Pro-Inflammatory Cytokines and Soluble Adhesion Molecules as Activating Triggers for Nanorobots

Lior Rosen, Adriano Cavalcanti, Moshe Rosenfeld, Shmuel Einav

Future developments in nanotechnology and molecular manufacturing will give birth to nanorobots - a new species of nanomachines, which will particularly be used in medicine for monitoring and therapeutic interventions inside the human body. Currently, simulations can assist in prototyping and design of nanorobots.

The coronary arteries are one of the most likely sites for atherosclerosis. Hence, the behavior and control of nanorobots flowing inside a stenosed LAD coronary artery model is simulated. The nanorobots are programmed to monitor the plasma concentrations of specific pro-inflammatory cytokines (such as IL-6), which may reflect the intensity of inflammation and determine plaque vulnerability. The nanorobots also monitor levels of soluble cellular adhesion molecules (such as sVCAM-1), whose transcardiac concentration gradient has been recently found to be correlative with the progression of coronary atherosclerosis. When a nanorobot senses elevated concentrations of these cytokines and adhesion molecules, it is activated, and follows their concentration gradients, terminating at their release source in the atherosclerotic plaque.

CFD simulations, followed by a practical 3D Nanorobot Control Design simulator, were used to test various cases, differing in stenosis severity, molecules concentration gradients, and plaque vulnerability. A design trade-off between measurement sensitivity and the time from activation until the nanorobot reaches its target is presented.

Author Information:

1. Lior Rosen, Tel Aviv University, Dept. of Biomedical Eng., email: lior@eng.tau.ac.il
2. Adriano Cavalcanti, Electrical and Computer Eng. School, Unicamp Campinas SP, Brazil, email: adrianocavalcanti@ieee.org
3. Moshe Rosenfeld, Tel Aviv University, Dept. of Fluid Mechanics and Heat Transfer, email: rosenf@eng.tau.ac.il
4. Shmuel Einav, Tel Aviv University, Dept. of Biomedical Eng., email: einav @eng.tau.ac.il

Suggested keywords:

1. nanorobots control simulation
2. coronary arteries
3. inflammatory cytokines
4. adhesion molecules