MASTER OF SCIENCE
IN
PHYSICS

DETERMINATION OF MECHANICAL PROPERTIES OF NANO STRUCTURES USING MOLECULAR DYNAMIC SIMULATION

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Determining mechanical properties from microscopic forces has become important in the light of utilizing nano scale systems. The molecular dynamic model was used to determine the modulus of elasticity and shear modulus of pure metallic micro lattice structures. Preliminary results indicate that the modulii of elasticity is determined to within 15% accuracy for five different metals of 500-atom structures when compared to the experiment values of bulk materials. Furthermore, the elastic modulus for copper structures was computed with different temperatures, different magnitudes of stresses, and various kinds of dislocations. From the preliminary results, it is concluded that the model accurately determines the mechanical properties of the nano scale systems.

KEYWORDS: Molecular Dynamics, Paradyn, Quantum Mechanics, Modulus of Elasticity, Shear Modulus, Modulus of Rigidity

GENETIC ALGORITHM DESIGN AND TESTING OF A RANDOM ELEMENT 3-D 2.4 GHZ PHASED ARRAY TRANSMIT ANTENNA CONSTRUCTED OF COMMERCIAL RF MICROCHIPS

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The United States Navy requires radical and innovative ways to model and design multi-function phased array radars. This thesis puts forth the concept that Genetic Algorithms, computer simulations that mirror the natural selection process to develop creative solutions to complex problems, would be extremely well suited in this application. The capability of a Genetic Algorithm to predict adequately the behavior of an array antenna with randomly located elements was verified with expected results through the design, construction, development and evaluation of a test-bed array. The test-bed array was constructed of commercially available components, including a unique and innovative application of a quadrature modulator microchip used in commercial communications applications. Corroboration of predicted beam patterns from both Genetic Algorithm and Method of Moments calculations was achieved in anechoic chamber measurements conducted with the test-bed array. Both H-plane and E-plane data runs were made with several phase-steered beams. In all cases, the measured data agreed with that predicted from both modeling programs. Although time limited experiments to beam forming and steering with phase shifting, the test-bed array is fully capable of beam forming and steering though both phase shifting and amplitude tapering.

KEYWORDS: Phased Array, Antenna, Radar, Radar Design, Air Search Radar, Evolutionary Computation, Genetic Programming, Genetic Algorithms, Theater Ballistic Missile Defense (TBMD), Area Air Defense, Fleet Air Defense (FAD)