Nanotechnology, IEEE Transactions on

Volume: 11, Issue: 1 Page(s): 21 - 33

Hui Xie, Régnier, S.
Inst. des Syst. Intelligents et Robot., Univ. Pierre et Marie Curie, Paris, France

High-Efficiency Automated Nanomanipulation With Parallel Imaging/Manipulation Force Microscopy

The atomic force microscope (AFM) has been widely used to manipulate nanoparticles, nanowires, and nanotubes for applications such as nanostructure building, nanocharacterization, and biomanipulation. However, conventional AFM-based nanomanipulation is inefficient because of the serial scan-manipulation-scan process involved. In this paper, high-efficiency automated nanomanipulation with a parallel imaging/manipulation force microscope (PIMM) is presented. With the PIMM, image scan and nanomanipulation can be performed in parallel through the collaboration between two cantilevers: one cantilever acts as an imaging sensor and the other is used as a manipulating tool. Two automated manipulation schemes were introduced for normal- and high-speed image scanning, respectively. An automated parallel manipulation task is managed by system control software with multithread through a procedure of dynamic image processing, task planning, two-tip collaboration, and a controlled pushing manipulation with amplitude feedback from the cantilevers. The efficiency of automated parallel nanomanipulation with normal-speed image scanning was validated by building nanoparticle patterns.

Volume: 11, Issue: 1 Page(s): 200 - 207

Kuscu, M.; Akan, O.B.
Dept. of Electr. & Electron. Eng., Koc Univ., Istanbul, Turkey

A Physical Channel Model and Analysis for Nanoscale Molecular Communications With Förster Resonance Energy Transfer (FRET)

In this study, a novel and physically realizable nanoscale communication paradigm is introduced based on a well-known phenomenon, Förster resonance energy transfer (FRET), for the first time in the literature. FRET is a nonradiative energy transfer process between fluorescent molecules based on the dipole-dipole interactions of molecules. Energy is transferred rapidly from a donor to an acceptor molecule in a close proximity such as 0 to 10 nm without radiation of a photon. Low dependence on the environmental factors, controllability of its parameters, and relatively wide transfer range make FRET a promising candidate to be used for a high-rate nanoscale communication channel. In this paper, the simplest form of the FRET-based molecular communication channel comprising a single transmitter-receiver nanomachine pair and an extended version of this channel with a relay nanomachine for long-range applications are modeled considering nanomachines as nanoscale electromechanical devices with some sensing, computing, and actuating capabilities. Furthermore, using the information theoretical approach, the capacities of these communication channels are investigated and the dependence of the capacity on some environmental and intrinsic parameters is analyzed. It is shown that the capacity can be increased by appropriately selecting the donor-acceptor pair, the medium, the intermolecular distance, and the orientation of the molecules.
Sub-0.1 nm-resolution quantitative scanning transmission electron microscopy without adjustable parameters

Atomic-resolution imaging in the scanning transmission electron microscope (STEM) constitutes a powerful tool for nanostructure characterization. Here, we demonstrate the quantitative interpretation of atomic-resolution high-angle annular dark-field (ADF) STEM images using an approach that does not rely on adjustable parameters. We measure independently the instrumental parameters that affect sub-0.1 nm-resolution ADF images, quantify their individual and collective contributions to the image intensity, and show that knowledge of these parameters enables a quantitative interpretation of the absolute intensity and contrast across all accessible spatial frequencies. The analysis also provides a method for the in-situ measurement of the STEM’s effective source distribution.

Real-time observation of Escherichia coli cells under irradiation with a 2-MeV H+ microbeam

A high-energy H+ microbeam generated by tapered glass capillary optics was applied to a single Escherichia coli cell, in order to evaluate the effects of irradiation on the activity of the flagellar motor and cell growth in real time. The flagellar motor of the tethered cells was stopped by irradiation with an average ion fluence of $2.0 \times 10^{12}$ protons/cm$^2$. When a lower dose was applied to the cells attached to the substrate, an elongated cell, which seemed ready to divide, divided into two daughter cells; however, the daughter cells did not elongate, neither did further cell division occur.
Absorption efficiency of gold nanorods determined by quantum dot fluorescence thermometry

In this work quantum dot fluorescence thermometry, in combination with double-beam confocal microscopy, has been applied to determine the thermal loading of gold nanorods when subjected to an optical excitation at the longitudinal surface plasmon resonance. The absorbing/heating efficiency of low (~3) aspect ratio gold nanorods has been experimentally determined to be close to 100%, in excellent agreement with theoretical simulations of the extinction, absorption, and scattering spectra based on the discrete dipole approximation.

Two-photon fluorescence properties of curcumin as a biocompatible marker for confocal imaging

Two-photon (TP) fluorescence properties of an antioxidant and anti-tumor molecule, curcumin, were investigated. The two-photon absorption (TPA) action cross-section was measured in organic solvents and found to be 6 GM in tetrahydrofuran and 2 GM in dimethyl sulfoxide. The measured TPA cross-section is comparable to that of rhodamine 6G. One-photon and TP confocal microscopy has demonstrated that curcumin is internalized in cells and can be used for imaging applications. Our investigation indicates that curcumin is a viable biocompatible TP fluorescent marker.

High potential sensitivity in heterodyne amplitude-modulation Kelvin probe force microscopy

A surface potential measurement method using amplitude-modulation and heterodyne techniques is proposed. The effect of the stray capacitance between a cantilever and a sample in Kelvin probe force microscopy and the electrostatic force spectroscopy measurements are almost completely removed,
because the distance \((z)\) dependence of the modulated electrostatic force increases from \(1/z\) to \(1/z^2\). This method improves the sensitivity of short range forces and reduces the surface potential measurement crosstalk that is induced by topographic feedback. This method has the advantage of high potential sensitivity due to the high cantilever Q value under vacuum. Quantitative surface potential measurements are demonstrated.

**Systems & Control Letters**

*Volume 61, Issue 7, July 2012, Pages 766 – 772*

Huanyu Zhaoa, Wei Renb, Deming Yuanc, Jie Chend

a Faculty of Electronic and Electrical Engineering, Huaiyin Institute of Technology, Huaian 223003, Jiangsu, PR China
b Department of Electrical Engineering, University of California, Riverside, CA 92521, USA
c School of Automation, Nanjing University of Science and Technology, Nanjing 210094, Jiangsu, PR China
d School of Automation, Beijing Institute of Technology, Beijing 100081, PR China

**Distributed discrete-time coordinated tracking with Markovian switching topologies**

This paper deals with the distributed discrete-time coordinated tracking problem for multi-agent systems with Markovian switching topologies. In the multi-agent team, only some of the agents can obtain the leader’s state directly. The leader’s state considered is time varying. We present necessary and sufficient conditions for boundedness of the tracking error system and show the ultimate bound of the tracking errors. A linear matrix inequality approach is developed to determine the allowable sampling period and the feasible control gain. A simulation example is given to illustrate the effectiveness of the results.

*Volume 61, Issue 7, July 2012, Pages 788 – 796*

João Almeidaa, Carlos Silvestrea, b, António M. Pascoala,

a Institute for Robotics and Systems in Engineering and Science (LARSyS), Instituto Superior Técnico, Technical University of Lisbon, Av. Rovisco Pais 1, 1049-001 Lisboa, Portugal
b Faculty of Science and Technology, University of Macau, Taipa, Macau

**Continuous-time consensus with discrete-time communications**

This paper addresses the problem of reaching consensus among a group of agents that evolve in continuous-time and exchange information at discrete-time instants, referred to as update times. Each agent has its own sequence of update times and therefore the agents are not required to keep synchronized clocks among them. At each update time, an agent receives from a subset of the other agents their state, as determined by the communication topology that may be time-varying. Due to transmission delays, the information may be received by an agent with latency. In our proposed solution, the state of each agent is augmented with an extra state variable that is updated instantaneously at update times. Between updates, the original state and the extra variable both evolve in a continuous fashion. It is shown that consensus is reached asymptotically by reducing the original problem involving continuous-time variables and asynchronous communications to a discrete-time equivalent and using known results for discrete-time consensus.
Characterization of surface stiffness and probe–sample dissipation using the band excitation method of atomic force microscopy: a numerical analysis

Recently Jesse and co-workers introduced the band excitation atomic force microscopy (BE-AFM) method (Jesse et al 2007 Nanotechnology 18 435503), in which the cantilever probe is excited in a continuum frequency band in order to measure its response at all frequencies in the band. Analysis of the cantilever response using the damped harmonic oscillator model provides information on the stiffness and level of dissipation at the tip–sample junction as the sample is scanned. Since its introduction, this method has been used in magnetic, electromechanical, thermal and molecular unfolding applications, among others, and has given rise to a new family of scanning probe microscopy techniques. Additionally, the concept is applicable to any field in which measurement of the frequency response of harmonic oscillators is relevant. In this paper we present an analytical and numerical analysis of the excitation signals used in BE-AFM, as well as of the cantilever response under different conditions. Our analysis is performed within the context of viscoelastic characterization. We discuss subtleties in the cantilever dynamics, provide guidelines for implementing the method effectively and illustrate the use of simulation in interpreting the results.