ABSTRACT

The proposed research will investigate the fundamental properties of self-assembled nanoscale materials which enable the fusion of computation with physical, chemical, and biological systems. This work will leverage recent advances in the synthesis of DNA nanostructures and their application to drug delivery, computing, sensing, data storage, and cellular signaling that have created new opportunities to study, and control, matter and the flow of information at a molecular level in a variety of physical contexts. Through the precise arrangement of molecular components on DNA scaffolds, single-molecule characterization, and time-correlated single photon detection it is possible to design and test complex molecular sensing and computational functionality in realistic micro-environments, e.g., in cell culture. This work will build on these successes to create new molecular structures which integrate computational capabilities into a physical environment which could radically alter how we approach key national security problems, e.g., CBRN detection and mitigation. The broader impact of the work will also contribute to more secure and robust cyberphysical systems by enabling fundamentally new computational tools *on* physical objects and spaces. The impact will be significant and widespread as the fundamental insights generated by this basic research reveal paths toward designing, understanding, and building molecular-scale systems which enhance and create new mission capabilities by bringing sophisticated computational power to nearly every niche of the physical world.