The mixed coarse-grained elastic network model: an efficient tool to explore dynamics of supramolecular assemblages at high-resolution

Özge Kürkçüoğlu, Robert L. Jernigan, Pemra Doruker

aDepartment of Chemical Engineering and Polymer Research Center, Bogazici University, Bebek 34342, Istanbul, Turkey
bL.H. Baker Center for Bioinformatics and Biological Sciences, Iowa State University, Ames, IA 50011-3020, USA

The elastic network model with normal mode analysis is a popular method to explore the functionally important dynamics of biological systems at low resolution. The mixed coarse-grained elastic network model has been recently introduced to investigate the collective motions of especially large biological systems with high- (at atomistic detail) and low-resolution (coarse-grained) regions (1). This method has proved to be a computationally efficient tool for exploration of the dynamic motions of supramolecular assemblages at atomic detail, difficult to attain with conventional full-atom/empirical potential simulation techniques. In this method, the nodes of the elastic network, either an atom or a coarse-grained residue, that fall within a cutoff distance are linked by harmonic springs varying according to the node size since they are calculated based on the total number of atom pair contacts. In this work, the collective motions of two widely-studied systems, triosephosphate isomerase (TIM) as an extension of previous studies, and ribosome together with its A-, P-, E-tRNA and mRNA components are investigated. Our efficient algorithm reveals the biologically important motions of the studied systems, such as TIM’s “rigid lid” loop 6 opening/closing motion and the experimentally observed ratchet-like rotation of ribosome’s subunits, showing the reliability of the model. This method promises to be an efficient tool for flexible protein-ligand docking in drug design.

(1) Kurkcuoglu O, Jernigan RL and Doruker P, 2006, Loop Motions of Triosephosphate Isomerase Observed with Elastic Networks, Biochemistry 45, 1173-1182