MASTER OF SCIENCE
IN
APPLIED MATHEMATICS

FORMATION CONTROL OF MULTI-SATELLITE SYSTEMS

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The concept of satellite formation has been studied in recent years as a method of improving high-resolution imaging capability. In contrast to the relatively simple single satellite model, a more innovative control mechanism must be developed for the purpose of stability and accurate synchronization of multi-satellite systems. A two-satellite system is adopted as our test model because the design criteria for both the multi-satellite and two-satellite systems are similar. To generate a more realistic appraisal of our model, random noise and unexpected errors are incorporated in the simulations. In addition to modeling, a formation controller is designed. Simulations are carried out to check the formation stability and the performance robustness in the presence of tracking error and measurement noise. All the simulations are based on Simulink.

DoD KEY YECHNOLOGY AREA: Command, Control, and Communications

KEYWORDS: Satellite, Formation, Control

AN EVALUATION OF HNeT (HOLOGRAPHIC QUANTUM NEURAL TECHNOLOGY) SOFTWARE PACKAGE

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This thesis investigates the properties of a software package called HNeT (Holographic/Quantum Neural Technology) which is based on the use of an artificial intelligence tool called Neural Networks. The basis for the investigation of this software is to establish its reliability, effectiveness and efficiency. Neural technology is a technological replication of the biological neural system designed to learn data patterns and process the data (stimulus) and then generate a response based on the memory of the data. HNeT theory is fundamentally different from the standard Artificial Neural System (ANS) in that it uses complex scalars to evaluate internal mappings of one set of values (stimuli) to another set of values (responses). HNeT employs a process known as *enfolding,* which allows the learning and subsequent recall of many stimulus-response associations to be compressed into a single HNeT neuron cell improving the speed of learning and recall accuracy as well as reducing storage requirements. Whereas the traditional ANS stores stimulus patterns separately as a reference template within a cell and are compared one at a time to a new incoming stimulus response pattern which in this case, requires larger amounts of memory.

DoD KEY TECHNOLOGY AREA: Computing and Software

KEYWORDS: Artificial Neural Networks, HNeT, Enfolding, Adaline, Madaline

INVISCID AERODYNAMIC PREDICTIONS OF HYPERSONIC ELLIPTICAL PROJECTILES: A COMPARATIVE STUDY OF THE EFFECTS OF STABILIZING SURFACES

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With the advent of “smart” munitions, the U.S. and its allies are attempting to design more accurate tactical weapons. Of interest are relatively inexpensive barrel-launched projectiles capable of accuracy associated with guided munitions. This research studies potential configurations for a new class of kinetic energy projectiles.

From past research, it has been shown that projectiles with elliptical cross-sections are more stable in flight than those with circular cross-sections. This research looks at one particular shape, an elliptical cone, and numerically predicts the aerodynamic attributes in inviscid, steady, hypersonic flow. In particular, the effects of different stabilizing surface configurations are evaluated. A residual benefit of this research is to show that ZEUS, an afterbody solver typically used for missile design, is capable of providing solutions for these configurations.

The findings of this research will be delivered to the Chief, Aerodynamics Branch, Army Research Laboratory, and will fulfill part of ARL’s commitment in a Key Technical Area agreement with the research laboratories of our allies.

DoD KEY YECHNOLOGY AREAS: Conventional Weapons, Modeling and Simulation

KEYWORDS: CFD, Inviscid, Aerodynamics, Hypersonic, Projectiles, Strakes, Flares