Learning Mesh-Based Simulations for Predicting Weapon Effects

Project Summary

Overview

This topic will address the fundamental challenges in real-time prediction of weapon effects (such as a tradeoff between precision and speed). Currently weaponeers rely on engineering models for lethality. These are low-fidelity models calibrated to a subset of munitions and environments. The resulting uncertainty often requires overallocation of munitions, which reduces the warfighter's capabilities against adversaries. High fidelity simulations can reduce uncertainty but are too computationally intensive and time consuming to be used by weaponeers. The proposed research will utilize recent advances in Machine Learning (ML) methods to rapidly provide surrogate data to weaponeers (based on offline training on high fidelity simulation data). Specifically, selected scholars will learn how to apply MeshGraphNets to learn and predict mesh-based finite element simulations. Also, the scholars will compare MeshGraphNets with other ML methods. The scholars will advance their ability to code and perform numerical analysis. This work will provide the scholars valuable experience with state-of-the-art code for ML and high-fidelity simulations.

Project Description

Introduction

Proposed Study

Propose the usage: the usage of mesh graph net as a replacement for simulation for analyzing operational deployment of ordinance

Purpose of the memo and study: Clearly state the reason for writing the memo and the objectives of the proposed study.
Background information: Provide a brief overview of the project or problem that the study aims to address.
Scope of the study: Outline the boundaries and limitations of the proposed study to set expectations for the readers.
Importance of the study: Explain why this study is crucial for the project or the organization.

Current State Of The Technology

Existing technology overview: Provide an overview of the current technology, methodologies, or processes related to the subject matter.
Strengths and weaknesses: Identify the advantages and limitations of the current technology, highlighting areas that need improvement.
Industry trends: Briefly mention any emerging trends or advancements in the field that are relevant to the study.
Gap analysis: Identify the gaps between the existing technology and the desired goals to show the need for further investigation.

Intended Impact

Project objectives: Clearly state the intended outcomes and objectives of the proposed study.
Potential benefits: Explain the potential positive impacts the study could have on the project, organization, or industry.
Risk assessment: Address any potential risks or challenges that may arise during the study and how they will be mitigated.
Timeline and resources: Provide an overview of the estimated timeline and resources required to conduct the study.

Background

Nueral Networks

Graphs

Meshgraphnets

Code Base

Nueral Networks

Graphs

Meshgraphnets

Results

Metrics

Test Model: CFD

Test Model: Impact

References Cited