Thesis Title   Modeling Nanorobot Control for Blood Vessel Repair:
A Non-Newtonian Blood Model
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Abstract

Using nanorobots for medical diagnostics and treatment has been an intriguing idea since the concept of nanotechnology was introduced. However, the current nanotechnology could only construct simple components. More extensive researches will be required to develop the nanorobots and to testify their compatibility until they could work within human body. In this study, we simulated nanorobots demonstrating as artificial platelets repairing a blood vessel. This demonstration can be used as a guideline for future nanorobot implementation to help thrombocytopenia patients, who has low platelet count. The nanorobots, in this study, adopt the design of early-stage nanorobots that have only essential characteristics for moving around inside the blood vessel, finding the wound, and self-assembling at the injured area. Instead of the Newtonian flow model as in previous nanorobot study, this study used a non-Newtonian blood flow model to better simulate the actual blood flow as the environment of the nanorobots. However, for simplicity the blood vessel is modeled as a rigid blood vessel. The locomotion of nanorobots is controlled based on particle swarm optimization technique (PSO), which is inspired by the bird flocking; each of nanorobots makes its own decision based on both individual knowledge and social knowledge. Aiming to provide useful ideas toward the realization of nanorobots in the near future, we investigated the effect of different nanorobot abilities including perception range, maximum velocity and response speed on the performance of nanorobot system. Through simulating the nanorobots, it could be evidenced that the PSO control algorithm could perform well. The higher perception range gives the greater chance for nanorobots to find the wound. For the maximum velocity, the nanorobots should be able to travel with the maximum velocity about the same level as the blood velocity. At low maximum velocity, nanorobots can hardly accomplish the goal due to the high velocity range at the middle of bloodstream, which is the behavior of non-Newtonian fluid. In term of the response speed, with the faster response speed the nanorobots could better adjust themselves to the highly dynamic environment like in the bloodstream.