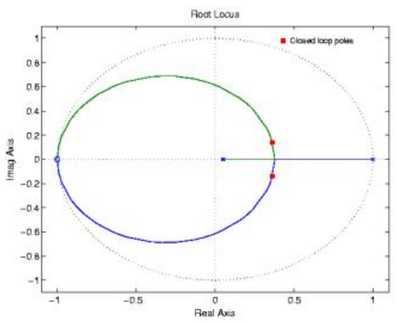


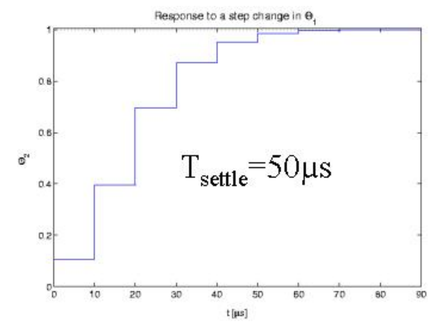
Scanning near-field optical microscope setup.

- Frequency control loop tracks resonance frequency of tuning fork.
- Distance control loop maintains constant separation between fiber tip and sample surface.

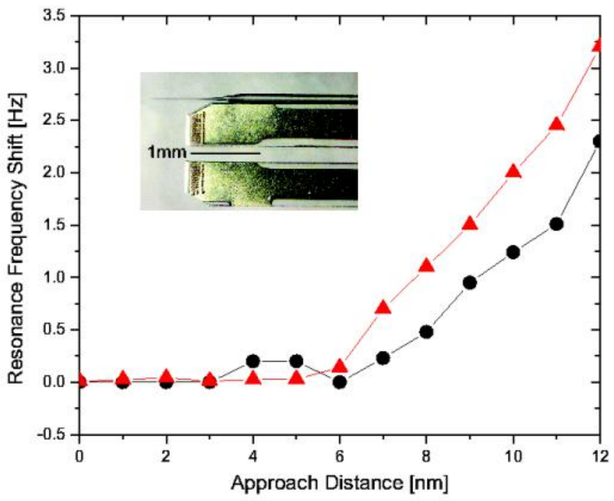
Frequency Control Loop



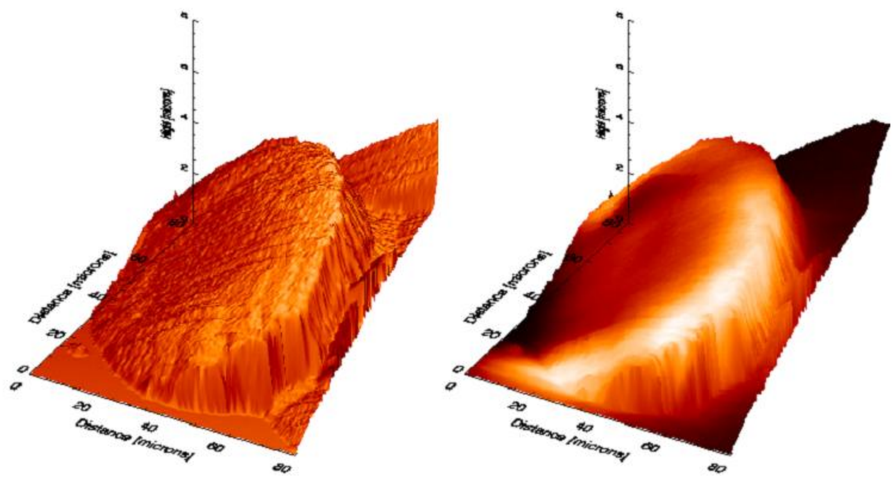




- Discrete realization of a second order PLL.
- DSP implementation of loop filter and VCO.
- Oscillation signal generation by direct digital synthesizer.



Photograph of a tuning fork with attached optical fiber probe used as a distance sensor.
Approach curves showing the change in resonance frequency of two different distance sensors with respect to the distance.



Surface scan and light emission emission below threshold of a Vertical Cavity Surface Emitting Laser (VCSEL) with 50µm diameter.

Distance Control Loop

- Discrete realization of set point PID controller.
- Settling time: 157 µs, Overshoot: 0.03%