Abstract

The main goal of this thesis is to introduce an artificial model for real tissues to be used in a verity of medical applications. In this regard, we focused on needle-based surgeries to generate an optimal path for needle steering so that the needle avoids obstacles so it finally hits the target. The optimization is based on having six partial costs used in a Lyapanov cost function that is minimized by a Hopfield neural network. The proposed model considers non-homogeneity and uncertainty of the tissue. The needle has a sharp bevel tip with a highly flexible shaft. In order to illustrate the validation of the modeled tissue, 13 tests are designed. The simulation results show that the behavior of this artificial tissue is very similar to that of a real tissue. Also, in order to demonstrate the effectiveness of the proposed cost function, two completely different tests are designed to evaluate the optimization approach. The results also show that the newly proposed partial cost, namely “bevel-change cost”, has a strong effect on the optimized path.

Keywords: Tissue modeling, needle steering, path planning, optimization, Hopfield neural network.